United States Department of the Interior
FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
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Sacramento, California 95825-1846

In reply refer to:
81420-2009-F-1036

DEC 18 2009

Memorandum

To: Area Manager, South Central California Area Office, Mid-Pacific Region, U.S. Bureau of Reclamation, Fresno, California

From: for Field Supervisor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California

Subject: Endangered Species Consultation on the Proposed Continuation of the Grassland Bypass Project, 2010 – 2019

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 July 21, 2009, on the potential effects to listed species from the third Use Agreement for the Grassland Bypass Project (GBP Extension), Fresno and Madera Counties, California. Your request was received in our office on July 22, 2009. This document represents the Service's biological opinion on the effects of the action on the endangered San Joaquin kit fox (*Vulpes macrotis mutica*), and on the threatened giant garter snake (*Thamnophis gigas*). Critical habitat has not been designated for the giant garter snake or San Joaquin kit fox. This response has been prepared pursuant to section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*), and in accordance with the regulations governing interagency consultations (50 CFR §402).

Reclamation has determined that the proposed action will have no effect on the federally listed species or critical habitats identified in Table 1 below and is not requesting concurrence with those determinations. Reclamation did not request Service concurrence with this determination, and as a result, these species are not considered further in this biological opinion. However, in the spirit of interagency cooperation, the Service would like to take this opportunity to discuss in more depth one of the species included in Reclamation's 'no effect' determination.

One of the primary functions of the Grasslands Bypass Project is to discharge contaminated agricultural drainwater into the San Joaquin River, which ultimately passes into the downstream Sacramento-San Joaquin Delta and various water bodies of the North Bay (*e.g.* Suisun Bay). These waters support the threatened Delta smelt (*Hypomesus transpacificus)* and include the smelt's designated critical habitat. Although current scientific opinion suggests that Delta smelt are not at significant risk for selenium and mercury toxicity under current loads and ecosystem dynamics, there is still uncertainty with respect to the ultimate environmental fate and ecosystem impact of selenium, salt and mercury discharges into the San Joaquin River (including those from the proposed action). These discharges presently impact already impaired downstream water bodies used by Delta smelt, and may be of significance if environmental fate dynamics are significantly altered under future proposed activities (including but not limited to the Bay Delta Conservation Plan). In the 2001 biological opinion of the previous renewal of the Grassland Bypass Project (Service File No. 01-F-0153), the Service concluded with respect to Delta smelt:

In the 2001 biological opinion of the previous renewal of the GBP (Service File No. 01-F-0153), the Service concluded with respect to Delta smelt:
"*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.*"

"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 regulations on interagency cooperation (50 CFR 402.14) state that formal consultation is required when an action *may affect* listed species or critical habitat (italics added). Based on this requirement, the information presented above, and the fact that Reclamation included the Delta smelt in its Biological Assessment (BA) for the GBP Extension, the Service believes that the smelt would more appropriately fall under the ‘may affect’ category, with the subsequent required analysis of whether or not the project is likely to adversely affect the species.

As explained in the Service’s 1998 Consultation Handbook on conducting section 7 consultations, an action agency’s determination of ‘no effect’ is within its purview and discretion, and no further action or response is required from the agency or the Service regarding the Act. Therefore, the Service is only providing this response to offer our perspective on this aspect of consultation for the proposed project. However, should Reclamation decide to re-evaluate its ‘no effect’ determination for the smelt, the Service is available to assist in any way.

The Service appreciates the efforts Reclamation has made on behalf of the San Joaquin kit fox under section 7 (a)(1) of the Act, including creation of escape dens in kit fox habitat and the work done toward a GIS-based, scientifically viable movement corridor model for the northern population. The Service commits to continue to provide assistance and acknowledgement as requested by Reclamation in the performance of future 7 (a)(1) actions.

Table 1. Threatened and endangered species and/or critical habitat potentially within the Action Area that Reclamation determined would not be affected by the proposed action.

Common Name	Scientific Name	Status[1]
Antioch Dunes evening-primrose	*Oenothera deltoides ssp. howellii*	E, H
Colusa grass	*Neostapfia colusana*	T, H
Contra Costa goldfields	*Lasthenia conjugens*	E, H
Contra Costa wallflower	*Erysimum capitatum ssp.angustatum*	E, H
Hoover's spurge	*Chamaesyce hooveri*	T, H
Palmate-bracted bird's-beak	*Cordylanthus palmatus*	E
Soft bird's-beak	*Cordylanthus mollis ssp. mollis*	E
Delta green ground beetle	*Elaphrus viridis*	T
Lange's metalmark butterfly	*Apodemia mormo langei*	E
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	T
Conservancy fairy shrimp	*Branchinecta conservatio*	E, H
Longhorn fairy shrimp	*Branchinecta longiantenna*	E, H
Vernal pool fairy shrimp	*Branchinecta lynchi*	T, H
Vernal pool tadpole shrimp	*Lepidurus packardi*	E, H
Delta smelt	*Hypomesus transpacificus*	T, H
Alameda whipsnake	*Masticophis lateralis euryxanthus*	T, H
Blunt-nosed leopard lizard	*Gambelia (=Crotaphytus) sila*	E
California red-legged frog	*Rana aurora draytonii*	T, H
California tiger salamander	*Ambystoma californiense*	T, H
California clapper rail	*Rallus longirostris obsoletus*	E
Fresno kangaroo rat	*Dipodomys nitratoides exilis*	E, H
Giant kangaroo rat	*Dipodomys ingens*	E
Riparian brush rabbit	*Sylvilagus bachmani riparius*	E
Riparian woodrat	*Neotoma fuscipes riparia*	E
Salt marsh harvest mouse	*Reithrodontomys raviventris*	E, H

[1] Status: (E) Endangered; (T) Threatened; (H) Designated Critical Habitat; (PH) Proposed Critical Habitat

This biological opinion is based on information provided in the July 2009 BA, *Grassland Bypass Project, 2010 – 2019, Merced and Fresno Counties, California* (USBR 2009); the Final and Draft Environmental Impact Statement and Environmental Impact Reports (EIS/R) prepared for the Reclamation and the Water Authority dated August 2009 and December 2008, respectively; the Third Agreement for the Use of the San Luis Drain (SLD) included as Appendix A of the FEIS/R; e-mail and telephone conversations between the Reclamation and the Service; meetings with the Central Valley Regional Water Quality Control Board (CVRWQCB); meetings with Reclamation, Summer's Engineering and H.T. Harvey and Associates; annual wildlife monitoring reports from the San Joaquin River Improvement Project's (SJRIP) drainage reuse area prepared by H.T. Harvey and Associates for the Water Authority and Grassland Basin Drainers (GBD)**;** the 2003 and 2007 Status Reports on compliance with the 2001 Biological Opinion on the GBP prepared by Reclamation, South-Central California Area Office, and the Grassland Area Farmers on behalf of the San Luis and Delta-Mendota Water Authority; annual, quarterly and monthly reports of the GBP compiled by the San Francisco Estuary Institute for the GBP Oversight Committee; a field tour of the Grasslands Bypass Project Area on April 6, 2000; a site visit by Dr. Joseph Skorupa of the Service's Sacramento Fish and Wildlife Office (SFWO) to the In-Valley- Treatment site of the GBP on May 22, 2001; Amendments to the 1996 Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) for the Control of Agricultural Subsurface Drainage Discharges (Grassland Amendments); the Staff Report of the CVRWQCB on the Review of Selenium Concentrations in Wetland Water Supply Channels in the Grassland Watershed, dated May 2000; the Mitigated Negative Declaration (MND) and Initial Study (IS) for *the San Joaquin River Water Quality Improvement Project,* dated 2007; the FEIS and ROD for the *San Luis Drainage Feature Re-evaluation* dated 2006*;* the DEIS and Supplemental Document for the *San Luis Unit Long Term Contract Renewals* dated 2005 and 2006; the Final Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) and IS on the *Groundwater Pumping/Water Transfer Project for 25 Consecutive Years,* prepared for Reclamation and the San Joaquin River Exchange Contractors Water Authority (SJRECWA), dated 2007; the FEIS and ROD for the *10-Year Water Transfer Program for the San Joaquin River Exchange Contractors Water Authority 2005 – 2014* dated 2004**;** the Final EA for the *Meyers Farms Groundwater Banking Project*, dated 2005; the FEIS for the *Mendota Pool Exchange Agreement* dated 2004; the California Toxics Rule (CTR) issued by the U.S. Environmental Protection Agency (USEPA) on May 18, 2000 (65 FR 31682), the Services' Biological Opinion on the CTR (Service File No. 98-F-21); the December 16, 1999 letter from USEPA to the Service and the National Marine Fisheries Service (NMFS) providing environmental commitments to conclude formal consultation on CTR; the Service's consultation with the USEPA and final Biological Opinion on the *Grassland Amendments* (Service File No. 00-F-0054); and other sources of information. A complete administrative record of this consultation is on file in the Service's SFWO.

CONSULTATION HISTORY

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

September 11, September 25 and October 26, 1995: The Service informally consulted on the proposed construction of the SLD/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 determination of "not likely to adversely affect" for the giant garter snake, providing Reclamation's proposed conservation measures during construction were followed. The Service recommended a selenium monitoring program, and toxicological studies to ascertain effects to delta smelt (Service File Nos. 95-I-1462 and 95-I-67).

November 3, 1995: Reclamation and the Water Authority signed an "Agreement for Use of the SLD". This Use Agreement and its extension in 1999 allowed the use of the SLD for the GBP for a five-year period that concluded September 30, 2001.

June 6, 1996: Informal consultation on the Operation and Maintenance of the SLD.

September 30, 1999: Reclamation asked the Service's SFWO for assistance in preparing a biological effects section of a combined EIS/R for continuation of the GBP from 2001 to 2009.

February 8, 2000: Reclamation requested that the Service develop a draft BA for the GBP.

February 9, 2000: Service's SFWO provided a list of 23 animal species (five mammals, three birds, two reptiles, 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 7.5 minute quadrangles of the action 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 BA to Reclamation.

January 31, 2001: Updated species list from the Service's SFWO.

February 16, 2001: Reclamation submitted a final BA to the SFWO's Endangered Species Division, and requested initiation of formal consultation.

September 28, 2001: The Service issues a Final Biological Opinion on the GBP, October 1, 2001 - December 31, 2009.

December 14, 2001: Panoche Drainage District transmits to the Service the *San Joaquin River Water Quality Improvement Project, Phase I, 2001 Wildlife Monitoring Report.*

February 4, 2002: Summers Engineering transmits via Fax to the Service information on siting of 30 mountain plovers at the SJRIP drainage reuse area.

December 5, 2003: HT Harvey and Associates transmits to the Service via e-mail the *San Joaquin River Water Quality Improvement Project, Phase I, 2002 Wildlife Monitoring Report*.

January 28, 2004: Summers Engineering transmits to the Service a facsimile regarding siting of 60 mountain plovers within the SJRIP drainage reuse area of the GBP.

February 11, 2004: Reclamation transmits to the Service the *First GBP Biological Opinion Status Report*, Service File No. 01-F-0153, prepared by Reclamation and the Grassland Area Farmers on behalf of the Water Authority.

September 24, 2004: Reclamation transmits to the Service via e-mail the *San Joaquin River Water Quality Improvement Project, Phase I, 2003 Wildlife Monitoring Report.*

March 2, 2005: Reclamation transmits to the Service a memo with Baseline survey of sediments and detritus in vernal pools along Mud Slough as required by the 2001 GBP biological opinion.

May 19, 2005: Summers Engineering transmits to the Service a letter with a summary of the mountain plover monitoring for 2005 within the SJRIP drainage reuse area of the GBP.

May 20, 2005: Panoche Drainage District transmits to Reclamation the *San Joaquin River Water Quality Improvement Project, Phase I, 2004 Wildlife Monitoring Report.*

August 11, 2006: Reclamation transmits to the Service the *San Joaquin River Water Quality Improvement Project, Phase I, 2005 Wildlife Monitoring Report.*

December 13, 2006: The Water Authority transmits a memo to Reclamation regarding the Agreement for Use of the SLD, and provides notice that sufficient funding has not yet been dedicated to meet the 2010 Mud Slough compliance date for selenium. As a result, the memo concludes, the Grassland Basin Drainers may need to continue discharges to the San Joaquin River beyond the term of the current Use Agreement, which expires in December 2009.

March 29, 2007: Representatives of the Service meet with meet with Panoche Drainage District, Firebaugh Canal Water District, Summers Engineering and the Water Authority regarding a possible extension of the GBP.

April 9, 2007: Panoche Drainage District transmits to Service the 2007 Mountain Plover Monitoring Report for the SJRIP drainage reuse area.

May 25, 2007: The Service transmits a letter to Panoche Drainage District requesting an extension of the California Environmental Quality Act (CEQA) comment period on the *Mitigated Negative Declaration and Initial Study for San Joaquin River Water Quality Improvement Project Phase I, Part 2*.

June 8, 2007: Representatives of the Service, California Department of Fish and Game (CDFG), Water Authority, Summers Engineering, HT Harvey and Associates, and URS Corporation participate in a conference call discussing questions raised in the Service's May 27, 2007 letter on the *Mitigated Negative Declaration and Initial Study for San Joaquin River Water Quality Improvement Project Phase I, Part 2*.

July 10, 2007: Panoche Drainage District transmits letter to the Service responding to questions raised by the Service on the June 8, 2007 conference call.

July 11, 2007: Summers Engineering transmits e-mail to the Service with information responding to questions raised by the Service on the June 8, 2007 conference call.

July 16, 2007: Reclamation transmits to the Service the *Second GBP Biological Opinion Status Report* , Service File No. 01-F-0153.

August 16, 2007: The Service transmits a letter to Panoche Drainage District with formal comments on the *Mitigated Negative Declaration and Initial Study for San Joaquin River Water Quality Improvement Project Phase I, Part 2* including a recommendation that Panoche Drainage District seek incidental take authority with regard to San Joaquin kit fox and giant garter snake, and that reinitiation of consultation on GBP Biological Opinion "is warranted."

August 29, 2007: Summers Engineering transmits responses to comments on the *Mitigated Negative Declaration and Initial Study for San Joaquin River Water Quality Improvement Project Phase I, Part* along with a copy of the adopted MND.

October 8, 2007: Summers Engineering transmits initial giant garter snake survey report for the SJRIP to the Service.

November 15, 2007: Panoche Drainage District transmits the *San Joaquin River Water Quality Improvement Project, Phase I Wildlife Monitoring Report 2006* to the Service.

November 28, 2007: Representatives of the Service and Reclamation meet with representatives of Panoche Drainage District and the Water Authority regarding the status of the GBP Extension development process including actions to mitigate wildlife use at the SJRIP drainage reuse area.

December 20, 2007: The Water Authority and Reclamation file a Notice of Preparation with the State Clearinghouse regarding their intent to prepare a DEIS/R for the Continuation of the GBP , 2010-2019.

January 16, 2008: The Service transmits a letter to Summers Engineering providing comments on the report titled *Giant garter snake survey Report Per Biological Opinion for the Grassland Bypass project Operation in Merced and Fresno counties, file number 01-F-0153.*

March 14, 2008: Panoche Drainage District transmits to Service the 2008 Mountain Plover Monitoring Report for the SJRIP drainage reuse area.

April 17, 2008: HT Harvey and Associates transmits to the Service and requests comments on a proposal for giant garter snake surveys in the SJRIP drainage reuse area.

April 23, 2008: The Service transmits email to HT Harvey and Associates authorizing further giant garter snake surveys in the SJRIP drainage reuse area.

May 7, 2008: Representatives of the Service meet with Panoche Drainage District and the Water Authority regarding update on GBP Extension.

May 15, 2008: HT Harvey and Associates transmits to the Service via e-mail an update on progress of giant garter snake surveys and a request for input on tiered contaminants monitoring program sampling for mammals and ongoing avian at the SJRIP drainage reuse area.

July 11, 2008: Panoche Drainage District transmits the *San Joaquin River Water Quality Improvement Project, Phase I Wildlife Monitoring Report 2007* to the Service.

October 14, 2008: The Service transmits a memo to Reclamation and Panoche Drainage District denying the request for concurrence that proposed construction at the SJRIP drainage reuse expansion area is not likely to adversely affect the federally-listed giant garter snake.

October 21, 2008: The Service transmits a memo to Reclamation and Panoche Drainage District providing comments on the SJRIP proposed tiered contaminant monitoring program.

November 12, 2008: The Service attends and provides comments at the public CEQA Scoping Meeting of the CVRWQCB in Rancho Cordova to amend the Basin Plan to allow an extension of the GBP.

December 16, 2008: Representatives of the Service and Reclamation meet with Summers Engineering and HT Harvey and Associates regarding construction and contaminant monitoring in the SJRIP drainage reuse area and the GBP Extension.

December 19, 2008: The Water Authority files a Notice of Availability (NOA) with the State Clearinghouse and Interested Agencies of a DEIS/R for the Continuation of the GBP, 2010-2019, SCH# 2007121110.

January 14, 2009: Reclamation releases the DEIS/R for the Continuation of the GBP, 2010 – 2019 for a 60-day public comment period.

February 2, 2009: Representatives of the Service meet with CVRWQCB regarding Service CEQA comments on the proposed extension of the GBP and the associated Basin Plan Amendment for the Control of Agricultural Subsurface Drainage Discharges.

March 19, 2009: The Service transmits written CEQA scoping comments to the CVRWQCB on the proposed extension of the GBP and the associated Basin Plan Amendment for the Control of Agricultural Subsurface Drainage Discharges.

March 23, 2009: The Service transmits written comments to Reclamation on the DEIS/R for the Continuation of the GBP from 2010 through 2019.

April 7, 2009: Reclamation transmits a memo to the Service providing an update regarding proposed minor construction in the SJRIP drainage reuse area to convey drain water within enclosed pipelines and committing to fully implementing take avoidance measures contained in the 2001 biological opinion for giant garter snake.

May 13, 2009: Representatives of the Service and Reclamation meet with Summers Engineering and the Water Authority regarding status and schedule for consultation on the new use agreement for the SLD, and agreement on closure of the reconsultation on the existing use agreement.

July 22, 2009: The Service receives from Reclamation the BA for the GBP Extension.

August 5, 2009: The Water Authority issues a NOA of a Final EIS/R for the Continuation of the GBP, 2010 – 2019, State Clearinghouse #2007121110.

September 16, 2009: The Water Authority transmits to the Service a summary of mountain plover monitoring on Panoche Drainage District lands for the 2008-09.

September 29, 2009: Reclamation issues a NOA of the FEIS for the Continuation of the GBP, 2010 - 2019.

October 8, 2009: The Water Authority issues a Notice of Determination certifying the Final EIS/R with comments and responses and record of project approval.

November 20, 2009: The Service transmits to Reclamation a draft Project Description for the Service's biological opinion on the GBP Extension for review.

December 9 – 17, 2009: The Service, Reclamation, and the Water Authority discuss measures to minimize the effect of take on giant garter snake and San Joaquin kit fox.

BACKGROUND AND RELATED PROJECTS

Grasslands Ecological Area

The Grasslands Ecological Area includes over 80,000 acres of federal, state, and privately-managed marsh, native pasture and riparian zones, including the largest contiguous block of wetlands remaining within the Central Valley. Prior to the early 1900's, this area was part of a vast network of some four million acres of wetlands spread throughout the Central Valley. Today that valley-wide network is down to 300,000 acres, of which the Grasslands area is a critical component. As much as thirty percent of the migratory birds that utilize the Central Valley frequent the Grasslands wetlands each winter. The area annually hosts hundreds of thousands of ducks, geese and waterbirds, and is recognized by the Western Hemisphere Reserve Shorebird Network as a place of international importance to wintering and migrant shorebirds. The Grasslands Ecological Area has also been designated a Wetlands of International Importance under the Ramsar Convention, the only international agreement dedicated to the worldwide protection of wetlands.

History of the GBP

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 to maintain arability of drainage-impaired agricultural lands. 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 environmental 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 Grasslands' public and private wetlands. The discovery of avian developmental abnormalities at Kesterson National Wildlife Refuge (NWR), 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 Camp 13 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 GBP. The original agreement for use of the SLD (Use Agreement) dated November 3, 1995, allowed the Water Authority to use a portion of the SLD to convey agricultural drainwater through adjacent wildlife management areas to Mud Slough (North), a tributary to the San Joaquin River. The 1995 Use Agreement allowed for use of the SLD until September 30, 2001. The 2001 Use Agreement allowed continuation of the use of the SLD through December 31, 2009. With implementation of the GBP from 1996 through the present, most of the drainage from farmlands in and adjacent to the Grassland Drainage Area (GDA) (the agricultural lands that participate in the Grasslands Bypass Project) was no longer conveyed in about 93 miles of Grasslands wetland supply channels. The continued use of the SLD beyond December 31, 2009, requires a revised Use Agreement, an amendment of the Basin Plan Amendment implementation schedule to comply with water quality objectives in impacted waters (particularly Mud Slough [North]) and portions of the San Joaquin River, and additional environmental review and compliance.

<u>Water Quality Objectives for the Grasslands Wetlands</u>

In 1988 the CVRWQCB 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 a site-specific selenium objective for wetland water supplies in the Grasslands of 2 µg/L on a monthly mean basis. In 1990, the USEPA approved the 2 µg/L monthly mean selenium objective for the water delivered to wetland areas within the Grassland watershed. A revised Basin Plan amendment was adopted by the CVRWQCB in 1996, as part of a set of amendments that focused on the control of selenium-laden agriculture subsurface drainage discharges in and from the Grassland watershed. The need to reduce selenium loadings to, 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 driving forces behind the CVRWQCB's adoption of the Control of Agricultural Subsurface Drainage Discharges (Grassland Amendments). The Service has previously reviewed and commented on drafts of these amendments. The Grassland Amendments were adopted May 3, 1996, by the CVRWQCB via Regional Board Resolution 96-147, and approved by the State Water Resources Control Board (SWRCB) in State Board Resolution 96-078 and by the State Office of Administrative Law on January 10, 1997 (CVRWQCB 1998). The Service completed a consultation with the USEPA on the CVRWQCB's Grassland Amendments on November 4, 2002 (Service File No. 00-F-0054).

San Luis Drainage Feature Re-evaluation ROD and ESA consultation

In 2006 Reclamation completed an EIS and ROD under the National Environmental Policy Act (NEPA), and the Service completed a Biological Opinion under section 7 of the Act (Service File No. 1-1-06-F-0027) and a Fish and Wildlife Coordination Act Report (CAR) in accordance with, the provisions of section 2(b) of the Fish and Wildlife Coordination Act (48 stat. 401, as amended; 16 U.S.C. 661, et seq.) on San Luis Drainage Feature Re-evaluation (SLDFR). Congress has not yet acted to authorize and make appropriations to implement the ROD, although Reclamation has the authority to complete some of the actions described in the EIS.

The purpose of the SLDFR project is to meet Reclamation's obligations under the Federal San Luis Unit Act of June 3, 1960, Public Law 86-488, 74 Stat. 156, Section 5, to provide drainage service to drainage-impacted lands within the San Luis Unit. Once fully implemented, Reclamation anticipated in the EIS and ROD that the drainage discharge from the San Luis Unit would be reduced to sufficient standards to meet the statutory and judicial requirements imposed. The GBP is fully included within the Northerly Area discussed in the SLDFR.

There are several key differences between what was analyzed in the Biological Opinion in SLDFR for the Northerly Area (the area consistent with the GBP Project Area) and what is being proposed for this consultation:

Delta Mendota Canal (DMC) sump drainage: the SLDFR project included construction of a Delta Mendota Canal Drain to collect and divert drainage currently discharged into the DMC and divert it to the drainage reuse area of the GBP. The GBP Extension FEIS/FEIR noted the following with respect to rerouting the DMC sump drainage to the reuse area: *"…any agreement to reroute the sumps for disposal through the Grassland Bypass Project must address Reclamation's responsibility for treatment and disposal of this additional subsurface drainage water and how this reduction fits into the respective obligations under the Regional Board's salt, boron and selenium TMDLs."*

Drainage reuse area: the drainage reuse areas in SLDFR were planned to have all conveyance of drainage by means of closed pipelines. The GBP drainage reuse area includes open ditches used to convey drainage, which expose wildlife to drainwater contamination through foraging opportunities in those ditches. The BA for the GBP Extension notes that, "*Over time, as funding becomes available, open ditches will continue to be removed or replaced with buried pipe to eliminate exposure to wildlife*."

Discharge to Mud Slough and the San Joaquin River: The SLDFR FEIS, biological opinion, and CAR were all based on the assumption that there would be zero discharge of agricultural drainage to Mud Slough (North) and the San Joaquin River by 2010. The SLDFR ROD changed language regarding when discharge to the San Joaquin River would cease to read "*as soon as practicable*". The GBP Extension would continue discharging to Mud Slough (North) and the San Joaquin River through the end of 2019. The CVRWQCB will need to extend the existing compliance date for selenium water quality objectives for Mud Slough (North) and the San Joaquin River from October 2010 to the end of 2019.

<u>San Joaquin River Settlement Agreement</u>
Reclamation and the Natural Resources Defense Council *et al*. have reached a settlement on the long-standing lawsuit over the reestablishment of flows in the San Joaquin River from Friant Dam to the confluence with the Merced River. This settlement, formally announced on September 13, 2006, is based on two goals and objectives:

1. A restored San Joaquin River with continuous flows to the Delta and naturally reproducing populations of Chinook salmon.

2. A water management program to minimize water supply impacts to San Joaquin River water users.

The parties will work together on a series of projects to improve the river channel in order to restore and maintain healthy salmon populations. Flow restoration is to be coordinated with these channel improvements, with spring and fall run Chinook salmon populations reintroduced in approximately six years. At the same time, the Settlement limits water supply impacts to Friant Division long-term water contractors by providing for new water management measures that are to be undertaken by Reclamation. These measures include: a recirculation plan that would allow Friant Division contractors to capture water from downstream areas after it has served its 'Restoration Purpose' and the water could be delivered to the contractor using either the State Water Project (SWP) or Central Valley Project (CVP) delivery system; and the creation of a 'Recovered Water Account' which would allow participating contractors to purchase water during certain wet conditions when water is available that is not needed to meet contractual obligations or Restoration Flows.

Restoring continuous flows to the approximately 60 miles of a generally dry river will take place in a phased manner. Planning, design work, and environmental reviews will begin immediately, and interim flows for experimental purposes will start in 2009. The flows will be increased gradually over the next several years, with salmon being re-introduced by December 31, 2012. The settlement continues in effect until 2026, with the U.S. District Court retaining jurisdiction to resolve disputes and enforce the settlement. After 2026, the court, in conjunction with the SWRCB, would consider any requests by the parties for changes to the restoration program.

The agreement also requires that long-term Friant Division water service contracts be amended to conform to the contracts to the terms of the settlement, and that passage of federal legislation, including appropriations and authorization, must occur before the project can be fully implemented.

Operations Criteria and Plan (OCAP)
Biological Opinions have been issued by NMFS (2009) and USFWS (2008) for the OCAP. Reclamation is currently engaged in reviewing those documents, and in the interim is implementing the Reasonable and Prudent Alternatives recommended by the regulatory agencies.

Interim and Long-Term Contract Renewals
Under the provisions of the Central Valley Project Improvement Act (CVPIA) Reclamation enters into water service contracts with water districts, municipalities, and other water users to provide for the delivery of CVP water for agricultural and municipal & industrial uses. As existing contracts expire, Reclamation enters into new long term or new interim contracts. Long-term contract renewal for the San Luis Unit (including Westlands Water District, Panoche Water District, San Luis Water District, the CDFG, and the Cities of Avenal, Coalinga, and Huron) has been on hold pending completion of the OCAP consultations. Reclamation has entered into interim contracts with the above named entities, but has not yet made a decision on the resumption of long term contract renewal.

BIOLOGICAL OPINION

Preamble
At the time of completion of this consultation (coincident with the FEIS/R), there remains significant uncertainty as to the technological and economical feasibility of some of the drainage treatment and disposal technologies that are being tested for implementation as part of the GBP. The implementation date for the treatment and disposal element of the GBP Extension is presently unknown, in part because of a lack of funding for development of economically viable treatment/salt disposal alternatives. Because the treatment and disposal element was not analyzed in any detail in the FEIS/R or BA for this project, implementation of this phase of the project would be subject to separate environmental review. Therefore, for the purposes of this biological opinion, the treatment and disposal element of the GBP Extension is not included in this Endangered Species Act (ESA) consultation by the Service. Reclamation and the Water Authority will have to complete a separate ESA consultation with the Service before a treatment and disposal element of the GBP Extension is implemented.

The FEIS/R Appendix I notes that without the treatment and disposal element, "all of the drainwater from the GDA cannot be managed." The main text of the FEIS/R states that if treatment and disposal are "*not fully implemented because treatment is not feasible, then the reuse area would operate as long as possible and more drainage would be recirculated on-farm with resulting impacts on production*." Increasing the recycling of drainage on-farm and in the drainage reuse area could result in potential runoff into the Grassland wetland supply channels. As a result, for the purposes of this consultation, it is assumed that some form of treatment and disposal will be implemented, and that a separate ESA consultation will be completed on that aspect of the project. If the treatment and disposal element of the GBP Extension is not implemented, reinitiation of this biological opinion will be required.

This opinion covers the activities described in the **Description of the Proposed Action** detailed below. Actions related to the development and growing of crops in GDA and drainage reuse areas, including installation of tile drains, installing temporary supply and tailwater ditches, disking, planting, harvesting and other agricultural related activities are not included project description nor considered in this Opinion.

DESCRIPTION OF THE PROPOSED ACTION

The Proposed Federal Action (GBP Extension) is the execution of the Third Use Agreement between Reclamation and the Water Authority for the Federally-owned SLD (Use Agreement). The term of the new Use Agreement is January 01, 2010, through December 31, 2019. Under the Proposed Action, the GBP Extension will continue to consolidate subsurface drainwater collected from the 97,400-acres of agricultural lands in the GDA and use a portion of the SLD to convey some of the highly contaminated drainwater around wetland habitat areas of the Grasslands. The collected drainwater is discharged from the SLD into 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. The federal action is the implementation of that Use Agreement.

The Proposed Action's goal is to meet water quality objectives that are applicable to the 2010–2019 period. Water quality objectives are defined in the California Water Code as the limits or levels of water quality constituents or characteristics that are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area (Basin Plan). The existing water quality objectives for selenium, from the CVRWQCB 1998 Basin Plan, relevant to the Proposed Action at three locations in the San Joaquin River system are summarized in Table 2 below. Except for short periods associated with heavy rainfall events, existing selenium water quality objectives (on a monthly mean basis) for Salt Slough and the Grassland wetland supply channels were met as a result of the 2001 GBP.

Table 2. Selenium Water Quality Objectives and Performance Goals for the San Joaquin River, Salt Slough, and the Grassland Wetland Supply Channels

Waterbody/Water Year Type	January 10, 1997	October 1, 2002	October 1, 2005	October 1, 2010
Salt Slough and Wetland Water Supply Channels listed in Appendix 40 of Basin Plan	2 μg/L monthly mean[a]			
San Joaquin River below the Merced River; Above Normal and Wet water year types		5 μg/L monthly mean[b]	5 μg/L 4-day average[a]	
San Joaquin River below the Merced River; Critical, Dry, and Below Normal water year types		8 μg/L monthly mean[b]	5 μg/L monthly mean[b]	5 μg/L 4-day average[a]
Mud Slough (North) and the San Joaquin River from Sack Dam to the Merced River				5 μg/L 4-day average[a]

Source: Regional Board 1996, 1998a

[a] Selenium Water Quality Objectives
[b] Performance Goals

The GBP's subsurface drainage flows discharged to Mud Slough (North) were to have met water quality objectives by October 1, 2010, as required by the CVRWQCB's 1998 Basin Plan. Although the 1998 Basin Plan does not expressly prohibit the discharge of subsurface drainage water, selenium in any untreated subsurface agricultural drainage discharged from the GDA significantly exceeds the Mud Slough (North) objective that takes effect October 1, 2010. Thus, the Grassland Area Farmers (GAF) would need to achieve essentially zero discharge once the compliance date arrives. The GBP's SJRIP was intended, by 2010, to treat and dispose all the drainwater volume from the GDA. However, the GAF were not able to obtain adequate funding for treatment and disposal technology to fully implement zero discharge by the 2010 deadline. It is anticipated that the proposed continuation of the GBP for an additional 10 years would allow enough time to acquire funds to develop and implement feasible treatment technology in order to meet the 1998 Basin Plan Objectives and Waste Discharge Requirements (WDRs). Because the October 1, 2010 compliance date for the San Joaquin River and Mud Slough (North) selenium water quality objectives cannot be met; amendments to the 1998 Basin Plan and revised WDRs are needed from the CVRWQCB and are expected sometime in early 2010 (GBP Extension FEIS/R).

The purposes of the 2010 Project are:

1. To extend the SLD Use Agreement to allow the GAF more time to acquire funds and develop, test and implement feasible drainwater treatment and disposal technologies to meet revised Basin Plan Objectives and WDRs for full implementation (including zero discharge into Mud Slough (North) and the San Joaquin River) by December 31, 2019;

2. To continue collection and discharge of highly contaminated agricultural drainwater from the GDA into the SLD and away from wetland water supply conveyance channels for the period 2010 to 2019; and,

3. To facilitate drainage management that maintains the viability of agriculture lands in the GDA and promotes improvement in water quality in the San Joaquin River over the life of the project.

The GBP has been in operation since October 1996. The Project has reduced the volume of drainwater discharged from the GDA into the San Joaquin River (by means of recycling and in-valley drainage reuse), and has rerouted drainage away from the Grassland wetland supply channels (where drainage had been discharged prior to 1996). Implementation of the GBP has resulted in significant reductions in selenium loading and contamination in the Grassland wetland water supply channels and the San Joaquin River.

The proposed action will be regulated by the following agencies as part of their respective responsibilities for monitoring and/or regulating water quality: CVRWQCB, SWRCB, and the USEPA. The CVRWQCB has been requested to issue new WDRs that will specify annual and monthly loads of selenium that can be discharged by the GBP into Mud Slough (North). The WDRs will also prohibit discharges of drainwater from the GDA into local wetland water supply channels except when the capacity of the SLD has been exceeded during heavy rainfall events. The USEPA has responsibility to review, comment on, and oversee the State of California's implementation of the Clean Water Act, but no independent or direct project regulatory authority over the GBP. Several agencies will continue to monitor impacts of the 2010 Project on physical and biological resources in the region[2].

Additional features of the GBP Extension include the following:

- *Revised selenium and salt load limit restrictions:* In 2015, more restricted load limits will apply in all water year types, reducing the allowable contaminant loadings to Mud Slough (North) and the San Joaquin River.

- *Implementation of In-Valley drainage management:* The GBP Extension will include a suite of actions to manage and dispose of drainage including: regional blending of drainage with agricultural water supplies for application in the GDA, drainage reuse (disposal of drainage by means of irrigation of salt-tolerant crops), and yet to be determined, funded and implemented methods of treating and disposing of drainage at the SJRIP (described in more detail below).

- *Removal and land disposal of SLD Sediment:* At some point during the life of the GBP Extension, it is envisioned that Reclamation and the Water Authority will remove existing and future sediments from portions of the SLD for disposal on agricultural, upland or residential or industrial lands in the vicinity. This Sediment Management Plan (SMP) in Appendix B of the FEIS/R addresses potential options for disposal of sediments dredged from the SLD in order to maintain capacity and flow rates. The purpose of this SMP is to identify applicable human health, ecologic risk, and hazardous material standards for selenium, and then to specify appropriate disposal or reuse actions for the dredged sediments. The sediments tend to become selenium-enriched through biogeochemical processes after deposition in the SLD. In general, the concentration of selenium in sediment tends to be higher at the north end of the SLD, particularly between checks 1 and 3. The highest concentrations of selenium in sediment were 74µg /g, dry weight (dwt) at check 3 in June of 2005 and 77µg /g, dwt at Check 1 in June of 2006 (McLaughlin 2006). Selenium concentration is also greater generally at deeper levels of sediment (3-8 centimeters depth).

- *Monitoring Program:* The GBP will continue the monitoring of flow, water quality, toxicity, and biota in the Mud Slough (North), Salt Slough, and the lower San Joaquin River. Monitoring data will be compiled and published monthly, quarterly, and annually. In addition, annual wildlife monitoring reports from the drainage reuse area will be published and distributed to interested parties.

- *Mud Slough Mitigation:* Because the Proposed Action would continue to discharge selenium in agricultural drainwater into Mud Slough after 2010, the GAF have committed to mitigating this impact by providing water for additional wetland habitat. This mitigation is not intended to compensate for impacts to federally listed species. The concept is to expand permanent wetlands in the area of Mud Slough to provide benefits to species such as waterfowl,

[2] California Department of Fish and Game, California Regional Water Quality Control Board, San Luis & Delta-Mendota Water Authority, US Environmental Protection Agency, US Fish and Wildlife Service, US Geological Survey, Bureau of Reclamation

shorebirds, and terrestrial wildlife. This habitat would be located on Service lands and CDFG lands.

CDFG Mitigation Proposal: Supply year-round water to a series of ponds between Mud Slough and the San Joaquin River. Water would be delivered through an existing pipeline and turned out into natural swales to create wetland habitat. The water surface area of the ponds would be approximately 95.3 acres. As a result of the applied water, vegetation would emerge in and around the ponds. Water would likely be developed locally from wells.

Service Mitigation Proposal: Create year-round wetlands on Service lands (to be identified). One option under consideration establishes 31.6 acres of year-round wetland marsh habitat. It may create wetland slough habitat in a drainage ditch next to the Schwab Unit (BG001). This could create a broad yet linear habitat that could provide slough mitigation habitat. The Service proposal has not been fully developed. If obstacles prevent the implementation of this option, then an alternate mitigation site would be found of approximately 31.6 acres of year-round wetland habitat.

The proposals were developed by the GAF working with Service and CDFG staff to determine the habitat needs within their respective wetland complexes. Ownership of all capital improvements on agency land would remain with the agencies after the term of the Use Agreement. Both proposals are under consideration, and both proposals would be implemented for a total acreage of 108.4 (GBP Extension FEIS/R).

<u>San Joaquin River Water Quality Improvement Project (SJRIP)</u>
One component of the GBP is the continued development of the SJRIP where drainwater from the GDA is disposed by means of irrigation of salt tolerant crops and halophytes. The 6,000-acre SJRIP began in 2002 by Panoche Drainage District and has successfully reduced the quantity of drainwater from the GDA that is discharged to the San Joaquin River (Figures 1 and 2).

Over the life of the GBP Extension, as funding becomes available, open ditches that convey drainage water in the SJRIP area will be removed or replaced with buried pipe to eliminate exposure to wildlife. A treatment facility is expected to be constructed to remove salt, selenium, and boron; and some means of land disposal is expected to be deployed to remove salts "in valley" and ultimately eliminate drainwater discharges into Mud Slough (North) and the San Joaquin River. At completion, the SJRIP facility is planned to handle all of the drainwater produced in the GDA (up to 29,500 acre-feet annually)[3] and would include three phases, described in more detail below:

- *Phase I:* Purchase of land and planting to salt-tolerant crops and halophytes;
- *Phase II:* Installation of subsurface drainage and collection systems;
- *Phase III:* Completion of construction of treatment removal and salt disposal systems.

[3] This estimate is based on a drainage model that assumes all 6,900 acres were developed with the drains and 4.25 acre-feet per acre of applied drainage and a depth to groundwater of 6.6 feet, then the reuse area plus treatment facility could handle up to 29,500 acre-feet annually (GBP Extension FEIS/R).

Phase I: Most of the target lands have been permanently acquired (6,009 acres) out of 6,900 acres planned (GBP Extension FEIS/R). The 2001 GBP biological opinion included up to 6,200 acres planned. The additional lands targeted for acquisition will expand the total SJRIP area to 6,900. The newly acquired lands of the SJRIP lie directly south of the private wetlands in the South Grasslands (Figure 2). The additional lands proposed for acquisition and development were analyzed in the Biotic Study prepared in 2005 (HT Harvey and Associates 2005), and the MND and IS completed by Panoche Drainage District in 2007 (Panoche Drainage District 2007).

Application of drainwater will be controlled and managed to prevent water table rise. Perimeter drains will be installed to capture water prior to offsite migration. Groundwater monitoring will be conducted to confirm migration is not occurring. If needed, additional drainage management measures would be implemented. The purpose of these actions would be to minimize exposure of wildlife to the drainage water

Phase II: The second phase is ongoing, as funding and acquisition opportunities occur. Panoche Drainage District is installing subsurface drainage and collecting system (tile) systems so the soil can be leached and a salt balance maintained. Currently (and for the foreseeable future) any tile water captured within the reuse areas is blended back with the reuse area irrigation supply and used on whatever crop is located down slope. Salt, selenium and other drainage constituents will be collected in the water coming out of the subsurface drainage systems, continue to be recirculated and utilized on site or, discharged subject to load reduction obligations.

By late 2007, Phase II was partially implemented with the installation of subsurface drains on approximately 1,700 acres within the 3,800-acre planted area. On-site tile drainage water is returned to the irrigation system or discharged. The Proposed Action would expand the drains and sequential reuse to the full acquired and planned acreage, up to 6,900 acres.

Phase III: The final phase is expected to be developed during the GBP Extension to attain the selenium and salt load reductions needed to meet the revised Basin Plan compliance schedule for selenium and salinity water quality objectives. This phase is envisioned to include construction of treatment and disposal facilities. Because of the uncertainty of the final treatment design, it is not possible to include this action as part of the Proposed Federal Action, and it will be consulted on separately as appropriate.

No treatment has been implemented to date, although a pilot treatment project has been approved with its own CEQA review and is expected to remain in operation for 1 year. This phase would include expansion of the pilot treatment/salt disposal (during Phase II) with construction of full-scale treatment/salt disposal facilities, as well as waste disposal units. Phase III is now expected to include both treatment and disposal facilities, with or without the production of usable water.

Figure 1. Grassland Bypass Project Area Map.

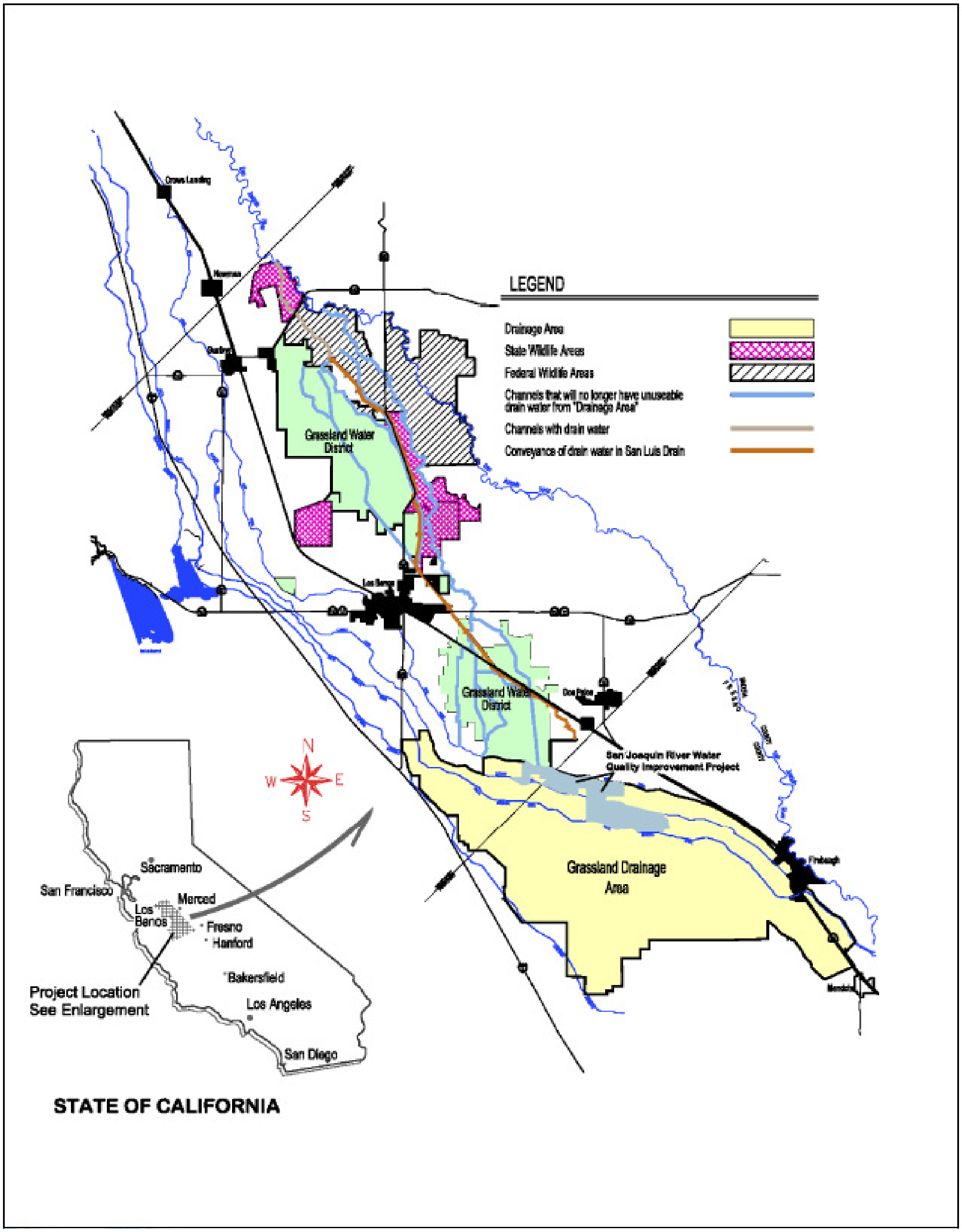
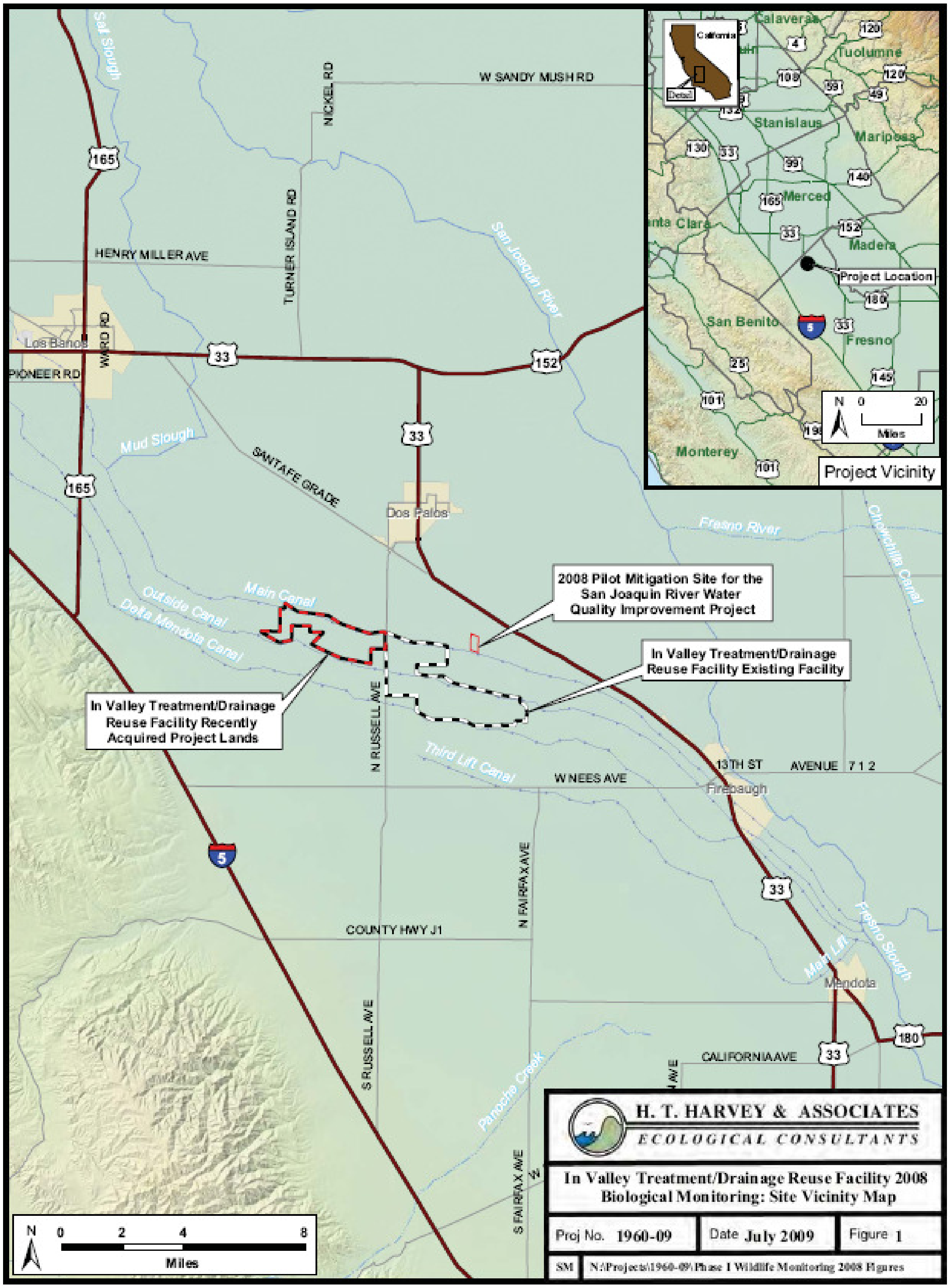


Figure 2. Map of the San Joaquin River Improvement Project Drainage Reuse Area and Mitigation Site (from HT Harvey and Associates 2009).



The implementation date for Phase III is presently undetermined, in part because inadequate funds have been available for development of economically viable treatment/salt disposal alternatives. The goal of treatment is to remove the salt from the drainage system, maintain a salt balance for continued agricultural production in the region, and provide appropriate salt disposal. Phase III would be applied only to permanently acquired parcels and would be subject to separate review under CEQA (URS Corporation 2007). If Phase III is not fully implemented because treatment is not feasible, then the drainage reuse area would operate as long as possible and more drainage would be recirculated on-farm with resulting impacts on production (GBP Extension FEIS/R).

Conservation Measures

The Service's standard avoidance and minimization measures for the San Joaquin kit fox and giant garter snake will be implemented, where appropriate and to the greatest degree possible, for construction activities associated with the continued SJRIP development (see below) and sediment management in the SLD.

In addition to the primary drainage management actions associated with the GBP Extension that will reduce exposure to selenium and improve water and habitat quality, the following conservation measures are included in the project description to avoid or minimize impacts to special status species, especially during any construction.

Under the Proposed Action, quarterly biological monitoring of Mud Slough will continue throughout the proposed project life to determine the selenium risk levels at Mud Slough for warmwater fish (USBR 2009). This information can be used to assess risks to listed species. Through requirements of the Service's biological opinion on interim water contract renewals (USFWS 2000a), Reclamation will support studies on selenium impacts to giant garter snakes (USBR 2009).

<u>San Joaquin kit fox, *Vulpes macrotis mutica*</u>
The Panoche Drainage District, its staff and its subcontractors will follow the 1999 *U.S. Fish and Wildlife Service Standardized Recommendations for Protection of the San Joaquin Kit Fox Prior to or During Ground Disturbance* protocols for all construction activities conducted in the GDA and SJRIP.

A tiered contaminant monitoring program will continue to be implemented with recommendations from the Service to detect potential selenium exposure to San Joaquin kit foxes at the SJRIP drainage reuse area (URS Corporation 2007). Selenium uptake by salt-tolerant crops irrigated with drainwater at the SJRIP will continue to be monitored. Some of the selenium concentrations in these crops exceeded 3 µg/g (a level of concern threshold for dietary effects identified in the 2001 GBP biological opinion), triggering additional small mammal monitoring in 2008. The selenium level detected in 2 vegetation samples and 10 small mammal samples in 2008 exceeded the threshold of 3 µg/g triggering the next level of monitoring in the Tiered Biological Monitoring Program, which is to monitor selenium levels in coyotes to determine selenium bioaccumulation levels in a canid predator. The monitoring will be elevated to San Joaquin kit foxes, in coordination with the Service (a permit is required) and CDFG, if the risk reaches a Level of Concern based on coyote monitoring or other small mammal monitoring at the SJRIP site and selenium effects on mammals.

Giant garter snake, *Thamnophis gigas*
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 SJRIP drainage reuse area, a giant garter snake survey will be conducted by a Service-approved biologist 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. Panoche Drainage District will follow established protocols to survey potential habitat within all construction areas in the SJRIP drainage reuse area. Such potential habitat, if found, will be further inspected at least six months prior to any construction activities that may affect potential giant garter snake habitat.

All construction activities within giant garter snake habitat will be limited to May 1 through October 1, when the snakes are usually active. The construction area will be surveyed for the snake 24-hours prior to construction activities, and any sightings reported to the Service. Survey of the construction area will be repeated if a lapse in construction activity of two weeks or greater has occurred.

Construction personnel will receive Service-approved training to instruct workers to recognize the snake and its habitat.

Giant garter snake habitat within and adjacent to SJRIP construction sites will be flagged as environmentally sensitive areas. Movement of heavy equipment to and from SJRIP 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 action 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.

Reclamation and the Water Authority considered including in the proposed action the addition of approximately 1,100 acres of farmland adjacent to the GDA that currently drain into the

Grassland wetland supply channels. This would require the construction of up to three short culverts from existing sumps to the GBP channel through highly disturbed embankments. At this time, however, the funding and design of this activity is too speculative to incorporate into the project description. If, in the future, the design and funding are developed to annex these lands to the GBP, Reclamation will formally consult with the Service for effects to giant garter snake.

<u>Environmental Commitments from the Third Use Agreement of the SLD</u>
Environmental commitments are included in the Agreement for Third Use of the SLD between the Reclamation and the Water Authority (Third Use Agreement; Appendix A of the GBP Extension FEIS/R). The Third Use Agreement succeeds and supersedes the Second Use Agreement between Reclamation and the Water Authority. Environmental commitments in the Third Use Agreement include the following:

- *Control of Drainage and Compliance with Applicable Requirements and Laws*: The Water Authority shall be responsible for ensuring that only drainage water from the GDA enters the SLD, 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.

- *Management Plans*: By the end of Year Four (2013), a report will be provided to the Oversight Committee at a noticed meeting regarding the Grassland Drainers plan to meet selenium and salt loads in Years Six through Ten of the GBP Extension (2015-2019). No later than Year Seven of the project (2016), the Water Authority shall begin developing a long-term storm water management plan, which may include evaluation of utilizing the SLD to bypass storm water flows around some wetland areas.

- *Drainage Oversight Committee*: The Drainage Oversight Committee will meet as needed. The Oversight Committee reviews progress and operation of the project including drainage reduction goals, progress in achieving water quality objectives, monitoring data, etc. It makes recommendations to the Water Authority, Reclamation, and/or the CVRWQCB, as appropriate, regarding all aspects of the project, including modifications to project operation, appropriate mitigation, and termination of the Third Use Agreement if necessary. The Oversight Committee is composed of agency managers from Reclamation, the Service, the USEPA, CDFG, and the CVRWQCB. 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.

- *Downstream Users Notification*: The Water Authority will make flow and monitoring data available to downstream parties that have requested it. The Water Authority will provide advance notice to such parties of operations that may cause sudden changes in flow or quality and will develop procedures to coordinate with such parties on such operations. The Water Authority will work cooperatively with downstream parties regarding the timing of discharges and establish procedures that will ensure advance notice to, and coordination with, downstream diverters of upcoming releases.

• *Selenium Load Reduction Goals*: Selenium load reduction goals are identified in Appendix C of the Third Use Agreement. Load reduction values may be revised according to Appendix D of the Third Use Agreement if changes to the water quality objective for selenium in the lower San Joaquin River or changes to the Total Maximum Daily Load (TMDL) for selenium in the lower San Joaquin River are adopted.

• *Salinity Load Reduction Goals*: Salinity load reduction goals (annual and monthly salt loads) are identified in Appendix E of the Third Use Agreement.

• *Drainage Incentive Fee*: If the attributable discharge of selenium or salinity exceeds the applicable selenium or salinity load value in any given month or year during the term of the Third Use Agreement, a Drainage Incentive Fee shall be calculated in accordance with the Performance Incentive System as stated in section IV.B. of the Third Use Agreement and may be subject to termination pursuant to Section VII.B. No annual or monthly exceedences of salinity shall be the basis of termination pursuant to this section VII.B.

• *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 mitigation. Appropriate mitigation actions, depending on the situation, would include, but are not necessarily limited to, interruption of a specific identified contamination pathway through hazing or habitat manipulation; increased management, enhancement, and recovery activities directed at impacted species in channels cleaned up as a result of the project; and/or, establishment and attainment of more stringent contaminant load reductions. The costs of mitigation, as well as required clean up, shall be borne by the Draining Parties (the Water Authority member agencies as described on page 7 of the Use Agreement).

• *Comprehensive Monitoring Program*: The Water Authority shall be responsible for implementing a comprehensive monitoring program that meets the following objectives: 1) provides water quality data for purposes of determining compliance with Selenium Load Values and Salinity Load Values as set forth in the Third Use Agreement; 2) provides biological data to allow an assessment of whether or not any environmental impacts constitute "Unacceptable Adverse Environmental Effects" that have resulted from the Third Use Agreement; 3) provides data on sediment levels, distribution, and selenium content. Reclamation and the Water 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, no less frequently than monthly, the results of the monitoring program, including the monitoring results pertaining to the discharges of selenium and salts being delivered from the SLD to Mud Slough (North), shall be submitted to Reclamation, to the agencies participating in the Oversight Committee, and to other interested parties. The Water Authority shall be responsible for implementing this monitoring program up to Crows Landing (site N) on the San Joaquin River.

New Environmental Commitments from the GBP Extension FEIS/R SMP

Revised Acceptable Concentrations of Selenium in Dredged Material for Land Disposal on Uplands: The Service, in a comment letter dated March 23, 2009 on the Draft EIS/R for the GBP Extension, strongly objected to proposed disposal of SLD sediments with 2 – 390 µg/g selenium, dry weight, on nearby upland open areas because this range of concentrations in sediment would likely pose a risk to wildlife foraging in the upland areas where dredged material is disposed of. As a result, the range of acceptable concentrations of selenium in dredged material was redefined to <2 µg/g dry weight selenium in the SMP of the GBP Extension FEIS/R, as shown in Table 3 below:

Table 3. Acceptable Concentrations of Selenium in Dredged Material by Land Use from the SMP, Appendix B of the FEIS/R for the GBP Extension

Land Use	Acceptable Concentration of Se in Sediment
Residential development	< 100 µg Se /g, wet weight
Industrial development	< 100 µg Se /g, wet weight
Agriculture	< 10 µg Se /g, dry weight*
Open Space (Wetland and Upland)	< 2 µg Se /g, dry weight

Note: *Source: Zawislanski et al 2001. The 10 µg/g concentration is a general guideline recommended by the Lawrence Berkeley National Laboratory which if exceeded triggers certain monitoring as described in Section 4.2.2 below.

Sediment Disposal Criteria for Application on Open Space Lands: Prior to application of dredged materials onto open space areas, wetland areas will be delineated and avoided. Sediments deemed not "hazardous material" and meeting the criteria provided in Table 2 above may be applied to upland areas outside of the wet season.

Post-Land Disposal of Drain Sediments Monitoring: The following monitoring protocol, as recommended by the Lawrence Berkeley National Laboratory study (Zawislanski *et al*. 2002) will be applied to all land application sites until selenium levels have decreased to unrestricted use (in areas where applied sediments exceeded ecological or human health risk criteria, where applicable). In areas where re-vegetation was conducted as part of the application of sediments, monitoring will continue until the predetermined success criteria for the re-vegetation program is met (i.e. percent cover or establishment of a particular vegetation community).

- Quarterly monitoring of soil water and groundwater to confirm that soluble selenium is not migrating toward the water table.

- Biannual soil sampling to monitor selenium displacement and solubility.

- Annual plant sampling and analysis at agriculture and open space sites to confirm that selenium is not being accumulated to levels of concern. Selenium uptake may change as selenium solubility increases.

- Installation of either neutron probe access pipes and/or tensiometers in agricultural sites to measure soil water movement.

- In agricultural area where sediments greater than 10 µg/g are applied and crops are grown for human consumption, the selenium concentration of the plants will be tested prior to harvest. If the selenium concentration is greater than 10 µg/g, compliance monitoring designed for small mammals as required by the 2001 Service GBP biological opinion will be implemented to confirm that selenium uptake by wildlife is not being accumulated to levels of concern.

<u>Additional Environmental Commitments from the MND /IS for SJRIP Expansion</u>
In August 2007, the Panoche Drainage District finalized a MND for the expansion of the SJRIP drainage reuse area (URS Corporation 2007). The MND covered the acquisition of up to 2,900 acres of land to expand the existing 4,000-acre drainage reuse facility of the GBP. The MND included a number of mitigation measures to avoid or reduce potentially significant impacts to biological resources as follows:

- *Closing, piping or netting drains*: The majority of shorebird nesting in the SJRIP drainage reuse area consists of killdeer and recurvirostrids nesting within, or adjacent to, the irrigation ditches. Reducing the attractiveness of the ditches and their immediate surroundings would diminish the level of shorebird exposure to selenium by reducing nesting proximal to selenium-laden foraging habitat. Deep drains not required will be filled. Remaining drains that are determined to be an exposure risk for wildlife will be netted and/or replaced with subsurface pipelines. Construction activities to fill or pipe drains will be conducted after biological surveys and any required steps to avoid construction effects for special status species.

- *Hazing birds to discourage nesting and foraging near drainage ditches:* Shorebird nests are concentrated in the vicinity of irrigation ditches. Hazing desirable shorebird habitat, as identified during monitoring, will be undertaken to reduce exposure by reducing the number of nesting birds.

- *Flooded field contingency plan:* A contingency plan has been adopted to prevent accidental flooding that can create ideal foraging conditions for shorebirds. The contingency plan includes: daily monitoring of water conditions on the SJRIP sites during the bird breeding season, March through July. The Service and CDFG will be notified in the event of inadvertent flooding for a period longer than 24 hours. An event-specific monitoring plan will be developed to monitor the impacts to birds resulting from exposure to ponded water. Any monitoring program will include the date of the event, selenium concentration in the floodwater, number of birds using the flooded area, the duration of exposure, selenium and boron concentrations in eggs, hatchability of eggs, and the assessment of collected embryos. The results from the monitoring program will be included in the annual SJRIP wildlife monitoring report and incorporated into the three-year mitigation assessment reports. The exposure effects and mitigation prescriptions will be revised using the number of birds exposed (number of nest attempts at the project site) and the degree of exposure (egg-selenium content). The Service and/or CDFG will have the option of collecting supplemental monitoring data and biological samples in full coordination with Panoche Drainage District (HT Harvey and Associates 2009).

- *Compensation breeding habitat:* If after employing other measures mentioned above, monitoring still shows nesting shorebirds are exposed to elevated selenium levels as a result of the proposed project, compensation habitat for residual impacts will be provided. The results of the project site monitoring will be evaluated every 3 years in a mitigation assessment report to determine the appropriate acreage of the compensation habitat for the following 3-year period. Since 2006, breeding habitat comprising 50 acres of cultivated rice has been created for shorebirds (HT Harvey and Associates 2009).

- *Collaborate with the Service to refine and implement the tiered contaminant monitoring program:* The tiered contaminant monitoring program at the SJRIP will be refined to more accurately determine the selenium concentrations in plant tissues within the project site and potential bio-accumulation of selenium in prey of San Joaquin kit fox. Monitoring will continue for the duration of the SJRIP. The results of all aspects of the tiered contaminant monitoring program will be included in the SJRIP annual wildlife monitoring report.

- *Avoid the loss of sensitive habitats within a 151-acre parcel adjacent to the SJRIP:* The Panoche Drainage District will not utilize a 151-acre parcel south of the Main Canal comprised of alkali scrub, alkali meadow, and freshwater marsh habitats for the SJRIP element of the GBP. This parcel was receiving tailwater in 2007 from adjacent agricultural fields. Since 2008, tailwater has been precluded from entering the freshwater marsh habitats and replaced with clean freshwater. A record of freshwater supplied to the site will be included in the SJRIP annual wildlife monitoring report.

<u>New Environmental Commitments from 2009 Federal Reclamation Appropriations</u>
Redirect DMC Sump Discharge to the SJRIP reuse facility: Reclamation was appropriated $500,000 in 2009 to develop and construct the modification of existing DMC Interceptor Sumps (sumps) currently discharging into the DMC by constructing new discharge pipelines for each sump and rerouting the discharge into the GBP's regional drainage system where it will be managed with the GDA drainwater through recirculation and reuse. The project will include the installation of up to 6 new electric pumps and corresponding electrical controls, construction of new discharge pipelines to the new discharge location, construction of pipe crossings of the DMC where required and in accordance with Reclamation standards, and discharge facilities, including energy dissipaters, metering, and valves, as required (C. Eacock, USBR, *in litt.* 2009). The recipient of funds will be responsible for completing environmental compliance for the

project, including, but not limited to, a CEQA Categorical Exemption. The FEIS/R for the GBP Extension noted the following with respect to this measure,
"The GBD have requested that Reclamation enter into a process to identify and negotiate terms to include Reclamation's Delta-Mendota Canal (DMC) sumps into the GBP and SJRIP facility reuse area and to remove DMC sump discharges from the Delta-Mendota Canal. These sumps were installed under a long-term commitment by Reclamation to mitigate for drainage impacts in the unlined portion of the Delta-Mendota Canal resulting from its construction and operation. The DMC sumps provide a benefit to Central Valley Project operations generally and are separate from the Grassland Bypass Project. Therefore, any agreement to reroute the sumps for disposal through the Grassland Bypass Project must address Reclamation's responsibility for treatment and disposal of this additional subsurface drainage water and how this reduction fits into the respective obligations under the Regional Board's salt, boron and selenium TMDLs."

Environmental Mitigation for Operation of the SJRIP Drainage Reuse Area: Reclamation was appropriated $1,494,719 in 2009 to implement environmental mitigation required for operation of the SJRIP drainage reuse area. Environmental mitigation may include, but is not limited to, burying seepage drains or converting seepage drains to pipes within the SJRIP area, covering the existing drainage conveyance systems, installing groundwater monitoring wells, and conducting biological surveys to evaluate mitigation practices. Approximately five miles of open drains will be converted to closed pipe, and an additional six miles of open drains no longer needed will be buried using these funds (C. Eacock, *in litt*., 2009). It is unknown what the total linear area of open drains and ditches will be operational when the full 6,900 acre area of the SJRIP drainage reuse area is receiving drainwater.

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION ANALYSES

Jeopardy Determination

In accordance with policy and regulation, the jeopardy analyses in this Biological Opinion rely on four components: (1) the *Status of the Species*, which evaluates the species' range-wide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the Delta smelt, giant garter snake and San Joaquin kit fox.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the species' current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

The jeopardy analysis in this Biological Opinion places an emphasis on consideration of the range-wide survival and recovery needs of the giant garter snake and San Joaquin kit fox and the role of the action area in the survival and recovery of the giant garter snake and San Joaquin kit fox as the context for evaluating the significance of the effects on the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

ACTION AREA

The action area is determined based on consideration of all direct and indirect effects of the proposed agency action [50 CFR 402.02 and 402.14(h)(2)]. Two hydrologic areas are affected by the GBP. 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 GBP 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 Delta and San Francisco Bay. Specifically, the action area encompasses 97,400-acres of the drainage impaired lands in Broadview, Panoche, Pacheco, and the southern portion of the San Luis water districts; 40,400 acres of drainage impaired lands in Central California Irrigation District (CCID) and Firebaugh Canal Water District (FCWD); approximately 36,000 acres of adjacent lands within the GDA; and the San Joaquin River down to Vernalis for terrestrial species, and to the estuary for aquatic species. Vernalis was chosen as the downstream end point because the effects on terrestrial species are not expected to be detectable beyond that point. The estuary was selected for aquatic species as there is some evidence that contaminant loading may be detectable and significant to that point.

STATUS OF THE SPECIES

Giant Garter Snake

Listing

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

Description

The giant garter snake is one of the largest garter snake species reaching a total length of approximately 64 inches (162 centimeters). Females tend to be slightly longer and proportionately heavier than males. Generally, the snakes have a dark dorsal background color with pale dorsal and lateral stripes, although coloration and pattern prominence are geographically and individually variable (Hansen 1980; Rossman *et al*. 1996).

Historical and Current Range

Giant garter snakes formerly occurred throughout the wetlands that were extensive and widely distributed in the Sacramento and San Joaquin Valley floors of California (Fitch 1940; Hansen and Brode 1980; Rossman and Stewart 1987). The historical range of the snake is believed to have extended from the vicinity of Chico, in Butte County, southward to Buena Vista Lake, near Bakersfield, in Kern County (Fitch 1940; Fox 1948; Hansen and Brode 1980; Rossman and Stewart 1987). Early collecting localities of the giant garter snake coincide with the distribution of large flood basins, particularly riparian marsh or slough habitats and associated tributary streams (Hansen and Brode 1980). Loss of habitat due to wetlands reclamation, agricultural activities and flood control have extirpated the snake from the southern one third of its range in former wetlands associated with the historic Buena Vista, Tulare, and Kern lake beds (Hansen 1980; Hansen and Brode 1980).

Upon federal listing in 1993, the Service identified 13 separate populations of giant garter snakes, with each population representing a cluster of discrete locality records (USFWS 1993). These 13 populations largely coincide with historical flood basins and/or tributary streams throughout the Central Valley: (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, (11) North and South Grasslands, (12) Mendota, and (13) Burrel Lanare. Population clusters 1 through 4 above were associated with rice production areas, especially channels and canals that delivered or drained agricultural irrigation water. These populations were determined to be extant in 1993. Population clusters at Butte, Sutter, and Colusa Basins (1,2, and 3) were determined to be not imminently threatened with extirpation. Populations 4 through 13 were determined to be imminently threatened with extirpation. The area covered by these populations (4 through 13) included the San Joaquin Valley, portions of the eastern fringes of the Delta, and the southern Sacramento Valley; an area encompassing about 75 percent of the species' known geographic range (USFWS 1993a).

The known range of the giant garter snake has changed little since the time of listing. The northern-most population of giant garter snakes was found 5 miles west of the city of Chico at the Chico Water Pollution Control Plant in 2005 (Kelly 2007). The southernmost known occurrence is in Fresno Slough at Mendota WA in Fresno County. Only one individual giant garter snake has been trapped in Mendota WA since 2002 (Hansen 2008b). No sightings of giant garter snakes south of Mendota WA within the historic range of the species have been made since the time of listing (Hansen 2002; Wylie and Amarello 2008).

Essential Habitat Components

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, rice fields and the adjacent uplands (USFWS 1999). Essential habitat components consist of: (1) wetlands with adequate quantity and quality of 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 overwintering habitat with escape cover (vegetation, burrows) and underground refugia (crevices and small mammal burrows) (Hansen 1988). Summer aquatic habitat is essential because it supports the frogs, tadpoles, and small fish on which the giant garter snake preys. Rice and natural wetlands adjacent to the ditches and canals may serve as vital nursery habitat for young giant garter snakes and as "way stations" for snakes as they make their way through systems of ditches and canals. Females will often give birth in rice fields and the newly born snakes will feed on the small prey items that are prevalent in rice fields, but are rare or absent from other permanent aquatic habitat types (E. Hansen, pers. comm. 2008). Snakes are typically absent from larger rivers and other bodies of water that support introduced populations of large, predatory fish, and from wetlands with sand, gravel, or rock substrates (Hansen 1988; Hansen and Brode 1980: Rossman and Stewart 1987). Riparian woodlands do not provide suitable habitat because of excessive shade, lack of basking sites, and absence of prey populations (Hansen 1988). Giant garter snakes require water during the active phase of their life cycle in the summer (Paquin *et al.* 2006).

Foraging Ecology

Giant garter snakes are the most aquatic garter snake species and are active foragers, feeding primarily on aquatic prey such as fish and amphibians such as Pacific chorus frogs (*Pseudacris regila*) (Fitch 1941). As long as there are abundant prey species present, giant garter snakes share wetland areas communally, and only extend into other areas when the prey base declines (E. Hansen, pers. comm. 2008). Because prey species historically foraged upon by giant garter snakes are either declining, extirpated, or extinct, the predominant food items are now introduced species such as carp (*Cyprinus carpio*), mosquitofish (*Gambusia affinis*), other small fish, and larval and sub-adult bullfrogs (*Rana catesbiana*) (Fitch 1941; Hansen 1988; Hansen and Brode 1980; Rossman *et al.* 1996).

Reproductive Ecology

The giant garter snake breeding season begins in March and April and females give birth to live young from late July through early September (Hansen and Hansen 1990). The breeding season for the giant garter snake begins soon after emergence from overwintering sites and extends from March into May, and resumes briefly during September (G. Hansen, pers. comm. 1998). Males immediately begin searching for mates after emerging (G. Hansen, pers. comm. 1991). Females brood young internally, and typically give birth to live young from late July through early September (Hansen and Hansen 1990). Young immediately scatter into dense cover and absorb their yolk sacs, after which they begin feeding on their own (USFWS 1993a). Although growth rates are variable, they typically more than double in size by one year of age, and sexual maturity averages three years in males and five years for females (USFWS 1993a).

Movements and Habitat Use

The giant garter snake is highly aquatic but also occupies a terrestrial niche (USFWS 1999; Wylie *et al.* 2004a). The snake typically inhabits small mammal burrows and other soil and/or rock crevices during the colder months of winter (*i.e.,* October to April) (Hansen and Brode 1993; Wylie *et al.* 1996; Wylie *et al.* 2003a), and also uses burrows as refuge from extreme heat during its active period (Wylie *et al.* 1997; Wylie *et al.* 2004a). Giant garter snakes can be communal in their habits, sharing burrows during the colder months and when escaping extreme heat (E. Hansen, pers. comm. 2008). While individuals usually remain in close proximity to wetland habitats, Wylie *et al.* (1997) documented snakes using burrows as much as 165 feet (50 meters) away from the marsh edge to escape extreme heat; and as far as 820 feet (250 meters) from the edge of marsh habitat for over-wintering habitat.

In studies of marked snakes in the Natomas Basin, snakes moved about 0.25 to 0.5 miles (0.4 to 0.8 kilometers) per day (Hansen and Brode 1993). Total activity, however, varies widely between individuals. Individual snakes have been documented to move up to 5 miles (8 kilometers) over a few days in response to dewatering of habitat (Wylie *et al.* 1997) and more than 8 miles (12.9 kilometers) of linear aquatic habitat over the course of a few months. Estimated home ranges in the Natomas Basin and Colusa NWR of giant garter snakes have averaged about 0.1 mile^2 (25 hectares) in both the Natomas Basin and the Colusa NWR (Wylie 1998a; Wylie *et al.* 2002a; Wylie *et al.* 2002b). Home range estimates for giant garter snakes near the restored wetlands at Colusa NWR were generally smaller than previously found at the refuge when the lands were managed for waterfowl and in other off-refuge study areas (Wylie *et al.* 2000a). Wylie hypothesized that maintaining water in restored wetlands and nearby habitat provided sufficient conditions to meet the biological requirements of the giant garter snakes; individuals were less likely to move further distances as in previous years when conditions were drier and water was not maintained specifically to benefit giant garter snakes (Wylie *et al.* 2000a).

Recent studies provide limited information on the use of agricultural wetlands by giant garter snakes. Wylie *et al.* (1997) found that giant garter snake densities were highest, and average home range was smallest, in permanent wetlands (Badger Creek, Sacramento County) compared to agricultural wetlands (Gilsizer Slough, Sutter County) or managed marshes (Colusa NWR, Colusa County). However, Wylie *et al.* (2000) reported that in wetlands managed specifically to benefit giant garter snakes, home range estimates were smaller than for those areas lacking comparable management (wetlands managed for waterfowl). Wylie (1998b) also documented 14 captures and recaptures of giant garter snakes using natural channels or sloughs in the Grasslands Area in Merced County, compared to four captures and recaptures of snakes using irrigation canals. These observations may indicate that giant garter snakes may concentrate in the best habitat when all other surrounding habitat has been eliminated or highly degraded. It also may indicate that habitat in agricultural wetlands and some managed marshes are meeting some of their biological needs, but not to the fullest extent possible.

As noted in the Draft Recovery Plan, giant garter snakes use rice lands extensively and depend on them for habitat (USFWS 1999). Giant garter snake seasonal activity associated with rice cultivation occurs as follows:

Spring: Rice is planted and the fields are flooded with several inches of water. Rice fields that contain prey species such as small fish or frogs attract giant garter snakes.

Summer: While the rice grows, garter snakes continue to use rice fields as long as their prey is present in sufficient densities.

Late Summer/Fall: The water is drained from the rice fields and garter snakes move off the fields to other adjacent habitats. Rice is harvested at this time and female garter snakes have just borne young and need food to regain their body weight. In August and September the snakes can get a good supply of food from the rice lands because prey animals are concentrated in the rice drains. The dry-down of the rice fields in fall is thought to be important because prey, which have been proliferating, are concentrated in the remaining pockets of standing water where snakes can gorge prior to the period of winter inactivity.

Winter: Giant garter snakes are dormant in the winter and rice fields are fallow.

Giant garter snakes require water during the active phase of their life cycle in the summer, and this summer aquatic habitat is essential because it supports the frogs, tadpoles, and small fish on which the giant garter snake preys (Paquin *et al.* 2006). Rice fields have become important for spring and summer habitat when the snakes are active and winter habitat when the snakes are hibernating, particularly where rice is associated with canals and their banks (Hansen 2004; Wylie 1998). While within the rice fields, snakes forage in the shallow water for prey, using rice plants and vegetated berms dividing rice checks for shelter and basking sites (Hansen and Brode 1993). If there is a shallow warm water wetland available to a gravid female as the time for birth approaches, she will move into that area to give birth. These shallow wetland areas (either a natural area or a rice field) are very productive during the July-August timeframe when the young of the year are born (E. Hansen, pers. comm. 2008). The presence of persistent shallow summer wetlands are vital for the survival of snake neo-nates to juvenile and adult because these wetlands provide ideal forage in the very productive water column and shelter areas where dense vegetation is present (E. Hansen, pers. comm. 2008.).

In the Natomas Basin in the Sacramento Valley, habitat used by snakes consisted almost entirely of irrigation ditches and established rice fields (Wylie 1998; Wylie *et al.* 2004b), while in the Colusa NWR, snakes were regularly found on or near edges of wetlands and ditches with vegetative cover (Wylie *et al.* 2003a). Telemetry studies also indicate that active snakes use uplands extensively, particularly where (wetland) vegetative cover exceeds 50 percent in the area (Wylie 1998).

Reasons for Decline and Threats to Survival
Loss and degradation of habitat: The current distribution and abundance of the giant garter snake is much reduced from former times (USFWS 1999). Prior to reclamation activities beginning in the mid- to late-1800s, about 60 percent of the Sacramento and San Joaquin Valleys was subject to seasonal overflow flooding providing expansive areas of snake habitat (Hinds 1952). Now, less than 10 percent, or approximately 319,000 acres (129,000 hectares) of the historic 4.5 million acres (1.8 million hectares) of Central Valley wetlands remain (USDOI 1994), of which very little provides habitat suitable for the giant garter snake. Loss of habitat due to wetland reclamation, agricultural activities and flood control have extirpated the snake from the southern one-third of its range in former wetlands associated with the historic Buena Vista, Tulare, and Kern lakebeds (R.W. Hansen 1980, Hansen and Brode 1980).

Valley floor wetlands are now subject to cumulative effects of upstream watershed modifications, water storage and diversion projects, as well as urban and agricultural development. The CVP, the largest water management system in California, created an ecosystem altered to such an extent that remaining wetlands depend on highly managed water regimes (USDOI 1994). For instance, on-going residential and commercial growth in the Central Valley between 1990 and 2004 is consuming an estimated 10,646 acres of Central Valley farmland each year, with an estimated additional loss of 821,046 acres by the year 2050 (American Farmland Trust 2007). Environmental impacts associated with urbanization include loss of biodiversity and habitat, alteration of natural fire regimes, fragmentation of habitat from road construction, and degradation due to pollutants. Further, encroaching urbanization can inhibit rice cultivation (J. Roberts, pers. comm. 2006). Rapidly expanding cities within the snake's range include Chico, Marysville, Yuba City, Galt, Stockton, Gustine, Los Banos and the cities of the Sacramento metropolitan area.

The primary threats to the giant garter snake continue to be habitat loss and degradation. For example, the American Farmland Trust (2007) projects a loss of more than one million acres of Central Valley farmland to residential and commercial uses by the year 2040 if the current rates of urbanization continue. Farmland lost to urbanization includes land that is presently cultivated in rice. The relatively abundant populations of giant garter snake in the Sacramento Valley may reflect the expansion of available habitat that is provided from rice cultivation. Dependence of populations on rice cultivation leaves the giant garter snake vulnerable to wide-scale habitat loss in the event of changes in crop type (e.g., grapes, fruit or nut producing orchards, or annual row crops such as wheat, tomatoes or cotton) to those less water intensive or land fallowing (Paquin *et al.* 2006) or encroaching urbanization, which may inhibit rice cultivation (J. Roberts, pers. comm. 2008) and changes in precipitation patterns and water availability and timing associated with climate change (CDWR 2008). Unlike flood irrigated rice fields, other agricultural cropping systems do not hold sufficient water for long enough time periods to create artificial, temporary wetlands. Giant garter snakes in the San Joaquin Valley are threatened by a lack of summer surface water in wetlands and fields, and the age structure of populations in this part of the range has been found to be senescing with very few if any young individual snakes being found during trapping surveys conducted over the last 5 years (Hansen 2008a). Availability of clean summer water is especially important for young snakes to survive and grow (E. Hansen, pers. comm. 2008).

The Final Rule to list giant garter snake noted the typical waterfowl habitat management prescription involves flooding when garter snakes are inactive and draining to promote dry conditions when garter snakes need the water during the active period of their life cycle from mid-spring to early fall. This is antithetical to the habitat requirements of the giant garter snake, which requires ponded water throughout this period. As such, water is drained during the giant garter snake birthing season of July to September, thereby eliminating any potential habitat value during this critical reproductive period. Receding water levels act to concentrate prey species and giant garter snakes in small depressions that hold residual water, which in turn attract large numbers of predators, especially predatory birds, such as herons, egrets, and hawks. Thus, these areas may function a population sinks, which attract adult and juvenile giant garter snakes but expose them to high levels of mortality, to the extent that recruitment to the population is negated. Consequently, the many State and Federal wildlife refuges and private lands managed primarily for waterfowl likely afford little or no habitat value to the giant garter snake (USFWS 1993a).

Ongoing maintenance of aquatic habitats for flood control and agricultural purposes eliminates or prevents the establishment of habitat characteristics required by snakes for survival, growth and reproduction (Hansen 1988). Such practices can fragment and isolate available habitat, prevent dispersal of snakes among habitat units, and adversely affect the availability of habitat required to produce the snakes' food items (Hansen 1988; Brode and Hansen 1992). For example, tilling, grading, harvesting and mowing may kill or injure giant garter snakes (Wylie *et al.* 1997). Biocides applied to control aquatic vegetation reduce cover for the snake and may be toxic to the snake or it's prey (Wylie *et al.* 1995). Rodent control threatens the snake's upland estivation habitat (Wylie *et al.* 1995; Wylie *et al.* 2004a). Restriction of suitable habitat to water canals bordered by roadways and levee tops renders snakes vulnerable to vehicular mortality (Wylie *et al.* 1997). Rolled erosion control products, which are frequently used as temporary berms to control and collect soil eroding from construction sites, can entangle and kill snakes (Stuart *et al.* 2001; Barton and Kinkead 2005). Livestock grazing along edges of water sources degrades water quality and can contribute to the reduction of available quality snake habitat (Hansen 1988; E. Hansen, pers. comm. 2008). Giant garter snakes have been observed avoiding areas that have been grazed by cattle (E. Hansen 2003). Fluctuation in rice and agricultural production affects stability and availability of habitat (Paquin *et al.* 2006; Wylie and Casazza 2001; Wylie *et al.* 2003b; Wylie *et al.* 2004b).

<u>Harassment associated with recreational activities:</u> Other land use practices also currently threaten the survival of the snake. Recreational activities such as fishing can disturb snakes and disrupt thermoregulation and foraging activities (E. Hansen, pers. comm. 2008). While large areas of seemingly suitable snake habitat exist in the form of private duck clubs and waterfowl management areas, water management of these areas typically does not provide summer water needed by the species (Beam and Menges 1997; Dickert 2005; Paquin *et al.* 2006).

Predation: Nonnative predators, including introduced predatory game fish, bullfrogs, and domestic cats, can threaten snake populations (Dickert 2003; Hansen 1986; USFWS 1993a; Wylie *et al.* 1995; Wylie *et al.* 2003c). Nonnative competitors such as the introduced water snake (*Nerodia fasciata*) in the American River and associated tributaries near Folsom, may also threaten the giant garter snake (Stitt *et al.* 2005). Giant garter snake populations appear to be much reduced or absent from areas supporting permanent populations of nonnative predators or competitors. Observations made during fish kills and episodic drying of ditches and canals throughout the study area suggest that the composition and population structure of predatory fishes in the San Joaquin Valley differ from those noted in the rice growing regions of the Sacramento Valley. Striped bass frequently exceeding three to five pounds have been commonly observed in all permanent ditches and drains observed throughout much of the San Joaquin Valley (Hansen 2008b). In addition, channel catfish and black basses from two to eight pounds were not uncommon to San Joaquin Valley waterways where giant garter snakes were once historically abundant. Striped bass have not been observed in the rice growing regions of the Sacramento Valley (Hansen 2005).

Predation by native species upon the giant garter snake has not been well documented. Anecdotal information includes observations of hawks, herons, and river otters preying upon the giant garter snake. Although no quantitative data exist on predation of giant garter snakes by river otters, three to four giant garter snakes have been observed that were believed to be killed by otters (G. Wylie *in litt.* 2006). According to Rossman *et al.* (1996), garter snakes may be important prey for several vertebrate predators including jays (*Cyanocitta cristata*) and crows (*Corvus brachyrhynchos*), carnivorous fish, and small mammals. Small native mammalian predators are likely to include raccoons, skunks, opossums, and foxes. Anthropogenic (human caused) changes in ecosystem dynamics and reductions in suitable habitat for giant garter snakes may favor and subsidize these predator populations. The result may be an increase in predation pressure upon the giant garter snake (USFWS 2006).

In rice growing regions, irrigation systems are dried down at the end of each growing season, preventing predatory fish from becoming large enough to consume giant garter snakes. Because much of the water conveyance infrastructure in the San Joaquin Valley is also used to divert tile and surface drainage and to provide water for overwintering waterfowl, the water in canals and ditches tends to be more permanent. Subsequently, unlike their counterparts in the rice growing regions of the Sacramento Valley, predatory fishes in the San Joaquin Valley likely grow through multiple seasons and attain larger sizes. Because much of the private wetlands in the San Joaquin Valley are dried down in the summer months (during the snake's active season) to support moist soil management, giant garter snakes are likely forced to forage and inhabit the waterways that form the foundation of irrigation and drainage systems, which likely exposes them to elevated rates of predation by these larger fishes (Hansen 2008b).

Contaminants: The disappearance of giant garter snakes from much of the west-side San Joaquin Valley was approximately contemporaneous with the expansion of subsurface drainage systems in the area, providing circumstantial evidence that the resulting contamination of ditches and sloughs with drainwater contstituents (principally selenium) may have contributed to the reduction in range of giant garter snake populations in this area (USFWS 1993a; 2006). 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. Dietary uptake is the principal route of toxic exposure to selenium in wildlife, including reptiles such as the giant garter snake (Beckon *et al*. 2003; Lemly 1996a; Maier and Knight 1991). Many open ditches in the San Joaquin Valley carry subsurface drainwater with elevated concentrations of selenium within the range and concentrations associated with adverse effects on predatory aquatic reptiles (Hopkins *et al.* 2002; Saiki 1998).

<u>Fragmentation and isolation of populations:</u> Extensive habitat destruction and fragmentation have contributed to smaller, more isolated populations of giant garter snakes. Small populations have a higher probability of extinction than large populations because their low abundance renders them susceptible to stochastic (i.e., random) events such as high variability in age and sex ratios, and catastrophes such as floods, droughts, or disease epidemics (Lande 1988; Frankham and Rails 1998; Saccheri et al. 1998). Similarly, isolated populations are more susceptible to extirpation by accidental or natural catastrophes because the likelihood of recolonization has been diminished. These chance events can adversely affect small, isolated populations with devastating results. Extirpation can even occur when the members of a small population are healthy, because whether the population increases or decreases in size is less dependent on the age-specific probabilities of survival and reproduction than on chance (sampling probabilities). Owing to the probabilistic nature of extinction, many small populations will eventually go extinct when faced with these stochastic risks (Caughley and Gunn 1996).

<u>Climate change and drought:</u> At present, there is no quantitative analysis of how ongoing climate change is currently affecting giant garter snakes in the San Joaquin Valley. Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field *et al*. 1999; Cayan *et al*. 2005; Cayan *et al*. 2006; IPCC 2007). Although predictions of future climatic conditions for smaller sub-regions in California remain uncertain (Christensen et al. 2007; Field *et a*l. 2007; Moser *et al*. 2009), daily minimum and maximum temperatures have begun to change (Moser *et al*. 2009), and interannual precipitation variability has already begun to increase (Kelly and Goulden 2008; Loarie *et al*. 2008). Across the mid-latitudes of the northern hemisphere, spring plant green-up has advanced by almost two weeks and animals in many areas are responding to such changes by breeding earlier and shifting their ranges (see review in Field *et al*. 2007). The California Department of Water Resources (CDWR) has described current climate change effects including reductions in early spring snowpack in the Sierra Nevada over the last century, a loss of 1.5 million AF of snowpack storage; sea level rise and ambient winter and night time temperature increases in a White Paper titled, "*Managing An*

Uncertain Future, Climate Change Adaptation Strategies for California's Water" (CDWR 2008).

The giant garter snake's dependence upon permanent wetlands signifies the importance of water availability on survival and recovery. In a state where wetland habitat is maintained by managed water regimes, competing interests may preclude consistent and timely delivery of water to sustain suitable habitat. Drought conditions will place additional strains on the water allocation system. Where populations persist on only marginal habitat, the addition of drought conditions is likely to result in high rates of mortality in the short term with the effects of low fecundity and survivorship persisting after the drought has ceased. It is unknown how quickly giant garter snake populations may rebound after severe climatic conditions (USFWS 2006).

Status with Respect to Recovery

The draft recovery plan for the giant garter snake subdivides its range into four proposed recovery units (USFWS 1999): (1) Sacramento Valley Recovery Unit; (2) Mid-Valley Recovery Unit; (3) San Joaquin Valley Recovery Unit; and (4) South Valley Recovery Unit.

The Sacramento Valley Unit at the northern end of the species' range contains sub-populations in the Butte Basin, Colusa Basin, and Sutter Basin (USFWS 1999; USFWS 2006). Protected snake habitat is located on State refuges and refuges of the Sacramento NWR Complex in the Colusa and Sutter Basins. Suitable snake habitat is also found in low gradient streams and along waterways associated with rice farming. This northernmost recovery unit is known to support relatively large, stable sub-populations of giant garter snakes (Wylie *et al* 1995; Wylie *et al.* 1997; Wylie *et al.* 2002a; Wylie *et al.* 2003a; Wylie *et al.* 2004a). Habitat corridors connecting subpopulations, however, are either not present or not protected, and are threatened by urban and agricultural encroachment; or changes in cropping patterns.

Studies by U.S. Geological Survey (USGS) Western Ecological Research Center are underway at the Colusa NWR and in the Colusa Basin Drainage Canal (Wylie 2000, 2003; Wylie and Martin 2004; Wylie *et al.* 1997; Wylie *et al.* 2002a; Wylie *et al.* 2003a, 2004a). Density estimates range from 58 to 152 snakes per mile (36 to 95 snakes per kilometer) depending on the trapping location (Wylie *et al.* 2004a). The size distributions found in the Colusa NWR continue to reflect a healthy population of giant garter snakes with successful recruitment of young (Wylie *et al.* 2004a). The Colusa NWR represents a stable, relatively protected sub-population of snakes within the Colusa Basin. Outside of protected areas, however, snakes in these Basin clusters are still subject to all threats identified in the final rule, including habitat loss due to development, maintenance of water channels, and secondary effects of urbanization. As reported in the Five Year Status Review (USFWS 2006), the abundance and distribution of giant garter snakes have not changed significantly since the time of listing. Although some snakes have been discovered in several southern populations that were thought to be extirpated, these populations remain in danger of extirpation because their numbers remain very low and discontinuous, and they are located on isolated patches of limited quality habitat. Further, the available information indicates a tenuous connection between sub-populations clustered at the northern and the southern end of the Basin.

Stony, Logan, Hunters, and Lurline Creeks, as well as the Colusa Drain, and Glenn-Colusa, Tehama-Colusa, and Colusa Basin Drainage Canals, Little Butte Creek between Llano Seco (NWR unit) and Upper Butte Basin WA; and Butte Creek between Upper Butte Basin and Gray Lodge WA; Lands adjacent to Butte Creek, Colusa Drainage Canal, Gilsizer Slough, the land side of the Toe Drain along the Sutter Bypass, Willow Slough and Willow Slough Bypass in Yolo County, and associated wetlands, are important as snake habitat and movement corridors for the animal. These waterways and associated wetlands provide vital permanent aquatic and upland habitat for snakes in areas with otherwise limited habitat.

The Mid-Valley Unit includes sub-populations in the American, Yolo, and Delta Basins (USFWS 1999; USFWS 2006). The status of Mid-Valley sub-populations is very uncertain; each is small, highly fragmented, and located on isolated patches of limited quality habitat that is increasingly threatened by urbanization (Hansen 2002, 2004; USFWS 1993a; Wylie 2003b; Wylie and Martin 2004; Wylie *et al.* 2004b; Wylie *et al*. 2005; G. Wylie, pers. comm. 2005).

The San Joaquin Valley Unit, which includes sub-populations in the San Joaquin Basin, formerly supported large snake populations, but numbers have severely declined, and recent survey efforts indicate numbers are extremely low compared to Sacramento Valley sub-populations (Dickert 2002, 2003; Hansen 1988; Williams and Wunderlich 2003; Wylie 1998). Giant garter snakes currently occur in the northern and central San Joaquin Basin within the Grassland Wetlands of Merced County and the Mendota WA of Fresno County; however, these sub-populations are extremely small, fragmented, and unstable; the numbers of individual snakes trapped over the last decade have declined dramatically in this area of the snake's historic range (Dickert 2003, 2005; G. Wylie, pers. comm. 2006; Hansen 2008a).

The South Valley Unit included sub-populations in the Tulare Basin, however, agricultural and flood control activities and lack of summer water habitat are presumed to have extirpated the snake from the Tulare Basin (Hansen 1995; Wylie and Amarello 2008). Wylie and Amarello (2008) surveyed locations in the Tulare Basin in 2006 including Buena Vista Lake, Fresno Slough, Kern Refuge, Kings River and North Kings River. No snakes were detected at any of the locations sampled. Wylie and Amarello noted that suitable habitat does exist in Kern NWR so that reintroduction may be considered feasible in the future should summer water supplies (incremental Level 4) be secured.

The draft recovery criteria require multiple, stable sub-populations within each of the recovery units, with sub-populations well-connected by corridors of suitable habitat. This entails that corridors of suitable habitat between existing snake sub-populations be maintained or created to enhance sub-population interchange to offset threats to the species (USFWS 1999). Currently, only the Sacramento Valley Recovery Unit is known to support relatively large, stable giant garter snake populations.

It is important to note that habitat corridors connecting sub-populations, even in the Sacramento Valley Recovery Unit, are either not present or not protected. Overall, the future availability of habitat in the form of canals, ditches, and flooded fields are subject to market-driven crop choices, agricultural practices, and urban development, and are, thus, uncertain and unpredictable.

Conservation Needs of Giant Garter Snake in the Action Area
The decline of giant garter snakes in the action area is due principally to loss and degradation of both aquatic and upland habitat and insufficient availability of summer wetland water supplies. Conservation measures, therefore, should protect and secure habitat in the Grasslands, and Mendota areas with an emphasis on protection and enhancement of habitat and connectivity between populations. These measures are listed as priority task one in the revised draft Giant Garter Snake Recovery Plan (USFWS 1999) and recommended future tasks in the Five-Year Review (USFWS 2006a). Additional priority task one measures include the development and implementation of management plans, acquisition of water rights for restoration of aquatic habitat and provision of summer water habitat, and studies to determine the effects of selenium to the species. Conservation easements in the Grasslands could be re-negotiated to include suitable management of lands to increase population numbers and to broaden distribution. Corridors, primarily aquatic corridors, could either be re-established and/or protected such that suitable habitat may be recolonized throughout the action area. Reconnecting the habitats occupied by the various sub-populations would also allow for an exchange of genetic material improving viability. Further, sources of selenium contamination in the Grassland wetland supply channels should be reduced or minimized from entering this water supply.

San Joaquin Kit Fox

Listing
The San Joaquin kit fox was listed as an endangered species on March 11, 1967 (USFWS 1967) (32 **FR** 4001) and was listed by the State of California as a threatened species on June 27, 1971. This canine is the umbrella species for the Recovery Plan for Upland Species of the San Joaquin Valley, California (USFWS 1998).

Description
The kit fox is the smallest canid species in North America and the San Joaquin kit fox is the largest subspecies in skeletal measurements, body size, and weight. Adult males average 80.5 centimeters (31.7 inches) in total length, and adult females average 76.9 centimeters (30.3 inches in total length (Grinnell *et al.* 1937). Kit foxes have long slender legs and are approximately 30 centimeters (12 inches) high at the shoulder. The average weight of adult males is 2.3 kilograms (5 pounds), and the average of adult females is 2.1 kilograms (4.6 pounds) (Morrell 1972).

General physical characteristics of kit foxes include a small, slim body, relatively large ears set close together, narrow nose, and a long, bushy tail tapering slightly toward the tip. The tail is typically carried low and straight.

Color and texture of the fur coat of kit foxes varies geographically and seasonally. The most commonly described colorations are buff, tan, grizzled, or yellowish-gray dorsal coats (McGrew 1979). Two distinctive coats develop each year: a tan summer coat and a silver-gray winter coat

(Morrell 1972). The ear pinna (external ear flap) is dark on the back side, with a thick border of white hairs on the forward-inner edge and inner base. The tail is distinctly black-tipped.

Historical and Current Range
In the San Joaquin Valley before 1930, the range of the San Joaquin kit fox extended from southern Kern County north to Tracy, San Joaquin County, on the west side, and near La Grange, Stanislaus County, on the east side (Grinnell ***et** al.* 1937; USFWS 1998). Historically, this species occurred in several San Joaquin Valley native plant communities. In the southernmost portion of the range, these communities included Valley Sink Scrub, Valley Saltbush Scrub, Upper Sonoran Subshrub Scrub, and Annual Grassland.

Kit foxes currently inhabit some areas of suitable habitat on the San Joaquin Valley floor and in the surrounding foothills of the coastal ranges, Sierra Nevada, and Tehachapi Mountains, from southern Kern County north to Contra Costa, Alameda, and San Joaquin Counties on the west, and near La Grange, Stanislaus County on the east side of the Valley, and some of the larger scattered islands of natural land on the Valley floor in Kern, Tulare, Kings, Fresno, Madera, and Merced Counties**.**

Table 4 provides the most current information on the status of kit fox populations including areas where the kit fox has declined or become locally extirpated. The largest extant populations of kit foxes are in western Kern County on and around the Elk Hills and Buena Vista Valley, Kern County, and in the Carrizo Plain Natural Area, San Luis Obispo County**.** Though monitoring has not been continuous in the central and northern portions of the range, populations were recorded in the late 1980s at San Luis Reservoir, Merced County (Briden *et al.* 1987); North Grasslands and Kesterson NWR area on the Valley floor, Merced County (Paveglio and Clifton 1988); and in the Los Vaqueros watershed, Contra Costa County in the early 1990s (USFWS 1998). Smaller populations are also known from other parts of the San Joaquin Valley floor, including Madera County and eastern Stanislaus County (Williams 1990).

Currently, the entire range of the kit fox appears to be similar to what it was at the time of the 1998 Recovery Plan; however, population structure has become more fragmented, at least some of the resident satellite subpopulations, such as those at Camp Roberts, Fort Hunter Liggett, Pixley National Wildlife Refuge NWR, and the San Luis NWR, have apparently been locally extirpated (White *et al*. 2000; Moonjian 2007; P. Williams, Kern NWR, *in litt.* 2007; B. Cypher, ESRP, *in litt.* 2007; R. Parris, San Luis NWR, *in litt*. 2007; M. Moore, Camp Roberts, *in litt*. 2008), and portions of the range now appear to be frequented by dispersers rather than resident animals (Moore *in litt*. 2008; M. Mueller, Contra Costa Water District, *in litt*. 2008; Cypher *in litt*. 2009). For example, at Fort Hunter Liggett, although approximately 36,000 acres is considered to be potential kit fox habitat, the greatest number of kit fox observed in one year was 22 (in 1990), and no kit fox have been observed since 2000 (USFWS 2007a). Kit fox abundance appears to be below detection levels in much of San Luis Obispo County outside of the Carrizo Plains (Moonjian 2007). Recent surveys have generally failed to detect kit fox subpopulations in the most northerly portion of the range (San Joaquin, Alameda, and Contra Costa Counties), although individual kit foxes have been observed periodically (CDFG 2008; Mueller *in litt.* 2008).

Table 4. Core and satellite areas identified as historically and/or currently occupied by subpopulation units of the San Joaquin kit fox.

Name	**Current trend**	**Last observed**	**Last surveyed**	**Reference**
Western Kern County Core Area	Inter-annual fluctuation based on environmental conditions. Slow overall decline expected due to continuing habitat loss.	2008	2008	Smith *et al*. 2006; CNDDB 2008; B. Cypher**; B. Cypher ***
Carrizo Plains Core Area	Inter-annual fluctuation	2006	2008	CNDDB 2008
Ciervo-Panoche Core Area	Presumed declining	2007	2005 - 2007	EG&G 1981; Smith *et al*. 2006; CNDDB 2008; B. Cypher ***
Alameda, Contra Costa, and San Joaquin Counties	Have declined, no known breeding	2002	Area-specific surveys§ in 1983, 2003	Orloff *et a*l. 1986; Smith *et al*. 2006; CNDDB 2008; B. Cypher**
Western Merced and Stanislaus Counties	Have declined, presence in S. portion	2005	Area-specific surveys§ in 2003	CNDDB 2008; B. Cypher**
Central Merced County	Presumed extirpated	2000		Parris *in litt*. 2007, 2008; CNDDB 2008; B. Cypher**
Western Madera County	Presumed extirpated	1990	Area-specific surveys§ in 2003	Smith *et al*. 2006; CNDDB 2008,
Southwestern Fresno County	Isolated	2005	None	CNDDB 2008
Southwestern Kings County	Isolated	2005	Area-specific surveys§ 2000, 2001	CNDDB 2008; CNDDB 2008,
Southwestern Tulare County	Isolated **(Pixley NWR extirpated)**	2004	Area-specific surveys§ 2004	Smith *et al*. 2006; CNDDB 2008; B. Cypher**
Tulare County Foothills	Unknown	1992	Area-specific surveys§ 2004	Smith *et al*. 2006; CNDDB 2008, B. Cypher**
Northwestern Kern County	Unknown	2006	Area-specific surveys§ 2004, 2005, 2006	CNDDB 2008, B. Cypher**
Northeast Bakersfield	Stable	2008	Area-specific surveys§ 2002-2006	CNDDB 2008, B. Cypher**
Metropolitan Bakersfield	Stable	2008	2008	CNDDB 2008, B. Cypher**
Cuyama Valley (San Luis Obispo and Santa Barbara Counties)	Unknown, presumed extant	1979	1979	CNDDB 2008, B. Cypher**
Salinas-Pajaro (San Luis Obispo, Monterey and San Benito Counties)	Camp Roberts: potentially extirpated **Fort Hunter Liggett: extirpated**	CR: 2007 FHL: 2000	Area-specific surveys§ at Camp Roberts: 2008 FHL: 2008	Moonjian 2007; Moore *in litt*. 2008. L. Clark 2008 *pers. comm.*

Bold = extirpated, with occasional sightings of presumed dispersers. ** B. Cypher, pers. comm. 2008 *** B. Cypher *in litt*. 2008.

§ Area-specific surveys are surveys occurring in specific areas within the core or satellite area.

Essential Habitat Components

Kit foxes prefer loose-textured soils (Grinnell *et al.* 1937; Hall 1946; Egoscue 1962; Morrell 1972), but are found on virtually every soil type. Dens appear to be scarce in areas with shallow soils because of the proximity to bedrock (O'Farrell and Gilbertson 1979; O'Farrell *et al.* 1980), high water tables (McCue *et al.* 1981), or impenetrable hardpan layers (Morrell 1972). However, kit foxes will occupy soils with a high clay content, such as in the Altamont Pass area in Alameda County, where they modify burrows dug by other animals (Orloff *et al.* 1986). Sites that may not provide suitable denning habitat may be suitable for feeding or providing cover.

[Note: The following sections discussing land values for kit fox were prepared for Reclamation by Brian Cypher in the report *Kit Fox Conservation in the San Luis Drainage Unit Study: Ecological Considerations Relevant to the Development of a Conservation Strategy for Kit Foxes* (Cypher 2006).]

<u>Natural Land Values</u>: Kit foxes are an aridland-adapted species. They occur in arid regions, typically deserts, throughout North America (Cypher 2003). Accordingly, in the San Joaquin Valley, optimal habitats for San Joaquin kit foxes generally are those in which conditions are more desert-like. These include arid shrublands and grasslands (USFWS 1998). These areas are characterized by sparse or no shrub cover, sparse ground cover with patches of bare ground, short vegetative structure (herbaceous vegetation < 18 inches tall), and sandy to sandy-loam soils.

Tall and/or dense vegetation generally is less optimal for foxes (Smith *et al.* 2005). Such conditions make it difficult for foxes to detect approaching predators or capture prey. Kit foxes also tend to avoid rugged, steep terrain. Predation risk apparently is higher for foxes under such topographic conditions (Warrick and Cypher 1998). In general, flat terrain or slopes under 5% are optimal, slopes of 5-15% are suitable, and slopes greater than 15% are unsuitable. For this reason, the foothills of the Coast Ranges generally are considered to demark the western boundary for suitable kit fox habitat. Finally, kit foxes appear to be strongly linked ecologically to kangaroo rats. Kit foxes are especially well adapted for preying on kangaroo rats, and consequently, kit fox abundance and population stability are highest in areas where kangaroo rats are abundant (USFWS 1998, Cypher 2003). Kangaroo rats also are aridland-adapted species, and thus, reach their greatest densities in the San Joaquin Valley in arid habitats.

Following are assessments of relative value for various natural habitats present in the San Joaquin Valley:

Saltbush scrub: This is an aridland habitat generally dominated by saltbush shrubs *(Atriplex* spp.), and with ground cover dominated by non-native Brome grasses *(Bromus* spp.). Kangaroo rats are abundant. This habitat is **optimal** for kit foxes, and they generally achieve their highest densities in areas with this habitat type (e.g., Lokern Natural Area, Buena Vista Valley, Carrizo Plain, Elkhorn Plain). Although this habitat is favorable for foxes, it should be noted that dense patches of shrubs provide cover for kit fox predators and may be avoided by foxes.

Arid grasslands: This is an aridland habitat with few or no shrubs, and which is dominated by non-native grasses, particularly red brome *(Bromus madritensis rubens)***.** Vegetation structure is low and patches of bare ground are common. Kangaroo rats are abundant. This habitat is **optimal** for kit foxes. Grazing can further reduce the vegetative structure rendering this habitat even more suitable.

Alkali sink: This habitat occurs in lower regions closer to the Valley center, and thus is subject to soil saturation and seasonal flooding in the winter and spring. It usually is dominated by iodine bush (*Allenrolfea* spp.) or sinkweed (*Suaeda* spp.) shrubs with a patchy, low-structure ground cover. Kangaroo rats can be abundant. This habitat can be **suitable** for kit foxes, particularly if slightly higher topography is available for dens.

Mesic grasslands: This habitat type is more common in the eastern and northern portions of the Valley where precipitation is more abundant. This type tends to have few or no shrubs and is dominated by non-native wild oat grasses *(Avena* spp.). Vegetation structure may be higher than 18 inches and dense, particularly in years with above-average precipitation, and this could result in increased predation risk for kit foxes. Bare ground may be sparse. The rodent community tends to be dominated by California ground squirrels instead of kangaroo rats. This habitat can be **suitable** for kit foxes, particularly if it is moderately-to-heavily grazed.

Oak woodland savannah: This habitat occurs primarily off the Valley floor up in the Coast Ranges. Oak trees *(Quercus* spp.) tend to form a sparse to moderate canopy, and the herbaceous cover is dominated by non-native wild oats and other grasses. Vegetation structure and density tends to be high with little bare ground. Kangaroo rats are not abundant and California ground squirrels are common. This type probably is **marginally suitable** for kit foxes at best, although grazing can improve vegetation structure for kit foxes.

Chaparral: This habitat occurs in higher, more-mesic areas in the Coast Ranges. It is characterized by a diverse and dense shrub community. Predation risk is high and kangaroo rats are uncommon. This habitat is **unsuitable** for kit foxes.

Wetland and riparian forests: These habitats are characterized by wetland and riparian vegetation that can be quite dense. Constant or periodic flooding preclude den establishment and kangaroo rats are less common. These habitats are **unsuitable** for kit foxes.

<u>Agricultural Land Values:</u> Agricultural lands inherently present challenges for kit foxes. Ground disturbance is frequent (e.g., tilling, maintenance, harvesting), which can destroy dens. Also, most agricultural lands in the Valley are irrigated, which can flood and collapse dens. Agricultural lands also are subject to intensive chemical applications, including fertilizers, pesticides, and defoliants. Use of rodenticides is common in some agricultural environments and is particularly problematic for kit foxes due to the potential for secondary poisoning. Finally, all of the factors above in addition to the relative sterility of most agricultural fields (e.g., weed suppression) result in a lack of prey availability for kit foxes.

Another detrimental attribute of agricultural lands is the presence of coyotes and non-native red foxes. Coyotes are the primary cause of mortality for kit foxes in most areas (Cypher *et al.*

2003). The threat to kit foxes from red foxes is still being evaluated, but the potential for both interference and exploitative competition is high (Cypher *et al.* 2001). These highly adaptable species are able to persist in agricultural lands. They are not dependent on dens for cover, they are highly mobile which facilitates avoiding dangers and locating food, and they are highly omnivorous. Also, kit foxes are more vulnerable to predation in agricultural areas due to the relative scarcity of den sites, as described previously. Thus, agricultural lands are generally not suitable for long-term occupation by kit foxes, although lands adjacent to natural habitats may be used for occasional foraging (Warrick *et al.* 2007).

Most available information on the value of agricultural lands to kit foxes is qualitative in nature, but one quantitative investigation has been conducted (Warrick *et al.* 2007). Following are assessments of relative value for several types of agricultural lands:

Annual crops (e.g., cotton, tomatoes, alfalfa, carrots): Lands with these crops usually have low to no prey (except possibly alfalfa), and are subject to frequent disturbance, irrigation, and chemical application. Kit foxes do not appear able to permanently occupy these lands, and use primarily appears limited to occasional foraging when these lands are adjacent to natural habitats.

Orchards (e.g., fruit trees, nut trees): Lands with these crops are not always cleared of all herbaceous vegetation, and therefore sometimes may support some prey (primarily ground squirrels, deer mice, and house mice). Also, the open understory of orchards facilitates predator detection by kit foxes. Kit foxes have been observed to forage in orchards as well as to occasionally spend a day or so resting, usually in man-made structures (e.g., pipes, rubble piles). Orchards are probably relatively permeable for kit foxes, although the risk of an unsuccessful crossing most likely increases with distance.

Vineyards: Lands with these crops are not always cleared of all herbaceous vegetation, and therefore sometimes may support some prey (primarily ground squirrels, mice). Vineyards probably are permeable to kit foxes, but as with orchards, the risk of an unsuccessful crossing most likely increases with distance. Also, the rodent-proof fences erected around some vineyards would severely inhibit entry by kit foxes.

Fallow lands: Some agricultural lands may be fallowed for a season, a year, or multiple years. The value of these lands for kit foxes is highly dependent upon the duration of fallowing and the location of the lands. Lands that are fallowed for only a season likely have little value to foxes. Generally, a season is not sufficient time for a prey base to reestablish. Also, renewed ground disturbance and irrigation at the end of the season likely would result in the destruction of any fox dens created during the fallow period. Lands that are fallowed for 1 or more years could have greater value to kit foxes. This time period might be sufficient for the reestablishment of some prey and the creation of dens. Lands fallowed for multiple years could even potentially be used by kit foxes to produce and raise young. Kit foxes likely would be forced from these lands when they were returned to agricultural production. Kit foxes would be at risk of injury or death during the reinitiation of agricultural activities if they failed to vacate the property in a timely manner. Foxes that did vacate also would be at greater risk if they were forced into unfamiliar areas.

Fallow lands immediately adjacent to natural lands might be used relatively quickly by kit foxes. In Kern County near Bakersfield, foxes have been observed to utilize agricultural lands within weeks of being fallowed with use increasing as these lands remained fallowed (B. Cypher, pers. comm. 2008). As the distance between fallow lands and occupied habitat increases, the potential for use by kit foxes decreases. As described above, kit foxes face risks when crossing agricultural lands and this risk may preclude colonization or use of fallow lands that are not adjacent to occupied habitat.

Foraging Ecology

The diet of the San Joaquin kit fox varies geographically, seasonally, and annually, based on temporal and spatial variation in abundance of potential prey. In the southern portion of their range, kangaroo rats, pocket mice, white-footed mice (*Peromyscus* spp.), and other nocturnal rodents comprise about one-third or more of their diets. Kit foxes are also known to prey on California ground squirrel, black-tailed hares, San Joaquin antelope squirrels, desert cottontails, ground nesting birds, and insects (Scrivner *et* al. 1987a; Cypher and Brown 2006). Known prey species of the kit fox include white-footed mice, insects, California ground squirrels, kangaroo rats (*Dipodomys* spp.), San Joaquin antelope squirrels, black-tailed hares (*Lepus californicus*), and chukar (*Alectoris chukar*) (Jensen 1972, Archon 1992), listed in approximate proportion of occurrence in fecal samples. Kit foxes also prey on desert cottontails (*Sylvilagus audubonii*), ground-nesting birds, and pocket mice (*Perognathus* spp.).

Recent studies have supported early observations that kit fox appear to be strongly linked ecologically to kangaroo rats. In natural areas, kit fox density and population stability are highest in areas with abundant kangaroo rats (Spiegel *et al*. 1996; Cypher *et al*. 2000; Cypher 2006; see also Bean and White 2000). Cypher *et al*. (2000) has documented that annual finite growth rates were positively correlated with consumption of kangaroo rats and negatively correlated with consumption of other prey items, suggesting that kit fox in the area feed preferentially on kangaroo rats and that declines in kangaroo rat densities negatively affect kit fox survival. An annual finite growth rate (or annual finite rate of increase) is a measure of the relative rate of growth of a population. Local extirpation of kit fox communities has also been linked to the previous loss of kangaroo rat populations (Bean and White 2000; Williams *in litt*. 2007).

In some locations ground squirrels have been identified as the primary prey consumed by the kit fox (Orloff *et al*. 1986). California ground squirrels were found to be the most common prey item in the Bethany Reservoir area of Alameda County (Orloff *et al*. 1986). No kangaroo rats were detected at this site (Orloff *et al*. 1986), but ground squirrels have also been important food items in some areas where kangaroo rats appeared to be abundant (Balestreri 1981), although the relative densities of kangaroo rats in these areas is not known. In eastern Contra Costa County, a crash in the kit fox population was associated with extirpation of the California ground squirrel due to a ground squirrel eradication program (Orloff *et al*. 1986). To date no studies have addressed the energetic relationships for the kit fox associated with capture effort and food value of different prey species. In the Bakersfield vicinity, urban fox have access to anthropogenic food resources to supplement available natural prey so, in general, food is abundant and fox abundance shows little inter-annual variation (Cypher *in litt*. 2007, as cited in Ralls *et al.* 2007).

Precipitation-mediated changes in prey availability are most often related to changes in vegetation. Low precipitation levels characteristic of droughts result in reduced seed production in the natural habitats of the San Joaquin Valley (Germano and Williams 2005; Rathbun 1998; Williams *et al*. 1993, all cited in Bureau of Land Management [BLM] 2008). During several years of drought, seed resources for granivorous rodents, such as kangaroo rats, become scarce, resulting in declining abundance of these kit fox prey species (see Williams *et al*. 1993, Rathbun 1998, Germano and Williams 2005, all cited in BLM 2008j). Declining prey levels usually continue until higher germination of annual plants resumes with average precipitation levels (Cypher *et al*. 2000). In many locations, population abundance of kit fox responds to lower prey abundance by declining, although there generally is a lag-time of one or more years before kit fox declines occur (Cypher *et al*. 2000; Dennis and Otten 2000). High rainfall events also are known to reduce prey abundance dramatically (Cypher *in litt.* 2007; Williams *in litt.* 2007).

The diets and habitats selected by coyotes and kit foxes living in the same areas are often quite similar. Hence, the potential for resource competition between these species may be quite high when prey resources are scarce such as during droughts, which are quite common in semi-arid, central California. Competition for resources between coyotes and kit foxes may result in kit fox mortalities. Coyote-related injuries accounted for 50 to 87 percent of the mortalities of radio collared kit foxes at Camp Roberts, the Carrizo Plain Natural Area, the Lokern Natural Area, and the Naval Petroleum Reserves (Cypher and Scrivner 1992; Standley *et* al. 1992).

Reproductive Ecology and Demography
Adult San Joaquin kit foxes are usually solitary during late summer and fall. In September and October, adult females begin to excavate and enlarge natal dens (Morrell 1972). Typically, pups are born between February and late March following a gestation period of 49 to 55 days (Egoscue 1962; Morrell 1972). Mean litter sizes reported for San Joaquin kit foxes range from 2.0 young (White and Ralls 1993) to 3.8 young at the Naval Petroleum Reserve (Spencer *et al.* 1992; Spiegel and Tom 1996; Cypher *et al.* 2000). Pups appear above ground at about age 3 to 4 weeks, and are weaned at age 6 to 8 weeks.

The proportion of females bearing young, of adult San Joaquin kit foxes vary annually with environmental conditions, particularly food availability. Annual rates range from 0 to 100 percent, and reported mean rates include 61 percent at the Naval Petroleum Reserve (Cypher *et al.* 2000), 64 percent in the Lokern area (Spiegel and Tom 1996), and 32 percent at Camp Roberts (Spencer *et al.* 1992). Although some yearling female kit foxes will produce young, most do not reproduce until age 2 years (Spencer *et al.* 1992; Spiegel and Tom 1996; Cypher *et al.* 2000). Some young of both sexes, but particularly females may delay dispersal, and may assist their parents in the rearing of the following year's litter of pups (Spiegel and Tom 1996). The young kit foxes begin to forage for themselves at about four to five months of age (Koopman *et al.* 2000; Morel1 1972).

Mean annual survival rates reported for adult San Joaquin kit foxes range from 44 to 60 percent (Cypher *et al.* 2000; Standley *et* al. 1992; Spiegel and Disney 1996; Ralls and White 1995).

However, survival rates vary widely among years (Spiegel and Disney 1996; Cypher *et al.* 2000). Mean survival rates for juvenile San Joaquin kit foxes (< 1 year old) are lower than rates for adults. Survival to age 1 year ranged from 14 to 21 percent (Cypher *et al.* 2000; Standley *et al.*1992; Ralls and White 1995). For both adults and juveniles, survival rates of males and females are similar. San Joaquin kit foxes may live to ten years in captivity (McGrew 1979) and 8 years in the wild (Berry *et al.* 1987).

Estimates of fox density vary greatly throughout its range, and have been reported as high as 1.2 animals per square kilometer in optimal habitats in good years (USFWS 1998). At the Elk Hills in Kern County, density estimates varied from 0.7 animals per square kilometer in the early 1980s to 0.01 animals per square kilometer in 1991 (USFWS 1998). Kit fox home ranges vary in size from approximately 2.6 square kilometers to 31.2 square kilometers (Spiegel and Tom 1996; USFWS 1998). Knapp (1978) estimated that a home range in agricultural areas is approximately 2.5 square kilometers. Individual home ranges overlap considerably, at least outside the core activity areas (Morrell 1972; Spiegel 1996).

Movements and Habitat Use
Although most young kit foxes disperse less than 8 kilometers (Scrivner *et al.* 1987b), dispersal distances of up to 122 kilometers have been documented for the San Joaquin kit fox (Scrivner *et al.* 1993; USFWS 1998). Dispersal can be through disturbed habitats, including agricultural fields, and across highways and aqueducts. The age at dispersal ranges from 4 to 32 months (Cypher 2000). Among juvenile kit foxes surviving to July 1 at the Naval Petroleum Reserve, 49 percent of the males dispersed from natal home ranges while 24 percent of the females dispersed (Koopman *et al.* 2000). Among dispersing kit foxes, 87percent did so during their first year of age. Some kit foxes delay dispersal and may inherit their natal home range.

San Joaquin kit foxes are primarily nocturnal, although individuals are occasionally observed resting or playing (mostly pups) near their dens during the day (Grinnell *et al.* 1937). A mated pair of kit foxes and their current litter of pups usually occupy each home range. Other adults, usually offspring from previous litters, also may be present (Koopman *et al.* 2000), but individuals often move independently within their home range (Cypher 2000). Average distances traveled each night range from 9.3 to 14.6 kilometers and are greatest during the breeding season (Cypher 2000).

Kit foxes maintain core home range areas that are exclusive to mated pairs and their offspring (White and Ralls1993, Spiegel 1996, White and Garrott 1997). This territorial spacing behavior eventually limits the number of foxes that can inhabit an area owing to shortages of available space and per capita prey. Hence, as habitat is fragmented or destroyed, the carrying capacity of an area is reduced and a larger proportion of the population is forced to disperse. Increased dispersal generally leads to lower survival rates and, in turn, decreased abundance because greater than 65 percent of dispersing juvenile foxes die within 10 days of leaving their natal range (Koopman *et al.* 2000).

Kit fox establish home ranges that are extensive, but home range sizes vary among locations. Home range size is thought to be related to prey abundance (White and Ralls 1993; White and Garrott 1997). At the National Petroleum Reserves (NPRC), Cypher *et al*. (2001) determined the mean adult home range size to be 1,071.7± 352.1 acres, while the mean home range for pups was 525.4±61.8 acres. Kit fox on the Carrizo Plains establish home ranges estimated to average approximately 2866 acres in size (White and Ralls 1993). In western Merced County, Briden *et al*. (1988) found that denning ranges (the area encompassing all known dens for an individual) average 1169 acres (1.8 square miles) in area. However, at Camp Roberts Army National Guard Training Site (Camp Roberts), the average home range was found to be 5,782 acres, based on a radio-telemetry study (Root and Eliason 2001, as cited in CANG 2008). Urban fox have access to anthropogenic food sources and fox in this urban area have smaller home ranges than those in non-urban areas.

The San Joaquin kit fox seems to prefer more gentle terrain and decreases in abundance as terrain ruggedness increases (Grinnell *et al.* 1937; Morrell 1972; Warrick and Cypher 1998). The kit fox is often associated with open grasslands, which form large contiguous blocks within the eastern portions of the range of the animal. San Joaquin kit foxes also exhibit a capacity to utilize habitats that have been altered by humans. The listed canine can utilize some types of agriculture (e.g. orchards and alfalfa), although the long-term suitability of these habitats is unknown (Jensen 1972; USFWS 1998). Orchards sometimes support prey species if the grounds are not manicured; however, denning potential is typically low and kit foxes can be more susceptible to predation by coyotes within the orchards (Orloff 2002). Alfalfa fields provide an easily accessible prey base (Woodbridge 1998; Young 1989), and berms adjacent to alfalfa fields sometimes provide good denning habitat (Morrell 1972).

Kit foxes use some types of agricultural land where uncultivated land is maintained, allowing for denning sites and a suitable prey base (Knapp 1978; Hansen 1988; Warrick ***et al.*** 2007). In the Lost Hills area, radio collared kit foxes predominantly used natural habitat remaining in the California Aqueduct right-of-way (Warrick *et al.* 2007), even though this habitat had lower availability relative to other habitats. Orchards were the second most frequently used habitats, followed by row crops and other habitats (residential, grassland, and fallow fields). Kit foxes were documented to travel a maximum distance of 1.5 kilometers into orchards and 1.1 kilometers into row crops (Warrick *et al.* 2007). No dens were observed in the agricultural areas. Kit foxes appear reluctant to cross these lands due to insufficient refugia from predators (Cypher *et al.* 2005). The lack of kit fox occupancy in farm land is in contrast to observations of the closely related swift fox in western Kansas (Jackson and Choate 2000; Matlack *et al.* 2000). Differences in habitat use between the species may be due to differences in farming practices (Warrick *et al.* 2007). Farmland in the San Joaquin Valley is more heavily disturbed. The farmlands are irrigated, and fields are not left fallow for as long a duration as the farmlands in Kansas. These practices in California likely result in a sparse prey base and unsuitable habitat for denning, discouraging the kit fox from occupying agricultural lands.

Dens are used by kit foxes for temperature regulation, shelter from adverse environmental conditions, and escape from predators. Kit foxes are reputed to be poor diggers, and their dens are usually located in areas with loose-textured, friable soils (Morrell 1972; O'Farrell 1984). However, the depth and complexity of their dens suggest that they possess good digging abilities, and kit fox dens have been observed on a variety of soil types (USFWS 1998). Some studies have suggested that where hardpan layers predominate, kit foxes create their dens by enlarging the burrows of California ground squirrels (*Spermophilus beecheyi*) or badgers (*Taxidea taxus)* (Jensen 1972; Morrell 1972; Orloff *et al.* 1986). In parts of their range, particularly in the foothills, kit foxes often use ground squirrel burrows for dens (Orloff *et al.* 1986). Kit fox dens are commonly located on flat terrain or on the lower slopes of hills. About 77 percent of all kit fox dens are at or below midslope (O'Farrell 1984), with the average slope at den sites ranging from 0 to 22 degrees (CDFG 1980; O'Farrell 1984; Orloff *et al.* 1986). Natal and pupping dens are generally found in flatter terrain. Common locations for dens include washes, drainages, and roadside berms. Kit foxes also commonly den in human-made structures such as culverts and pipes (O'Farrell 1984; Spiegel and Tom 1996). In the Bakersfield vicinity, kit fox selection of den sites appears to be associated with areas of open space, or areas having light or infrequent disturbance, such as canal right of ways and detention basins (Bjurlin *et al*. 2005).

Natal and pupping dens may include from two to 18 entrances and are usually larger than dens not used for reproduction (O'Farrell *et al.* 1980; O'Farrell and McCue 1981). Natal dens may be reused in subsequent years (Egoscue 1962). It has been speculated that natal dens are located in the same location as ancestral breeding sites (O'Farrell 1984). Active natal dens are generally 1.9 to 3.2 kilometers from the dens of other mated kit fox pairs (Egoscue 1962; O'Farrell and Gilbertson 1979). Natal and pupping dens usually can be identified by the presence of scat, prey remains, matted vegetation, and mounds of excavated soil (i.e., ramps) outside the dens (O'Farrell 1984). However, some active dens in areas outside the valley floor often do not show evidence of use (Orloff *et al.* 1986). During telemetry studies of kit foxes in the northern portion of their range, 70 percent of the dens that were known to be active showed no sign of use (e.g., tracks, scats, ramps, or prey remains) (Orloff *et al.* 1986).

A kit fox can use more than 100 dens throughout its home range, although on average, an animal will use approximately 12 dens a year for shelter and escape cover (Cypher *et al.* 2001). Kit foxes typically use individual dens for only brief periods, often for only one day before moving to another den (Ralls *et al.* 1990). Possible reasons for changing dens include infestation by ectoparasites, local depletion of prey, or avoidance of coyotes. Kit foxes tend to use dens that are located in the same general area, and clusters of dens can be surrounded by hundreds of hectares of similar habitat devoid of other dens (Egoscue 1962). In the southern San Joaquin Valley, kit foxes were found to use up to 39 dens within a denning range of 129 to 195 hectares (Morrell 1972). An average den density of one den per 28 to 37 hectares was reported by O'Farrell (1984) in the southern San Joaquin Valley.

Reasons for Decline and Threats to Survival
The distribution and abundance of the kit fox have decreased since its listing in 1967. This trend is reasonably certain to continue into the foreseeable future unless measures to protect, sustain, and restore suitable habitats, and alleviate other threats to their survival and recovery, are implemented. Threats that are seriously affecting kit foxes are described in further detail in the following paragraphs.

Loss of habitat: Less than 20 percent of the habitat within the historical range of the kit fox remained when the subspecies was listed as endangered in 1967, and there has been substantial net loss of habitat since that time. Historically, San Joaquin kit foxes occurred throughout California's Central Valley and adjacent foothills. Extensive land conversions in the Central Valley began as early as the mid-1800's with the Arkansas Reclamation Act. By the 1930s, the range of the kit fox had been reduced to the southern and western parts of the San Joaquin Valley (Grinnell *et al.* 1937). The primary factor contributing to this restricted distribution was the conversion of native habitat to irrigated cropland, industrial uses (e.g., hydrocarbon extraction), and urbanization (Laughrin 1970; Jensen 1972; Morrell 1972, 1975). Approximately one-half of the natural communities in the San Joaquin Valley were tilled or developed by 1958 (USFWS 1980).

This rate of loss accelerated following the completion of the CVP and the SWP, which diverted and imported new water supplies for irrigated agriculture (USFWS 1995). Approximately 7,972 square kilometers of habitat, or about 267 square kilometers per year, were converted in the San Joaquin region between 1950 and 1980 (CDFG 1988). The counties specifically noted as having the highest wildland conversion rates included Kern, Tulare, Kings and Fresno, all of which are occupied by kit foxes. From 1959 to 1969 alone, an estimated 34 percent of natural lands were lost within the then-known kit fox range (Laughrin 1970).

Land conversions contribute to declines in kit fox abundance through direct and indirect means: mortalities, displacement, reduction of prey populations and denning sites, changes in the distribution and abundance of larger canids that compete with kit fox for resources, and reductions in carrying capacity (Jensen 1972; Morrell 1975). Dens are essential for the survival and reproduction of kit fox, as the fox use dens year-round for shelter and escape, and in the spring for rearing young (Cypher *et al*. 2000). Kit fox may be buried in their dens during land conversion activities (Branco 2007), or permanently displaced from areas where structures are erected or the land is intensively irrigated (Jensen 1972; Morrell 1975). In addition to the direct loss of habitat for denning and foraging by kit fox, land conversion and associated human-intensive uses can bring additional stressors, including human disturbance, fire suppression, and pest control (Bunn *et al*. 2007).

Moderate fragmentation or loss of habitat may be an important factor impacting the abundance and distribution of kit fox (Bjurlin *et al*. 2005; Warrick *et al*. 2007). Capture rates of kit foxes at the Naval Petroleum Reserve in Elk Hills were negatively associated with the extent of oil-field development after 1987 (Warrick and Cypher 1998). Likewise, the CEC found that the relative abundance of kit foxes was lower in oil-developed habitat than in nearby undeveloped habitat on the Lokern (Spiegel 1996). Researchers from both studies inferred that the most significant effect of oil development was the lowered carrying capacity for populations of both foxes and their prey species owing to the changes in habitat characteristics or the loss and fragmentation of habitat (Spiegel 1996, Warrick and Cypher 1998).

Land conversions and associated human activities can lead to widespread changes in the availability and composition of mammalian prey for kit foxes. For example, oil field disturbances in western Kern County have resulted in shifts in the small mammal community from the primarily granivorous species that are the staple prey of kit foxes, to species adapted to early successional stages and disturbed areas (e.g., California ground squirrels) (Spiegel 1996). Because more than 70 % of the diets of kit foxes usually consist of abundant leporids (*Lepus*, *Sylvilagus*) and rodents (e. g., *Dipodomys* spp.), and kit foxes often continue to feed on their staple prey during ephemeral periods of prey scarcity, such changes in the availability and selection of foraging sites by kit foxes could influence their reproductive rates, which are strongly influenced by food supply and decrease during periods of prey scarcity (White and Garrott 1997, 1999).

Dens are essential for the survival and reproduction of kit foxes that use them year-round for shelter and escape, and in the spring for rearing young. Kit foxes generally have dozens of dens scattered throughout their territories. However, land conversion reduces the number of typical earthen dens available to kit foxes. For example, the average density of typical, earthen kit fox dens at the Naval Hills Petroleum Reserve was negatively correlated with the intensity of petroleum development (Zoellick *et al*. 1987), and almost 20 % of the dens in developed areas were found to be in well casings, culverts, abandoned pipelines, oil well cellars, or in the banks of sumps or roads (USFWS 1983). These results are important because the Califoria Energy Commission (CEC) found that, even though kit foxes frequently used pipes and culverts as dens in oil-developed areas of western Kern County, only earthen dens were used to birth and wean pups (Spiegel 1996). Similarly, kit foxes in Bakersfield use atypical dens, but have only been found to rear pups in earthen dens (P. Kelly, Endangered Species Recovery Program, Fresno, pers. comm. to P. White, Fish and Wildlife Service, Sacramento, 2000). Hence, the fragmentation of habitat and destruction of earthen dens could adversely affect the reproductive success of kit foxes. Furthermore, the destruction of earthen dens may also affect kit fox survival by reducing the number, distribution and availability of escape refuges.

Habitat loss and modification due to agricultural conversion: In the San Joaquin and associated valleys, and in the border foothill areas, conversion of natural habitat to intensive agriculture continues to be the primary cause of habitat loss for the San Joaquin kit fox (Cypher *et al*. 2007). Conversion of natural lands to agriculture has continued since the kit fox was listed. By 1979, only approximately 1,497 square kilometers (370,000 acres) out of a total of approximately 34,400 square kilometers (8.5 million acres) on the San Joaquin Valley floor remained as undeveloped land (Williams 1985; USFWS 1980). Data from the CDFG (1985) and USFWS file information indicate that between 1977 and 1988, essential habitat for the blunt-nosed leopard lizard, a species that occupies habitat that is also suitable for kit foxes, declined by about

80 percent – from 311,680 acres to 63,060 acres, an average of about 22,000 acres per year (Biological Opinion for the Interim Water Contract Renewal, Service File No. 00-F-0056, February 29, 2000). Virtually all of the documented loss of essential habitat was the result of conversion to irrigated agriculture.

During 1990 to 1996, a gross total of approximately 71,500 acres of habitat were converted to farmland in 30 counties (total area 23.1 million acres) within the Conservation Program Focus area of the CVP. This figure includes 42,520 acres of grazing land and 28,854 acres of "other" land, which was predominantly comprised of native habitat. During this same period, approximately 101,700 acres were converted to urban land use within the Conservation Program Focus area (California Department of Conservation 1994, 1996, 1998). This figure comprises 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 Central 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.

Recent unauthorized conversions of suitable kit fox habitat to agriculture have also been documented on a smaller scale in the San Joaquin Valley. For example, in 2006, approximately 1,300 acres of saltbush scrub and sink scrub habitat along I-5 north of the Kings-Kern county line were disked and converted to agriculture (J. Vance, CDFG, *in litt.* 2006).

Denning opportunities on land converted to agriculture are limited due to agricultural practices, such as cultivation, irrigation, chemical treatments, and other disturbances. The loss of denning habitat can impede successful migration of kit fox across agricultural lands because of greater vulnerability to predation resulting from a lack of possible escapes.

Kit foxes use some types of agricultural land where uncultivated land is maintained, allowing for denning sites and a suitable prey base (Jensen 1972; Knapp 1978; Hansen 1988). Kit foxes also den on small parcels of native habitat surrounded by intensively maintained agricultural lands (Knapp 1978), and adjacent to dryland farms (Jensen 1972; Kato 1986; Orloff *et al.* 1986).

Habitat loss and modification due to urbaninzation: Loss and modification of habitat to urban development continues to be a threat to the kit fox throughout its range. Development along the San Joaquin Valley periphery continues to restrict both core habitat and movement corridors for the kit fox. The increasing human population of California, with the concomitant high demand for limited supplies of land, water, and other resources, has been identified as the primary underlying cause of habitat loss and degradation (Bunn *et al*. 2007). Between 1970 and 2000, the human population of the San Joaquin Valley doubled in size; it is expected to more than double again by 2040 (Field *et al.* 1999; Teitz *et al*. 2005). In roughly the same period (between 1987 and 2007), the Biological Opinions and Habitat Conservation plans completed by the Service's SFWO covered projects with permanent impacts to approximately 114,000 acres of natural habitat considered to be suitable for the San Joaquin kit fox. These projects also resulted in temporary impacts to close to an additional 20,100 acres of kit fox habitat (USFWS, unpublished data).

On the floor of the valley, urbanization occurs most often on previously cultivated lands, where natural habitat has been lost or degraded (Bunn *et al*. 2007). However, urbanization is also occurring along all edges of the San Joaquin Valley in areas of extant natural habitat that is important to the kit fox. Within these areas, cities that are undergoing substantial growth include, but are not limited to, Livermore, Antioch, Tracy, and Los Banos, in the northwestern portion of the fox's range; and Paso Robles, Tulare, and Bakersfield in the southern portion of the range. The City of Tracy has grown by 41 percent between 2000 and 2006, resulting in the loss and fragmentation of remaining kit fox habitat in the area. For example, a development proposed for the Tracy Hills would occupy all natural habitat having less than a 15 percent slope for a 2-mile portion of the kit fox corridor, while only preserving steeper areas for the kit fox, thereby reducing the width and viability of the needed kit fox corridor. Because the planned corridor is an integral part of the kit fox strategy for this area, construction of the proposed development is expected to place the strategy at risk (N. Pau, Service, *in litt*. 2002). Although the project has not been built as of 2009, Service files indicate that it is once again moving forward.

Habitat loss, modification, and fragmentation due to construction of solar facilities: A number of large-scale solar development projects that would threaten kit fox population clusters are currently proposed for construction in kit fox habitat. Within the Carrizo Core Area, two solar firms propose to install solar panels on 13 square miles of land on the valley floor of the Carrizo Plain, San Luis Obispo County, just north of the Carrizo Plain National Monument (DeBare 2008). Although this area of the Carrizo has a fair amount of dryland farming and is less likely to be optimal kit fox habitat than land within the National Monument (B. Cypher pers. comm. 2008), these projects will create barriers to the linkage between the Carrizo Plain Core Area, the Western Kern core area, and core and satellite areas to the north and west, thereby impeding kit fox dispersal and increasing habitat fragmentation. The Service expects that additional solar projects will be proposed on lands important to the kit fox at the southern extent of its range.

H*abitat loss and modification due to oil extraction and mining activities:* At the time that the San Joaquin kit fox was federally listed, extraction of petroleum products (including crude oil, propane, natural gas, etc.) was not considered to be a threat to the kit fox, as most of the petroleum-producing land was still relatively undisturbed (Jensen 1972). The Service has not found information to indicate that gravel and sand mining activities were considered to be a threat to the kit fox at the time of listing.

Currently, oil extraction and gravel mining may pose both direct and indirect risks to the San Joaquin kit fox. Direct risks to kit fox from oil-field development include human disturbance, loss of habitat and den sites (Zoellick *et al*. 1987; Spiegel and Small 1996; Warrick and Cypher 1998; Cypher *et al*. 2000; P. Kelly, Endangered Species Recovery Program, pers. comm. to P. White, USFWS, 2000; BLM 2008j), entombment, entrapment in sumps or oil spills, and exposure to contaminants (Spiegel and Disney 1996; Warrick and Cypher 1999; Cypher *et al*.

2000). San Joaquin kit fox have appeared to be tolerant of human activities; they have frequently been observed around facilities and are known to use manmade structures (pipe, culverts, foundations) as dens, although with some mortality (Cypher *et al*. 2000; BLM 2008j), suggesting that the direct effects of low density oil-field development on kit fox dynamics may be minimal (Warrick and Cypher 1998).

Indirect effects of oilfield development on kit fox include changes to remaining habitat, and changes in predator and prey community composition and abundance. Oil spills may create short-term disruptions of primary travel routes and foraging areas for fox (BLM 2008j). Between 1976 and 1995 oil spills that occurred on 64 sites resulted in effects to an unquantified number of acres that were contaminated by chromium, arsenic, and other materials, although all sites were remediated by 1995 (USFWS 1995). Short-term effects of oil spills have included a 67 percent difference in abundance of Heerman's kangaroo rats (*Dipodomys heermanni*) between spill areas and control areas (Warrick *et al.* 1997). Similarly, oil field disturbances in western Kern County have been found to result in shifts in the small mammal community from the primarily granivorous (seed-eating) species (kangaroo rats) that are a staple prey of kit fox, to species adapted to disturbed areas (murid, or old world rodents) (Spiegel *et al*. 1996). The effect of an altered prey community on the energetics of the kit fox is not currently known, but early studies suggest that such altered prey composition may result in lower kit fox density (Jensen 1972). The most significant effect of oil-field development appears to be lowered carrying capacity for populations of both fox and their prey species due to changes in habitat characteristics, and to loss and fragmentation of habitat (Warrick and Cypher 1998; Cypher *et al*. 2000).

The southwestern extent of the San Joaquin Valley harbors a high proportion of the remaining San Joaquin kit fox occurrences (Cypher *et al*. 2000; CNDDB 2008), and lands in this region that are important to the kit fox also support numerous areas of potential oilfield development. Development of these areas has continued since listing of the kit fox. By 2007, the Western Kern County Core Area included a number of high-density oil fields on private lands (e.g., Midway-Sunset, Elk Hills Oilfield [formerly the National Petroleum Reserve-1], Cymric, and South Belridge). The Midway-Sunset Oilfield contains the highest-producing BLM lease in the United States (BLM 2008i). The 74 square-mile Elk Hills Oilfield, the seventh largest oilfield in the United States, is surrounded on three sides by oil and gas fields and agricultural lands, while on the northwest side, it is adjacent to the 30,000-acre Lokern Natural Area (also known as the Lokern Road area), an area of relatively undisturbed publicly and privately-owned habitat (USFWS 1995). Federal lands under the jurisdiction of the BLM, including the Buena Vista Oilfield (formerly the Naval Petroleum Reserve No. 2), an area south of Lokern Road in Kern County, and lands in the Temblor Range east of Carrizo Plain National Monument occupy another 59,703 acres of the core area. Subsequent to passage of the Energy Policy Act in 2005, the BLM leased an additional 2,500 acres of Federal lands in September 2006 (BLM 2008i).

In the Carrizo Plain National Monument (Carrizo Plains Natural Area core area), approximately 130,000 acres of mineral rights are privately owned (Whitney, 2008a, b), including 30,000 acres of privately-held subsurface mineral rights in the center of the monument (BLM 2008h). In addition, five of the 13 “satellite areas”, which have been designated as important for recovering subpopulations of the kit fox, have substantial petroleum production areas. Between 5 and 8 percent of the acreage in each of these areas is comprised of lands currently open to oil and gas leasing. Most of the BLM lands in this area are scattered in a checkerboard pattern of one-square-mile (640-acre) parcels or smaller. Oil and gas leases on lands under the jurisdiction of BLM are subject to limited surface-use stipulations for the protection of threatened and endangered species (BLM 1984, 1997; Lowe *in litt.* 2006, 2007).

On public lands, including the Carrizo Plains National Monument and other BLM lands, oil and gas leasing continues to pose a threat to kit fox populations. Most oil and gas leasing and development activities on public lands occur in the San Joaquin Valley on lands managed by the BLM’s Bakersfield Office (BLM 2008i). Approximately 440,000 acres of Federal mineral estate holdings are located in the San Joaquin Valley (BLM 2008j). In past 10 years, oilfield development has increased in this area, with extensive new development initiated in shallow diatomite oil-bearing formations. During the period from 2001 to 2005, 10,873 wells were drilled, with 10,746 completed. During the same period, 8,844 wells were abandoned (BLM 2008j). This 10-year time period includes periods of very high, and very low, gas prices (BLM 2008j), suggesting that development will continue despite fluctuations in the oil and gas market. Additional incentive for development stems from new technology that is predicted to result in recovery of up to 3.5 billion additional barrels of undiscovered oil from existing reserves (USGS 2004). BLM lease offerings have included lands that were previously in row crops, and natural lands, including sparse saltbush scrub. Based on data collected in the past 10 years, the BLM predicts that up to 25,000 wells may be drilled on Federal, State, and private lands in the San Joaquin Valley over the next 10 years, with 1,250 – 2,500 wells on Federal Lands (BLM 2008j).

While BLM lands are subject to degradation by oil and gas exploration activities, the BLM Oil and Gas Programmatic Biological Opinion for Kings and Kern Counties limits modification of high quality habitat to less than 10 percent of each 640-acre section, and modification of lower quality habitat to less than 25 percent. The BLM Oil and Gas Programmatic also limits total permanent modification of kit fox habitat on BLM lands throughout Kings and Kern Counties to 1,725 acres. However, several sections within National Petroleum Reserve-2, however, had already exceeded the modification thresholds when the BLM acquired the properties (USFWS 2001, 2003) and are not subject to these limitations.

Currently, the southern half of the San Joaquin Valley continues to be an area of expansion and development activity for extraction of petroleum products. Recent and continuing oil and gas leases are being offered within the range of the kit fox in Kern, Kings, Fresno, San Benito, and Monterey Counties (BLM 2008a, b, c, d, e, f, and j) where they have the potential to affect kit fox habitat and dispersal corridors. In addition, within the Carrizo National Monument, Vintage Production LLC, a subsidiary of Occidental Petroleum, recently submitted a permit request to the BLM to explore for oil on 30,000 acres of subsurface mineral holdings in the heart of the Monument’s valley floor grasslands (BLM 2008h; Whitney 2008a, b). Work is projected to start in spring or summer of 2009 (BLM 2008h). Although exploration could set the stage for negotiations to purchase the oil rights (Whitney 2008a), it is also possible that exploration will result in development of oil resources in high-value kit fox habitat.

In addition to oil field development, existing and additional proposed sand and gravel mining activities are expected to affect areas in the Western Kern County Core area (e.g., the Johnny Cat mine) and in areas such as the Salinas River Watershed in northern San Luis Obispo County, where proposed linear sand/gravel mines are expected to present barriers to the movement of San Joaquin kit fox in the habitat corridor between the Carrizo Plain and Camp Roberts (USFWS 2006c; USFWS 2008).

The most robust kit fox populations now occur in the oil-producing region of the San Joaquin Valley, suggesting that kit fox can persist well with low-density oil development. The cumulative and long-term effects of oil extraction activities on kit fox populations are not fully known, but studies included herein indicate that moderate to high density oil fields contribute to a decrease in carrying capacity for kit fox through outright habitat loss and through changes in characteristics of remaining habitat over time (Spiegel 1996; Warrick and Cypher 1998; Cypher *et al*. 2000). Currently, the areas in which kit fox populations are most robust are also the areas slated for expansion of oil extraction activities, including focused activities on Federal lands that are usually thought to offer protection from development. It is therefore reasonably certain that oil field development will continue to threaten the kit fox into the foreseeable future, while increased development in the arid oil lands of Kern County may present exceptional threats to critical kit fox localities.

Oil fields in the southern half of the San Joaquin Valley also continue to be an area of expansion and development activity. This expansion is reasonably certain to increase in the near future owing to market-driven increases in the price of oil. The cumulative and long-term effects of oil extraction activities on kit fox populations are not fully known, but recent studies indicate that moderate- to high-density oil fields may contribute to a decrease in carrying capacity for kit foxes owing to habitat loss or changes in habitat characteristics (Spiegel 1996, Warrick and Cypher 1998). There are no limiting factors or regulations that are likely to retard the development of additional oil fields. Hence, it is reasonably certain that development will continue to destroy and fragment kit fox habitat into the foreseeable future.

Habitat loss, modification, and fragmentation due to construction of infrastructure: Construction of infrastructure projects continues to result in the direct loss and indirect modification of remaining kit fox habitat throughout the range of the kit fox. Paved roads, canals, reservoirs, water banks, sound walls, and similar facilities present both permanent loss of habitat and potential barriers to kit fox movement that fragments habitat.

Road construction in the San Joaquin Valley has resulted in the loss of kit fox habitat since listing. The Service does not have data to show the historic and current loss of kit fox habitat rangewide that is the direct result of road construction. However, rough calculations of the acreage of land lost to road development indicate that by 2003, over 7,000 acres of land had been transferred to Caltrans jurisdiction, including 590 acres in Kings County, 1,065 acres in Merced County, and 2,020 acres in Fresno County (K. Hau, Caltrans, pers. comm., as cited in Bjurlin and Cypher 2003).

Canals also present substantial barriers to kit fox movement across the canal features. Canals are known to be hazards that can result in wildlife drownings (J. Lowe, BLM, *in litt.* 2007). Monitoring has shown that some wildlife species, including red and gray fox, will utilize flumes, pipelines, and other structures to cross canals, including the California aqueduct and the DMC (Johnson *et al*. 1994), potentially suggesting that kit fox may achieve some cross-canal movement, although the mortality due to drowning is not known. However, use of such structures by kit fox predators may serve to deter kit fox from using the structures when available, and the Service has no information quantifying the use of these features by kit fox.

In contrast, several canal right-of-ways have been proposed as travel corridors between northern and central occurrences of the species along either side of the canal (Clark *et al*. 2003a). The natural lands in canal right-of-ways can provide relatively abundant prey, and are utilized by kit fox (Warrick *et al*. 2007), so may serve as linkages that facilitate north-south movement of the kit fox (Warrick *et al*. 2007). However, kit fox competitors, including red fox, also utilize these corridors (Clark *et al*. 2003a) and may inhibit their successful use by kit fox (Johnson *et al*. 1994; Clark *et al*. 2005; Cypher *et al*. 2005b; Smith *et al*. 2006).

San Luis Reservoir, Los Vaqueros Reservoir, Bethany Reservoir, and Clifton Court Forebay are impoundments that present barriers to kit fox movement in the northern portion of the kit fox range. The Los Vaqueros Reservoir was first constructed in 1999, causing permanent effects to 1,550 acres of kit fox habitat, and resulting in protection of 3,000 acres of kit fox habitat near the reservoir (McHugh 2004; USEPA 2005). Current CALFED Bay-Delta long-term plans call for enlarging Los Vaqueros Reservoir, which would inundate an additional 1,950 acres of kit fox habitat, including approximately 500 acres of the kit fox habitat conserved as compensation for the initial project (McHugh 2004). This added inundation is within a critical dispersal corridor linking kit fox in the northern extent of its range to the other kit fox populations. Construction of the project is expected to reduce the options for dispersal of kit fox in Eastern Contra Costa County.

<u>Predation and competition</u>*:* Studies in the last 20 years have shown that predation has become a significant cause of kit fox mortality. This predation has been noted to have strong effects on the demography and ecology of kit fox, at least locally (Cypher and Scrivner 1992). Predation (by coyotes [*Canis latrans*] and some bobcats [*Lynx rufus*]) was the primary cause of mortality for the kit fox population at the Naval Hills Petroleum Reserve (Cypher and Spencer 1998; Cypher *et al*. 2000). The percentage of mortality due to interactions with predators, primarily coyotes, ranged between 57 percent and 89 percent in the southern San Joaquin Valley (Cypher and Scrivner 1992; Standley *et al*. 1992; Ralls and White 1995; Spiegel and Disney 1996; Spiegel *et al*. 1996; Cypher and Spencer 1998; Cypher *et al*. 2000; Nelson *et al*. 2007), while in Western

Merced County it averaged 46 percent (Briden *et al*. 1992). In some locations coyotes only infrequently consume the kit fox they kill, suggesting that coyote attacks are competitive interactions that can include prey consumption rather than a strict predator-prey interaction (Cypher and Spencer 1998; Cypher *et al*. 2000; Nelson *et al*. 2007). Free-ranging dogs (*Canis familiaris*), non-native red fox (*Vulpes vulpes*), badgers (*Taxidea taxus*), and golden eagles (*Aquila chrysaetos*) have also been documented as kit fox predators (Briden *et al*. 1992; Cypher *et al*. 2000).

The diets and habitats selected by coyotes and kit foxes living in the same areas are often quite similar (Cypher and Spencer 1998). Competition between coyotes and kit foxes may not be significant in all areas or all years (Cypher et al. 2001), but may be high when prey resources are scarce, such as during droughts that are common in semi-arid, central California (Cypher and Spencer 1998). Land conversions and associated human activities have led to changes in the distribution and abundance of coyotes, which compete with kit foxes for resources.

Coyotes occur in most areas with abundant populations of kit foxes and, during the past few decades, coyote abundance has increased in many areas owing to a decrease in ranching operations, favorable landscape changes, and reduced control efforts (Orloff *et al.* 1986; Cypher and Scrivner 1992; White and Ralls 1993; White *et al.* 1995). Although coyotes are common in both natural and agricultural landscapes, they pose a greater predation threat to the kit fox on agricultural lands because of the decreased availability or absence of escape dens and vegetative cover (Cypher *et al.* 2005). Coyotes may kill kit foxes in an attempt to reduce resource competition. Coyote-related injuries accounted for 50 to 87 percent of the mortalities of radio collared kit foxes at Camp Roberts, the Carrizo Plain Natural Area, the Lokern Natural Area, and the Naval Petroleum Reserves (Cypher and Scrivner 1992; Standley *et al.* 1992; Ralls and White 1995; Spiegel 1996). Coyote-related deaths of adult foxes appear to be largely additive (i.e., in addition to deaths caused by other mortality factors such as disease and starvation) rather than compensatory (i.e., tending to replace deaths due to other mortality factors; White and Garrott 1997). The survival rates of adult foxes decrease significantly as the proportion of mortalities caused by coyotes increase (Cypher and Spencer 1998; White and Garrott 1997), and increases in coyote abundance may contribute to significant declines in kit fox abundance (Cypher and Scrivner 1992; Ralls and White 1995; White *et al.* 1996). There is some evidence that the proportion of juvenile foxes killed by coyotes increases as fox density increases (White and Garrott 1999). This density-dependent relationship would provide a feedback mechanism that reduces the amplitude of kit fox population dynamics and keeps foxes at lower densities than they might otherwise attain. In other words, coyote-related mortalities may prevent fox population growth, and may instead prolong population declines.

Land-use changes have also contributed to the expansion of normative red foxes into areas inhabited by kit foxes. Historically, the geographic range of the red fox did not overlap with that of the San Joaquin kit fox. By the 1970s, however, introduced and escaped red foxes had established breeding populations in many areas inhabited by San Joaquin kit foxes (Lewis *et al.* 1993). Red foxes are rarely observed in natural settings, and are much more abundant on agricultural lands. They appear to be dependent on the presence of water (Cypher *et al.* 2001), a resource readily available on irrigated farmlands, while kit foxes do not drink free water (Golightly and Ohmart 1983). Thus, there is no concern here that contaminated water may be directly ingested by kit fox. The larger and more aggressive red foxes are known to kill kit foxes (Ralls and White 1995), and could displace them, as has been observed in the arctic when red foxes expanded into the ranges of smaller arctic foxes (Hersteinsson and Macdonald 1982). The increased abundance and distribution of normative red foxes is perhaps a greater threat to kit foxes than coyotes because red foxes and kit foxes are closer morphologically and taxonomically, and would likely have higher dietary overlap, potentially resulting in more intense competition for resources. Two documented deaths of kit foxes due to red foxes have been reported (Ralls and White 1995), and red foxes appear to be displacing kit foxes in the northwestern part of their range (Lewis et al. 1993). At Camp Roberts, red foxes have usurped several dens that were used by kit foxes during previous years (California Army National Guard, Camp Roberts Environmental Office, unpubl. data). In fact, opportunistic observations of red foxes in the cantonment area of Camp Roberts have increased 5-fold since 1993, and no kit foxes have been sighted or captured in this area since October 1997. Also, a telemetry study of sympatric red foxes and kit foxes in the Lost Hills area has detected spatial segregation between these species, suggesting that kit foxes may avoid or be excluded from red fox-inhabited areas (P. Kelly, Endangered Species Recovery Program, pers. comm. to P. White, USFWS, 2000). Such avoidance would limit the resources available to local populations of kit foxes and possibly result in decreased fox abundance and distribution.

<u>Disease:</u> Wildlife diseases do not appear to be a primary mortality factor that consistently limits kit fox populations throughout their range (McCue and O'Farrell 1988; Standley and McCue 1992). However, central California has a high incidence of wildlife rabies cases (Schultz and Bairett 1991), and high seroprevalences of canine distemper virus and canine parvovirus indicate that kit fox populations have been exposed to these diseases (McCue and O'Farrell 1988; Standley and McCue 1992). Hence, disease outbreaks could potentially cause substantial mortality or contribute to reduced fertility in seropositive females, as was noted in closely-related swift foxes (*Vulpes velox)***.**

There are some indications that rabies virus may have contributed to a catastrophic decrease in kit fox abundance at Camp Roberts, San Luis Obispo County, California, during the early 1990s. San Luis Obispo County had the highest incidence of wildlife rabies cases in California during 1989 to 1991, and striped skunks (*Mephitis mephitis*) were the primary vector (Barrett 1990; Schultz and Barrett 1991; Reilly and Mangiamele 1992). A rabid skunk was trapped at Camp Roberts during 1989 and two foxes were found dead due to rabies in 1990 (Standley *et al.* 1992). Captures of kit foxes during annual live trapping sessions at Camp Roberts decreased from 103 to 20 individuals during 1988 to 1991. Captures of kit foxes were positively correlated with captures of skunks during 1988 to 1997, suggesting that some factor(s) such as rabies virus was contributing to concurrent decreases in the abundances of these species. Also, captures of kit foxes at Camp Roberts were negatively correlated with the proportion of skunks that were rabid when trapped by County Public Health Department personnel two years previously. These data suggest that a rabies outbreak may have occurred in the skunk population and spread into the fox population. A similar time lag in disease transmission and subsequent population reductions was observed in Ontario, Canada, although in this instance the transmission was from red foxes to striped skunks (Macdonald and Voigt 1985).

Pesticides and rodenticides: Some methods of pest and rodent control pose a threat to kit foxes through direct or secondary poisoning, and these threats are often encountered in agricultural settings. Kit foxes may be killed if they ingest rodenticide in a bait application, or if they eat a rodent that has consumed the bait (Orloff *et al.* 1986; Berry *et al.* 1992; Huffman and Murphy 1992; Standley *et al.* 1992; CDFG 1999; Hosea 2000; L. Briden, CDFG, *in litt.* 2006). Even sublethal doses of rodenticides may lead to the death of these animals by impairing their ability to escape predators or find food. Pesticides and rodenticides may also indirectly affect the survival of kit foxes by reducing the abundances of their staple prey species. For example, the California ground squirrel, which is the staple prey of kit foxes in the northern portion of their range and on agricultural lands, was thought to have been eliminated from Contra Costa County in 1975, after extensive rodent eradication programs. Field observations indicated that the long-term use of ground squirrel poisons in this county severely reduced kit fox abundance through secondary poisoning and the suppression of populations of its staple prey (Orloff *et al.* 1986). There also is the potential that availability of den sites may be impacted by rodent control programs, as kit fox can depend on ground squirrels to create potential burrows in areas with hardpan soil layers (Orloff *et al*. 1986; Orloff 2002).

The range of the San Joaquin kit fox overlaps with agricultural areas on about 10 million acres in 14 counties, mostly in the San Joaquin Valley (CDPR 2007). Although kit fox have been excluded from large portions of agricultural lands, kit fox currently utilize agricultural lands that border natural lands. Kit foxes occupying habitats adjacent to agricultural lands are also likely to come into contact with insecticides applied to crops owing to runoff or aerial drift. Kit foxes could be affected through direct contact with sprays and treated soils, or through consumption of contaminated prey. Data from the California Department of Pesticide Regulation (CDPR 2007) indicate that acephate, aldicarb, azinphos methyl, bendiocarb, carbofuran, chlorpyrifos, endosulfan, s-fenvalerate, naled, parathion, pernnethrin, phorate, and trifluralin are used within one mile of kit fox habitat. A wide variety of crops, as well as buildings, Christmas tree plantations, commercial/industrial areas, greenhouses, nurseries, landscape maintenance, ornamental turf, rangeland, rights of way, and uncultivated agricultural and non-agricultural land, occur in close proximity to San Joaquin kit fox habitat.

Efforts have been underway to reduce the risk of rodenticides to kit foxes (USFWS 1993b). The Federal government began controlling the use of rodenticides in 1972 with a ban of Compound 1080 on Federal lands pursuant to Executive Order. Above-ground application of strychnine within the geographic ranges of listed species was prohibited in 1988. A July 28, 1992, biological opinion regarding the Animal Damage Control (now known as Wildlife Services) Program by the U.S. Department of Agriculture (USDA) found that this program was likely to jeopardize the continued existence of the kit fox owing to the potential for rodent control activities to take the fox. As a result, several reasonable and prudent measures were implemented, including a ban on the use of M-44 devices, toxicants, and fumigants within the recognized occupied range of the kit fox. Also, the only chemical authorized for use by the Wildlife Services within the occupied range of the kit fox was zinc phosphide, a compound known to be minimally toxic to kit foxes (USFWS 1993b). Zinc phosphide became the only chemical authorized for use by the USDA to accomplish control of animal damage within the occupied range of the kit fox (USFWS 1992; USDA 2007). Zinc phosphide is considered a restricted use material and may only be legally applied by state-certified pesticide applicators (University of California 2009). Based on a 2007 concurrence letter from the Service, qualified individuals (certified applicators, biologists, Federal and State employees, county and UC extension agents) who have been trained to distinguish between dens and burrows of target and non-target species may also use sodium nitrate gas cartridges to kill coyotes inside active dens where the qualified personnel have positively observed coyotes (by sight or sound) at the time of, or immediately prior to treatment (USDA 2007; USFWS 2007b; C. Coolahan, APHIS, pers. comm. 2009).

In the intervening period since use of these original compounds became more restricted, two new generations of rodenticides have been developed. Currently both first and second-generation anticoagulant rodenticides may be used as rodent control agents within the range of the kit fox, although the appropriate use of individual anticoagulants differs depending on the terms of their registration. First-generation anticoagulant rodenticides (FGARs) include warfarin, chlorophacinone, and diphacinone, while brodifacoum, bromadiolone, difethialone, and difenacoum are considered second-generation anticoagulant rodenticides (SGARs). Both FGARs and SGARs interfere with blood clotting, leading to death from hemorrhaging. First-generation anticoagulant rodenticides require several days of consecutive feedings to deliver a lethal dose to the target species, while SGARs can deliver a lethal dose in only one night of feeding. However, with either type of anticoagulant, death does not occur until 5 to 7 days after the feeding (USEPA 2008), providing opportunities for secondary poisoning of diurnal predators and scavengers (Cox and Smith 1992). Secondary exposure to SGARs is particularly problematic due to the high toxicity of the compounds and their long persistence in body tissues. For example, brodifacoum, a common SGAR, is persistent in tissue, bioaccumulates, and appears to impair reproduction (Alterio 1996; Alterio and Moller 2000; Chen and Deng 1986; Eason *et al.* 1999; Eason *et al.* 2001; Eason *et al.* 2002; Hedgal and Colvin 1988; Howald *et al.* 1999; Mount and Feldman 1983; Munday and Thompson 2003). In addition, because these compounds are designed to be toxic after a single night's feeding, but death does not occur for 5 to 7 days, rodents may accumulate (and carcasses may contain) residues that may be many times the lethal dose. Finally, because compounds persist for extended periods in body tissues, predators and scavengers may sustain adverse or lethal effects from additive exposures through feedings that may be separated by days or weeks (Jackson and Kaukeinen 1972; Padgett *et al.* 1998; Stone *et al*. 1999; Eason *et al.* 2001; Munday and Thompson 2003; USEPA 2008). Exposed individuals are known to become progressively weaker and lethargic due to blood loss prior to death. Even in cases where the proximate cause of death has been identified as automobile strike, predation, or disease, toxicologists and pathologists have attained sufficient toxicological evidence to conclude that rodenticide-induced blood loss increased animal vulnerability to the proximate cause of death (USEPA 2008).

Rodenticides are used in urban, suburban, and rural areas to control a variety of rodents, including house mice, voles, pocket gophers, ground squirrels, and Norway rats (USEPA 2008), animals that may comprise prey for the kit fox. Both FGARs and SGARS are registered for use in and around buildings, transport vehicles, in alleys, and inside sewers, although difethialone and bromadiolone are not labeled for outdoor use in "non-urban" areas (B. Erickson, USEPA, *in litt*. 2006). Diphacinone and chlorophacinone are also registered for agricultural and field uses, including use in crop land, orchards and rangelands, in irrigation ditches, and on ditch banks, river banks, railroad tracks, fence lines, garbage dumps, and landfills (B. Erickson *in litt*. 2006; USEPA 2008). Chlorophacinone is used on rangelands to control rodents, including the Belding's ground squirrel (*Spermophilus beldingi*), California ground squirrel, pocket gopher (*Thomomys spp*.), deer mouse (*Peromyscus spp*.), and house mouse, and may be used for spot baiting for rodents in alfalfa (Ramey *et al*. 2007). Currently, approximately 4.53 million kg (10 million pounds) of anticoagulants are sold in California each year (O'Neill 2004), of which approximately 75 percent (by weight) is diphacinone (Timm *et al*. 2004).

Rodenticide use is known to occur in a variety of counties within the range of the kit fox, including Fresno, Merced, Kern, San Luis Obispo, and Monterey Counties (D.F. Williams *in litt.* 1989, as cited in USFWS 1998; Berry *et al*. 1992; Hosea *in litt.*1999; Hosea 2000; Briden *in litt*. 2006). For example, rodenticides were utilized at Camp Roberts in the past to reduce rodent populations (Berry *et al*. 1992). Between 1991 and 1998, rodenticide poisoning on adjacent private lands was determined to be a factor in the deaths of two, and possibly four kit fox (Berry *et al*. 1992; Standley *et al*. 1992). Limited use of the rodenticide, chlorophacinone, continued at Camp Roberts until 2003, when its use was discontinued. Currently zinc phosphide is the only rodenticide approved for use at Camp Roberts (M. Moore, Camp Roberts ANG, pers. comm. 2008). Rodenticide use on private rangelands adjacent to Fort Hunter Liggett has also been implicated in decreased rodent presence in the area (M. Littlefield, USFWS, pers. comm. 2007). Rodenticides have been used on Reclamation property to kill rodents threatening adjoining agricultural fields (USFWS 2000a).

Predatory mammals (particularly the kit fox) from the urban-suburban environment surrounding Bakersfield experience high levels of exposure to anticoagulant rodenticides (L. R. Broderick, CDFG, *in litt*. 2007). In 1987, a necropsy of a kit fox carcass found on a nursery in Bakersfield indicated chlorophacinone poisoning from bait spread at the site (E. Littrell, CDFG, *in litt*. 1987). Since then, ongoing toxicology studies of the carcasses of kit fox and other wild canids collected in the Bakersfield area show that the animals had elevated levels of anticoagulants in their livers (CDFG 1999; R. Hosea, CDFG, *in litt.* 1999; Hosea 2000; S. McMillin, CDFG, *in litt*. 2008). Between 1999 and the current time, 39 out of 51 kit fox livers sampled have contained residues of anticoagulant rodenticides: particularly brodifacoum, but also bromadiolone, pival, and chlorophacinone. Use of these rodenticides by the untrained public is thought to be the likely source of exposure for these animals (Broderick *in litt*. 2007). The carcasses of kit fox and other wild canids have also been collected from conserved lands in the Lokern Natural Area, which is remote high-quality desert habitat, has little agriculture, and is relatively undeveloped. Kit fox carcasses from the Lokern Natural Area do not contain anticoagulant residues, indicating that animals in the Lokern Natural Area do not experience exposure to these compounds. The other canids have shown the same pattern with exposure to rodenticides at Bakersfield and lack of exposure in the Lokern (McMillin *et al*. In review; McMillin *in litt*. 2008).

A September 22, 1993, biological opinion issued by the Service to the USEPA regarding the regulation of pesticide use (31 registered chemicals) through administration of the Federal Insecticide, Fungicide, and Rodenticide Act found that use of the following chemicals would likely jeopardize the continued existence of the kit fox: (1) aluminum and magnesium phosphide fumigants; (2) chlorophacinone anticoagulants; (3) diphacinone anticoagulants; (4) pival anticoagulants; (5) potassium nitrate and sodium nitrate gas cartridges; and (6) sodium cyanide capsules (USFWS 1993b). Reasonable and prudent alternatives to avoid jeopardy included restricting the use of aluminum/magnesium phosphide, potassium/sodium nitrate within the geographic range of the kit fox to qualified individuals, and prohibiting the use of chlorophacinone, diphacinone, pival, and sodium cyanide within the geographic range of the kit fox, with certain exceptions (e.g., agricultural areas that are greater than 1 mile from any kit fox habitat) (USFWS 1993b). For example, chlorophacinone could be used in agricultural areas that were one or more miles from kit fox habitat, as mapped by the California Environmental Protection Agency in consultation with the Service, or in areas where Service-approved surveys indicated that kit fox were not present within a mile of the use location (USFWS 1993b). In contrast, use of brodifacoum was not expected to jeopardize the kit fox's existence because of its restricted area of recommended use (around urban and agricultural buildings). Although kit fox occurrences around buildings at military bases, in urban/suburban Bakersfield, and in Kern County oil fields were noted, the Service concluded that use of the rodenticide would not jeopardize the kit fox due to the fact that many kit fox habitats are far removed from areas of rodenticide use, and prescribed only that brodifacoum be placed in tamper proof containers, and not be accessible to wildlife within the range of the kit fox (USFWS 1993b). The biological opinion, in effect, allowed for local adjustments to the rule based on detailed State-Federal coordination on preventive measures; however, to date measures are provided on a voluntary basis.

Due to ongoing concerns about exposure of non-target species to rodenticides, the USEPA re-evaluated 10 rodenticides in 2007, and considered classifying all products containing brodifacoum, bromadiolone, and difethialone as restricted use products (USEPA 2008). However, the USEPA stopped short of classifying these ingredients as restricted-use products, relying instead on sales and distribution limits on SGARs (brodifacoum, bromadiolone, difethialone, and difenacoum) that are intended to prevent general consumers from purchasing these compounds as residential use products (USEPA 2008). New requirements will go into effect in 2011 (USEPA 2008). It is unlikely that these new regulations will fully protect non-target wildlife such as kit fox from exposure. Kit fox may be exposed to products used legally or illegally, or even to products whose use has been discontinued (McMillin *et al*. In review). Although USEPA agreed to informally consult with the Service on the new regulations pertaining to SGARs, to date no consultation has been completed (N. Golden, USFWS, Arlington VA, pers. comm. 2008). In 2005, the Service submitted comments on the new regulations governing SGARS (USFWS 2005) that concluded, "*Rodenticide use under current regulations has resulted in wildlife exposure and mortality that may be in violation of the Endangered Species Act, the Bald and Golden Eagle Progection Act, and the Migratory Bird Treaty Act.*"

To date, no specific research has been conducted on the effects of different pesticide or rodent control programs on the kit fox (USFWS 1998). However, given the potential for secondary exposure of kit fox in agricultural areas, on rangelands, and along infrastructure projects, such as canals, that are utilized as foraging and denning habitat by kit fox, the Service expects that effects of rodenticide exposure could have substantial population level effects where exposure is present, especially where kit fox populations are small and where they rely on target species, such as ground squirrels and murid rodents, for prey. The reduction and elimination of prey species by pesticide use is a threat to kit fox. As discussed above, rodenticides are utilized specifically to reduce or eliminate rodents in rangelands, agriculture, and developed areas. In addition to loss of target species, rodenticide use is known to poison non-target rodent prey, such as kangaroo rats, and deer mice, etc. (Salmon *et al*. 2007). Past rodent eradication programs are thought to have eliminated the prey base for kit fox in areas such as Contra Costa County, severely reducing kit fox abundance in the area (Orloff *et al*. 1986; Bell *et al*. 1994). In recent years, use of rodenticides by individual landowners has continued to result in low densities of kit fox prey species on at least a local level (Orloff 2002; Briden *in litt*. 2006). The population consequences of this use have not been quantified, but could be substantial in areas where rodenticides are commonly used.

In addition to rodents, insects can be important prey for the San Joaquin kit fox, especially during periods of low prey availability (Hawbecker 1943; Scrivner *et al.* 1987; Archon 1992). In the northern portion of the kit fox' range, insects, especially grasshoppers and crickets, currently provide the primary prey for kit fox during the summer months, particularly July and August (Briden *et al.* 1992; Archon 1992). Insecticides that target grasshoppers and crickets (Scrivner *et al.* 1987) may suppress kit fox populations, reduce juvenile survivorship, or inhibit successful dispersal.

Organophosphate insecticides are used to control insect pests, and have been used since the 1980s in almond orchards, but may also be used on alfalfa, and on other stone fruits to control pests. Malathion, a broad-spectrum organophosphate insecticide, has been used to control the beet leaf-hopper (*Circulifer tenellus*) in rangeland habitat, fallow fields, oil fields, and cultivated areas on both public (BLM) and private lands in the San Joaquin Valley, and in adjacent valleys and foothills (USFWS 1997; BLM 2002; California Department of Food and Agriculture [CDFA] 2008a, b). The beet leaf-hopper is a vector for curly top virus, which negatively affects a number of crop types grown in the range of the kit fox. In the western and southern portions of the San Joaquin Valley, aerial spraying may occur during winter, spring, or fall control periods, and may include treatment of approximately 80,000 acres in years with low beet leaf-hopper populations, although annual treatment is not required in all areas (CDFA 2008a, b). Increases in beet leaf-hopper populations appear to be correlated with drought-mediated reductions in rangeland vegetation. In drought periods, increased beet leaf-hopper populations may require treatment of up to 200,000 acres of agricultural and natural lands, and also require treatment of the Salinas and Cuyama Valleys (CDFA 2008a, b). Treatment usually results in a target population decline of over 90% (CDFA 2008b); however, loss of insects important to the kit fox has not been quantified. Although the project is potentially immense in scale, the actual areas treated on an annual basis appear to be more restricted, but do include kit fox habitat in core, satellite, and linkage areas in the western and southern portions of the valley (CDFA 2008a). Depending on the baseline prey conditions and the magnitude of prey loss, lowered prey levels associated with pesticide usage could have the potential to contribute directly or indirectly to starvation of individual animals. Lowered prey abundance is expected to require kit fox to expend more effort and cover more territory while foraging, which increases their exposure to predation. Effects of prey reductions on kit fox populations would be hard to quantify, but have the potential to have observable population-level effects.

<u>Reduction in prey availability:</u> Kit fox have been strongly linked ecologically to kangaroo rats, with kit fox densities and population stability highest in areas with abundant kangaroo rats (Spiegel *et al*. 1996; Cypher *et al*. 2000; Cypher 2006; see also Bean and White 2000). Abundance of prey species, particularly abundance of kangaroo rats, has been linked with successful recruitment of young kit fox and increases in kit fox population numbers (Morell 1972; Orloff *et al.* 1986; White and Ralls 1993; Cypher *et al*. 2000; Bidlack 2007; L. Saslaw, BLM, pers. comm. 2008). Conversely, prey scarcity has been a primary factor contributing to decreased reproductive success during droughts (White and Ralls 1993), or to extirpation of kit fox in specific localities (Williams *in litt*. 2007). Early studies suggested that kangaroo rats were a preferred food for the kit fox throughout the range (Laughrin 1970), and that kit fox densities were lower in areas like those near Bakersfield where plant associations changed and abundant ground squirrels replaced kangaroo rats (Jensen 1972). Current studies have shown that kit fox subsist primarily on ground squirrels in some portions of their range, including areas around Bakersfield, and in valleys within the inner Coast Range (Balestreri 1981; Orloff *et al.* 1986; Cypher and Warrick 1993), while they may subsist on a variety of native and nonnative species in disturbed areas or areas near to agriculture, and often also rely upon insect prey during portions of the year (Spiegel *et al*. 1996; Cypher and Brown 2006).

Concurrent with the decline in kit fox, the kangaroo rat species and subspecies native to the range of the kit fox have also declined. Three taxa are currently State and federally-listed as endangered (giant kangaroo rat [*D. ingens*], Tipton kangaroo rat [*D. n. nitratoides*], and Fresno kangaroo rat [*D. n. exilis*]), although habitat loss also threaten other subspecies within the San Joaquin and associated valleys (Williams and Germano 1992). These small mammals are believed to have declined due to loss of habitat to agriculture (Williams and Germano 1992), increases in thick cover of exotic plant species and the related thatch build-up (Germano *et al.*

2001; L. Saslaw, pers. comm. 2008), and use of rodenticides and pesticides for pest control in rangelands and agricultural crops (Orloff *et al*. 1986; Bell *et al*. 1994). By 1979, the giant kangaroo rat occupied only about 1.6 percent of its historic geographic range, while the Tipton kangaroo rate occupied only 3.7 percent of its historic range by 1985 and the Fresno kangaroo rats was only known from several small, isolated, natural parcels west of Fresno (see review in Williams and Germano 1992). Since 1994, kangaroo rats and other small native mammals have declined precipitously in the southern San Joaquin Valley (Single *et al*. 1996, as cited in Germano *et al*. 2001). Loss of habitat and changes in vegetation have been covered elsewhere in this document in relation to direct effects to kit fox and will not be covered again here, but also negatively affect presence of kangaroo rats (Williams and Germano 1992; Germano *et al*. 2001; L. Saslaw pers. comm. 2008), which appear to be critical to kit fox recovery. Livestock grazing may affect individual kangaroo rats by damaging burrows (Germano *et al*. 2001), and potentially killing individuals. The Service expects these effects to comprise a threat primarily where livestock are concentrated in areas of kangaroo rat precincts (e.g. by watering and feeding stations, or by penning). While livestock grazing may damage individual precincts, cessation of grazing may also lead to larger-scale declines in kangaroo-rat populations during wet years due to negative effects related to dense growth of vegetation (Germano *et al*. 2001).

<u>Fragmentation and isolation of populations:</u> Historically, kit foxes may have existed in a metapopulation structure of core and satellite populations, some of which periodically experienced local extinctions and recolonization (USFWS 1998). Today's populations exist in an environment drastically different from the historic one, however, and extensive habitat fragmentation will result in geographic isolation, smaller population sizes, and reduced genetic exchange among populations, thereby increasing the vulnerability of kit fox populations to extirpation. Populations of kit foxes are extremely susceptible to the risks associated with small population size and isolation because they are characterized by marked instability in population density. For example, the relative abundance of kit foxes at the Naval Petroleum Reserves, California, decreased ten-fold during 1981 to 1983, increased seven-fold during 1991 to 1994, and then decreased two-fold during 1995 (Cypher and Scrivner 1992; Cypher and Spencer 1998).

The destruction and fragmentation of habitat could also eventually lead to reduced genetic variation in populations of kit foxes that are small and geographically isolated. Genetic assessments indicate that historic gene flow among populations was quite high, and that gene flow between populations is still occurring (Schwartz *et al.* 2005). However, extensive habitat loss and fragmentation continues to form more or less geographically distinct populations of foxes, which could reduce genetic exchange among them. An increase in inbreeding and the loss of genetic variation could increase the extinction risk for small, isolated populations of kit foxes by interacting with demography to reduce fecundity, juvenile survival, and lifespan (Lande 1988; Frankham and Rails 1998; Saccheri *et al.* 1998).

Kit fox groups in smaller patches of habitat are thought to be extremely vulnerable to local extinctions due to catastrophic or environmental events (Cypher *in litt*. 2007). An area of particular concern is Santa Nella in western Merced County where pending development plans threaten to eliminate the little suitable habitat that remains and provides a dispersal corridor for kit foxes between the northern and southern portions of their range. Preliminary estimates of expected heterozygosity from foxes in this area indicate that this population may already have reduced genetic variation.

Although status is unknown for kit fox in many of the satellite areas (CNDDB 2008), it appears that at least several of these small and isolated resident subpopulations have recently become locally extinct, including subpopulations at the Fort Hunter Liggett military reserve, and at San Luis and Pixley NWRs (Williams *in litt*. 2007; Cypher *in litt*. 2007; USFWS 2007a; Cypher pers. comm. 2008). In addition, at Camp Roberts military reserve, resident kit fox are no longer detected, while the last sighting of a kit fox was in 2003 (Moonjian 2007; M. Moore, Camp Roberts ANG, pers. comm. 2008).

The impacts of genetic isolation may already be apparent in the Salinas-Pajaro River water shed (i.e., Camp Roberts and Fort Hunter Liggett), Lost Hills area and Panoche populations. Estimates of the mean number of alleles per locus from foxes in these populations indicate that allelic diversity is lower than expected. The population in the Camp Roberts region may have been historically small, as evidenced by the lack of historical occurrences. Relatively low allelic diversity could be the result of a few individuals recolonizing the Camp Roberts area (founder event), and a subsequent low number of migrants contributing to genetic diversity. The Panoche population is located in a small, relatively isolated valley, and also appears to be experiencing a low number of migrants into the population (Schwartz *et al.* 2005).

Arid systems are characterized by unpredictable fluctuations in precipitation, which lead to high frequency, high amplitude fluctuations in the abundance of mammalian prey for kit foxes (Goldingay *et al.* 1997; White and Garrott 1999). Because the reproductive and neonatal survival rates of kit foxes are strongly depressed at low prey densities (White and Ralls 1993; White and Garrott 1997, 1999), periods of prey scarcity owing to drought or excessive rain events can contribute to population crashes and marked instability in the abundance and distribution of kit foxes (White and Garrott 1999). In other words, unpredictable, short-term fluctuations in precipitation and, in turn, prey abundance can generate frequent, rapid decreases in kit fox density that increase the extinction risk for small, isolated populations.

<u>Vehicle strikes:</u> Vehicle strikes are a consistent, but small source of kit fox mortality on natural lands (Cypher *et al*. 2000; see table summarizing study results in Bjurlin and Cypher 2003), with vehicle strikes accounting for 9 percent of mortality at the NPRC (Cypher *et al*. 2000). In natural lands, kit fox are sometimes killed by vehicle strikes (M. Stockton, Bitter Creek NWR, pers. comm. 2006; Williams *in litt.* 2007), but impacts of roads on kit fox ecology are generally thought to be low (Cypher *et al*. 2005a, b) although mortality due to vehicle strikes may significantly affect small populations (Williams *in litt*. 2007). Although vehicle strikes may not have population-level effects in natural lands where traffic volume is low, vehicle strikes appear to be a more substantial source of mortality in human-altered landscapes, including urban environments (Bjurlin *et al*. 2005; Cypher *et al*. 2003, as cited in Cypher and Brown 2006;

Briden *in litt*. 2006). In urban settings such as Bakersfield, vehicle strikes can be the largest source of kit fox mortality and may impact urban fox populations (Bjurlin *et al*. 2005).

Accidental shooting and harrassment: Although the effects of this threat have been reduced, it appears that kit fox are still subject to accidental and illegal shooting throughout most of their range. Kit fox may potentially be mistaken for other wild canids, especially coyotes. Inexperienced hunters could also potentially mistake kit fox for gray fox or red fox. Kit fox superficially resemble juvenile coyotes (Clark *et al*. 2007b), suggesting that kit fox may be particularly vulnerable to misidentification at particular times of the year. Both the coyote and the gray fox are nongame species that may be taken in any number. While the coyote may be taken all year, hunting gray fox is restricted to a season that runs from November 24 through February (CFGC 2008). Within the range of the kit fox, a closure on night hunting is in effect in those portions of Monterey and San Benito Counties lying east of Highway 101, but legal in the rest of the range (CFGC 2008). Coyote hunting by people using predator calls, and by sheepherders, has been reported in lands surrounding the former Nation Petroleum Reserve-1 (J.R. Bennett, USDA, pers. comm., as cited in Warrick and Cypher 1998).

Documented kit fox mortality due to shooting occurs occasionally on both public and private lands, including protected lands (Briden *et al*. 1992; Standley *et al*. 1992; Warrick and Cypher 1998). In addition, kit fox harassment in association with hunting has been reported (J. Vance, CDFG, pers. comm. 2007). Hunting is allowed at Fort Hunter Liggett, on most BLM lands, at a variety of Ecological Reserves managed by the CDFG (USDOD 2008; CDFG 2008), and at one or more conservation banks (see Service 1997 files). However, at one unit of CDFG's Carrizo Plains Ecological Reserve hunting of coyotes and ground squirrels has been prohibited to prevent incidental take of the kit fox (CDFG 2008). In total, the Service does not have information to suggest that illegal shooting of kit fox is a threat to kit fox subpopulations where animals are abundant, but loss of individual kit fox due to shooting could represent significant stochastic events where extant kit fox are rare, where only several family groups exist, or where recruitment and successful dispersal are key to continuation of small population groupings.

Off-road vehicle use: Use of off-road vehicles (ORVs) poses an unquantified threat to the San Joaquin kit fox, primarily through the potential for off-road travel to disturb soil, reduce or destroy herbaceous vegetation, and to destroy burrow systems of prey species, such as the kangaroo-rat, and to damage kit fox dens. Off-road travel also increases access to areas that are otherwise remote and little used. Off-road travel is expected to increase impacts to animals on large expanses of natural lands including both publicly and privately held lands (see Hammitt and Cole 1998). The southern San Joaquin Valley is experiencing increased demand for dispersed recreation and ORV use on public and private lands, including oil field holdings (Dixon pers. comm. 2009; Saslaw pers. comm. 2009). Near Taft, the BLM has experienced a spike in ORV use on 30,000 acres of holdings (Shepard 2007) that are within the range of the kit fox. ORV use is occurring in the Temblor Hills, California Aqueduct, and Chico Martinez areas where most use has been on existing roads, but where cross-country travel that creates new disturbance is also occurring (Shepard 2007; BLM 2008j). On public and oil company lands in western Kern County, increasing off-road vehicle use has resulted in a substantial increase in new, unauthorized roads and trails (Saslaw pers. comm. 2009). In addition, the recent, rapid increase in off-road use has expanded to privately-held conservation lands where ORV use has caused varying amounts of damage to good quality kit fox habitat (Dixon pers. comm. 2009). Land managers are working together to contain off-road vehicle use. Efforts include coordinated construction of fencing to preclude ORV use in conserved lands in the Lokern Natural Area and several other areas (Dixon pers. comm. 2009; Saslaw pers. comm. 2009). Efforts to contain and eliminate illegal off-road use in these areas and in protected areas is expected to increase ORV pressure on less-protected areas, such as unfenced lands in the Buena Vista Hills area (Dixon pers. comm. 2009). Kit fox present within the Carrizo Plains National Monument are protected from ORV use, as the core area of the Monument has been closed to off-road vehicle travel (Saslaw pers. comm. 2009), although areas peripheral to the monument may be accessible to increased use.

In summary, the increase in off-road vehicle use in this area appears to be an increasing threat to the kit fox in otherwise suitable habitat. Although effects to habitat have not been quantified in large portions of the western Kern County area (Dixon pers. comm. 2009; Saslaw pers. comm. 2009), in specific areas the recent increased use has substantially degraded soil and vegetation conditions on lands targeted for conservation.

<u>Climate change:</u> Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field *et al*. 1999; Cayan *et al*. 2005; Cayan *et al*. 2006; IPCC 2007). Although predictions of future climatic conditions for smaller sub-regions in California remain uncertain (Christensen et al. 2007; Field *et a*l. 2007; Moser *et al*. 2009), daily minimum and maximum temperatures have begun to change (Moser *et al*. 2009), and interannual precipitation variability has already begun to increase (Kelly and Goulden 2008; Loarie *et al*. 2008). Across the mid-latitudes of the northern hemisphere, spring plant green-up has advanced by almost two weeks and animals in many areas are responding to such changes by breeding earlier and shifting their ranges (see review in Field *et al*. 2007). The Service expects that kit fox populations are also subject to these commonly observed patterns.

Interannual precipitation variability increased in both Central and Southern California regions, beginning in the early to mid-1970s (McLaughlin *et al*. 2002; Kelly and Goulden 2008). As climate change models predict increased precipitation variability in the future (McLaughlin *et al*. 2002), the Service expects these weather events to continue to increase. Population extirpations have been linked to the amplified population fluctuations that are due to these increases in variability of precipitation (McLaughlin *et al.* 2002).

Kit fox subpopulations, including the relatively large subpopulations at the National Petroleum Reserve and Carrizo Plains areas, demonstrate large fluctuations in abundance in response to weather-mediated prey levels, which increases the potential for these groups to be extirpated (Cypher *et al*. 2000; Bean and White 2000; Bidlack 2007). Weather conditions usually vary over larger landscape scales, leading to the general expectation that drought-mediated decreases in kit fox abundance, or local extirpation of some groups, should not affect persistence of the species as long as healthy core kit fox populations are not limited to one portion of the range. However, the loss and fragmentation of habitat documented herein has reduced the likelihood that lost sites will be re-colonized (Williams *in litt*. 2007; Cypher 2006; Cypher *et a*l. 2007), which is expected to result in a cumulative loss of small groupings over time (Clark *et al*. 2007a). Because increased drying and droughts, and substantial precipitation events are expected to negatively affect the native prey species upon which the kit fox depends, the Service expects climate change to pose a substantial threat to the species by further exacerbating interannual fluctuations in kit fox reproductive success and abundance.

Recovery Status: **A** recovery plan approved in 1983 proposed interim objectives of halting the decline of the San Joaquin kit fox and increasing population sizes above 1981 levels (USFWS 1983). Conservation efforts subsequent to the 1983 recovery plan have included habitat acquisition by BLM, CDFG, CEC , Reclamation, the Service, and the Nature Conservancy. Purchases most significant to conservation efforts were the acquisitions in the Carrizo Plain, Ciervo-Panoche Natural Area, and the Lokern Natural Area. Other lands have been acquired as mitigation for land conversions, both temporary and permanent.

An updated recovery plan covering upland species of the San Joaquin Valley, including the kit fox, was written in 1998. The primary goal of the recovery strategy for kit foxes identified in the Recovery Plan is to establish a complex of interconnected core and satellite populations throughout the species' range. The long-term viability of each of these core and satellite populations depends partly upon periodic dispersal and genetic flow between them. Therefore, kit fox movement corridors between these populations must be preserved and maintained. In the northern range, from the Ciervo Panoche in Fresno County northward, kit fox populations are small and isolated, and have exhibited significant decline. The core populations are the Ciervo Panoche area, the Carrizo Plain area, and the western Kern County population. Satellite populations are found in the urban Bakersfield area, Porterville/Lake Success area, Creighton Ranch/Pixley Wildlife Refuge, Allensworth Ecological Reserve, Semitropic/Kern NWR, Antelope Plain, eastern Kern grasslands, Pleasant Valley, western Madera County, Santa Nella, Kesterson NWR, and Contra Costa County. Major corridors connecting these population areas are on the east and west side of the San Joaquin Valley, around the bottom of the Valley, and cross-valley corridors in Kern, Fresno, and Merced Counties.

The recovery criteria for the kit fox include site-specific objectives for habitat protection in each of the identified core and satellite areas (USFWS 1998, page 188). In the Carrizo Plains Natural Area (including BLM, CDFG, TNC, and private lands) in San Luis Obispo County, the protection level was set at 100 percent of existing potential habitat. In western Kern County (including BLM, CDFG, Kern County Water Agency, CDWR, US Dept of Energy, CNLM, and private lands) the protection level was set at 90 percent of the existing potential habitat, and at the Ciervo-Panoche Natural Area (including BLM, CDFG, and private lands) in Fresno and San Benito Counties, the "Protection Level" was set at 90 percent of the existing potential habitat. For the nine or more proposed satellite populations, the protection level was set at 80 percent of the existing potential habitat. The term "potential habitat" is not defined in the Recovery Plan;

however, the Service expects that to achieve recovery, habitat must include components, such as appropriate physical conditions, vegetative structure and community structure needed by the kit fox.

The first downlisting criterion, to secure and protect the three core populations and three satellite populations from incompatible uses, has not yet been achieved. Service files indicate that, although lands have been protected in many of the satellite areas though use of Habitat Conservation Plans (HCPs), conservation banks, etc., no satellite areas are sufficiently secured from incompatible uses.

The second recovery criterion requires that all protected lands identified as important to the kit fox's continued survival have management plans that include survival of the kit fox as a management objective. It has not yet been achieved.

The third recovery criterion stipulates that population in the specified recovery areas shows that the three core areas have stable or increasing populations through one precipitation cycle and that there is population interchange between one or more core populations and the three satellite populations. Because population dynamics of most kit fox populations can greatly fluctuate, and the isolation and loss of small subpopulations due to stochastic events and habitat fragmentation, this recovery criterion has not been achieved.

Conservation Needs of San Joaquin Kit Fox in the Action Area

Habitat protection/restoration of Kit fox core population and corridors**:** A potential core population of kit foxes has been identified in close proximity to the action area (USFWS 1998). This "Panoche Core Population" is generally located on lands west of 1-5 in the Panoche Valley and suitable lands to the north and south, such as the Silver Creek Ranch and lands from Little Panoche Creek up to Route 152. Because of the amount of available optimal habitat (e.g., saltbush scrub, arid grasslands), this population is probably not as extensive as the Western Kern County and Carrizo Plain Core Populations. Thus, it is critical that connectivity be maintained between the Panoche Core Population and the two core populations further south. This necessitates that a viable corridor be maintained on remaining natural lands between 1-5 and the foothills of the Coast Ranges. The need to conserve this corridor is identified prominently in Tasks 5.3.4, 5.3.5, 5.3.6, and 5.3.7 in the Recovery Plan for Upland Species of the San Joaquin Valley, California (USFWS 1998).

The recovery plan for the San Joaquin kit fox includes strategies for habitat protection that will maintain population interchange between areas adjacent to the action area. Connecting corridors for movement of kit foxes around the western edge of the Pleasant Valley and Coalinga in Fresno County should be maintained and enhanced. Existing natural lands in the Mendota area should be expanded and connected with the Ciervo-Panoche area, through restoration of habitat on retired, drainage-problem farmland. Natural lands that would provide a connection are scarce, because the land between these two populations is dominated by agriculture (USFWS 1998). Although kit fox will move up to 1.5 kilometers into farmland, they appear reluctant to cross large expanses of agricultural land due to the lack of escapes from predators (Cypher *et al.* 2005b). Six occurrences of kit fox in the lands connecting these populations were recorded in 1920; there have been no subsequent recorded observations in the agricultural lands connecting Ciervo-Panoche and the Mendota area. Retired agricultural lands may provide important stepping stones to maintain connectivity throughout the action area.

The Ciervo-Panoche core area includes over 52,000 acres of BLM holdings that offer some protection to the kit fox, although most BLM holdings in the core area are not suitable for kit fox due to their rugged character and shallow soils. Most suitable kit fox habitat in the core area occurs on private lands in the valley floors (EG&G 1981). Approximately 21,000 additional acres of potential kit fox habitat could be set aside for conservation by 2010 as required by the SWRCB Decision 1641 requiring mitigation for the unpermitted loss of alkali scrub habitat in agricultural areas in western Fresno County (primarily in Westlands Water District) that received water through the CVP (SWRCB 2000). However, there are no requirements that stipulate that lands for this mitigation be purchased in locations that would benefit the kit fox.

Land acquisitions to benefit kit fox should focus on the establishment of large blocks of land (at least 10,000 acres in size) on the San Joaquin Valley floor and western fringes. Such large parcels are critical to supporting sustainable populations of kit fox for long-term conservation, and should be linked with protected broad dispersal corridors. These acquisitions are most likely to aid kit fox recovery if they build on existing protected lands to achieve larger expanses of protected land, if acquired lands possess the vegetative structure and native prey base that are associated with thriving kit fox populations, and if acquired lands are not isolated from extant populations of either the kit fox or its prey species. Large holdings of native habitat are also expected to be less suitable for coyotes and red fox that are responsible for high levels of kit fox mortality. Lands no longer suitable for agriculture, such as those targeted for land retirement, may be restored and conserved through fee title acquisition, conservation easement acquisition, or conservation banking arrangements from willing sellers or participants. However, on suboptimal habitat, conservation planning should recognize the lag times inherent in restoration of the ecological community needed to support the kit fox. Linkages will be most effective in contributing to kit fox recovery where they link to habitat that retains the characteristics needed to sustain resident populations.

<u>Mapping</u>: Mapping efforts that quantify the acreage of suitable/native habitat and altered or degraded habitat in core, satellite, and linkage areas at 1) the time of the 1998 Recovery Plan, and 2) the current time, will assist the Service and other conservation entities in prioritizing conservation strategies and in determining progress in meeting recovery goals for protection of core and satellite areas. The locations, acreage, and quality (or characteristics) of protected habitat could also be compiled and mapped.

<u>Contaminant Studies</u>: Studies that assist in determining the population-level effects of contaminants, including first and second generation anticoagulant rodenticides, on kit fox or surrogate species are needed. Studies that test correlations between rodenticide use and kit fox population parameters, measure sublethal effects on behavior, or quantify rodenticide/pesticide

effects on availability of prey in relation to the energetic needs of the fox would provide information useful to recovery actions. The USEPA should complete ESA consultation on the effects of the use of SGAR's on the kit fox.

ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of past and ongoing human and natural factors leading to the current status of the species and any critical habitat within the action area. The baseline includes State, tribal, local, and private actions already affecting the species or that will occur at the same time as this consultation. Unrelated Federal actions affecting the same species that have completed formal or informal consultation are also part of the environmental baseline, as are Federal and other actions within the action area that may benefit listed species or critical habitat.

Grassland Bypass Project - Selenium

Selenium Ecological Risk Guidelines

In 1993, to evaluate the risks of the proposed GBP on biotic resources in Mud and Salt Sloughs, a set of Ecological Risk Guidelines based on selenium in water, sediment, and residues in several biotic tissues were developed by a subcommittee of the SLD Re-Use Technical Advisory Committee (CAST 1994; Engberg, *et al.* 1998). These guidelines are based on a large number of laboratory and field studies, most of which are summarized in USDOI (1998), Lemly (1993) and Presser and Luoma (2006). These guidelines are listed in Table 5. In areas where the potential for selenium exposure to fish and wildlife resources exists, these selenium risk guidelines can be used to trigger appropriate actions by resource managers, regulatory agencies, and dischargers (Beckon *et al.* 2008; USBR 2009).

Beckon *et al.* 2008 described the ranges of effect levels from the GBP Ecological Risk Guidelines as follows:

> In the **No Effect** range, risks to sensitive species are not likely. As new information becomes available it should be evaluated to determine if the No Effect level should be adjusted. Since the potential for selenium exposure exists, periodic monitoring of water and biota is appropriate.
>
> Within the **Concern** range, there may be risk to species sensitive to elevated contaminant concentrations in water, sediment, and biota, and should be monitored on a regular basis. Immediate actions to prevent selenium concentrations from increasing should be evaluated and implemented as appropriate. Long-term actions to reduce the selenium risks should be developed and implemented. Research on effects on sensitive species may be appropriate.

Within the **Toxicity** range, adverse effects are more likely across a broader range of species, and sensitive or listed species would be at a greater risk of toxic effects. These conditions will warrant immediate action to reduce selenium exposure through disruption of pathways, reduction of selenium loads, or other appropriate actions. More detailed monitoring, studies on site-specific effects, and studies of pathways of selenium contamination may be appropriate and necessary. Long-term actions to reduce selenium risks should be developed and implemented.

Table 5. Recommended Ecological Risk Guidelines for Selenium Concentrations.

Environmental Media	Effects on	Units	No Effect	Concern	Toxicity
Water (total recoverable selenium)	fish and bird reproduction	µg/L	< 2	2 -- 5	> 5
Invertebrates (as diet)	bird reproduction	µg/g (dry weight)	< 3	3 -- 7	> 7
Warmwater Fish (whole body)	fish growth/condition/survival	µg/g (dry weight)	< 4	4 -- 9	> 9
Avian egg	egg hatchability	µg/g (dry weight)	< 6	6 -- 10	> 10
Vegetation (as diet)	bird reproduction	µg/g (dry weight)	< 3	3 -- 7	> 7

Notes:

1/ These guidelines, except those for avian eggs, are intended to be population based. Thus, trends in means over time should be evaluated. Guidelines for avian eggs are based on individual level response thresholds (e.g., Heinz, 1996; Skorupa, 1998).
2/ A tiered approach is suggested with whole body fish being the most meaningful in assessment of ecological risk in a flowing system.
3/ The warmwater fish (whole body) concern threshold is based on adverse effects on the survival of juvenile bluegill sunfish experimentally fed selenium enriched diets for 90 days (Cleveland et al., 1993). It is the geometric mean of the "no observable effect level" and the "lowest observable effect level."
4/ The toxicity threshold for warmwater fish (whole body) is the concentration at which 10% of juvenile fish are killed (DeForest et al., 1999).
5/ The guidelines for vegetation and invertebrates are based on dietary effects on reproduction in chickens, quail and ducks (Wilber, 1980; Martin, 1988; Heinz, 1996).
6/ If invertebrate selenium concentrations exceed 6 µg/g then avian eggs should be monitored (Heinz et al., 1989; Stanley et al., 1996).

Adapted from Beckon *et al.* 2008. Grassland Bypass Project 2004-2005 Reports, Chapter 7.

Mud Slough (North), Salt Slough and the San Joaquin River

Selenium Water Quality, 1996-2008: In 1996, the year before the GBP began, the combined selenium load (pounds of selenium discharged/year) for Mud and Salt Sloughs was 9,491 pounds (Table 6). In 1996, selenium concentrations in water of Mud Slough (North) averaged 1.4 µg/L (<0.4 to 11.8) while Salt Slough averaged 16.0 µg/L (1.0 to 33.5) (CVRWQCB 1998, USBR *et al.* 1998). During the first year of the GBP, 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 µg/L) as Salt Slough concentrations dropped (1.0 µg/L) as expected (USBR *et al.* 1998). In 1998, an El Nino year caused record rainfall in the area, leading to the discharge of more than 9,000 pounds of selenium from the GBP. Monthly load targets and the maximum allowable annual load (6,600 pounds) were not met. The average selenium concentration in Mud Slough dropped slightly to 26.6 µg /L even though the maximum concentration detected was 104 µg/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 µg/L and the Salt Slough average was 1.5 µg/L (Crader 2000, Young 2000). 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 CVRWQCB 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 µg /L selenium standard (Young, 2001).

Since 2001, success has been achieved in meeting the selenium load limits prescribed by the CVRWQCB in the Waste Discharge Requirement for the GBP. The GBP has met 90% of the monthly[4] and all of the annual selenium loads values specified in the WDR. The monthly mean concentration of selenium in Salt Slough has been below the 2 µg /L standard during every month since October 1996. The concentration of selenium in the San Joaquin River below the Merced River has met the 5 ppb (four-day average) selenium concentration since 01 October 2005 (USBR 2009).

The Grassland Area Farmers have reduced the volume of drain water discharged from the GDA by 46 percent from the pre-project average of almost 50,000 acre feet per year (AFY) to about 27,000 AFY (USBR 2009). The annual load of selenium has been reduced from a pre-project average of over 8,800 pounds to less than 1,800 pounds in 2008 (Table 6).

However, the average concentration of selenium in drainwater discharged from the GBP into Mud Slough (North) still exceeds both the 2010 Basin Plan objectives (5 µg /L 4-day average) and the ecological risk assessment level of concern (2 µg /L) (USBR 2009). Further, occasional increases in selenium concentrations in Salt Slough associated with heavy rainfall events have resulted in exceedances of the 2 µg /L water quality objective for wetland water supply channels. The SWRCB included Salt Slough and Mud Slough (North) on the 2006 303(d) list of impaired water bodies for California as a result of exceedances of selenium water quality objectives for those channels (SWRCB 2007).

In 2008, average selenium concentrations in Salt Slough fell to the lowest observed since the onset of the GBP (0.4 µg /L). It is worth noting that the normal background range of selenium in freshwater usually falls within the range of 0.2 – 0.4 µg /L (as described in Maier and Knight 1994). Thus, Salt Slough has attained or is nearing normal background selenium concentrations in water.

[4] Fourteen exceedances of the monthly selenium objective during the 147 months between October 1996 and December 2008

Table 6. Selenium loads and water concentrations in the Grassland watershed for water years (October – September) 1996 through 2008 (C. Eacock, USBR, *in litt.,* 10.28.2009).

Year	Use Agreement Load Limit (pounds)	Annual Load (pounds)	San Luis Drain Station B (µg/L, mean and range)	Mud Slough (µg/L, mean and range)	Salt Slough (µg/L, mean and range)
1996 pre-project	NA	9,491	NA	1.4 (<0.4 - 11.8)	16.0 (1.0 - 33.5)
1997	6,660	7,722	60.6 (15.2 – 116)	29.0 (3.2 - 79.6)	1.0 (0.5 - 3.4)
1998	6,660	8,760	68.5 (20.2 – 134)	26.3 (3.1 – 104)	1.2 (<0.4 - 5.1)
1999	6,327	5,124	57.0 (22.7 – 121)	22.8 (3.7 – 50.7)	0.8 (<0.4 – 1.5)
2000	6,528	4,603	54.8 (23.3 – 104)	22.2 (3.7 – 66.0)	0.8 (<0.4 – 1.7)
2001	6,246	4,311	54.8 (22.5 – 97)	23.1 (3.2 – 50.8)	0.8 (<0.4 – 2.1)
2002	5,360	3,939	56.3 (24.1 – 85.4)	23.9 (4.5 – 54.9)	0.5 (<0.4 – 1.1)
2003	5.027	4,029	53.8 (21.3 – 96.4)	18.9 (4.0 – 48.0)	0.6 (<0.4 – 1.3)
2004	4,696	3,871	46.6 (18.6 – 89.8)	18.9 (3.6 – 48.9)	0.6 (<0.4 – 1.1)
2005	4,585	4,284	50.9 (19.8 – 110)	17.2 (2.9 – 36.6)	0.6 (<0.4 – 1.2)
2006	4,148	3,405	52.9 (22.5 – 106)	13.9 (3.0 – 39.9)	0.6 (<0.4 – 1.1)
2007	3,625	2,549	41.5 (9.1 – 106)	15.9 (1.0 – 51.2)	0.6 (<0.4 – 1.0)
2008	3,301	1,740	35.4 (7.7 – 78.7)	15.7 (1.8 – 51.1)	0.4 (<0.4 – 1.0)

Selenium in fish and invertebrates in Mud Slough (North) upstream of SLD discharge (Site C): This sampling location, about 400 m upstream of the outfall of the SLD, was intended to serve as a "reference site", representing the baseline conditions in Mud Slough that would prevail in lower Mud Slough (North) were it not for drainwater discharges into lower Mud Slough due to the GBP. However, fish samples at this site are likely influenced by upstream movement of fish from downstream drainwater (Beckon *et al.* 2008).

Except for red shiners (*Cyprinella lutrensis*) and fathead minnows (*Pimephales promelas*), most species of fish remained at levels generally below the threshold of concern for warmwater fish (4 µg/g). The average selenium concentration in fish collected in the period 2003 – 2005 (3.58 µg/g) was statistically significantly higher than in 1998 – 2002 (3.10 µg/g). The increase in average selenium concentration in fish coincides with an increase in selenium in invertebrates evidently due to an increase in the proportion of invertebrate samples being comprised of the invasive species of freshwater shrimp, the Siberian shrimp *(Exopalaemon modestus*), a species effective at accumulating selenium (Beckon *et al.* 2008).

The average selenium concentration in invertebrates increased during the period 2003 – 2005 (2.31 µg/g) compared with the period 1998 – 2002 (1.72 µg/g). Beckon *et al.* (2008) noted that this increase appears to be related to rapidly increasing numbers of the non-native Siberian freshwater shrimp. By 2003, this species became one of the most common invertebrate species seined at this location in Mud Slough. Beckon *et al.* (2008) further observed that Siberian freshwater shrimp bioaccumulate selenium more effectively than other arthropod species in the area.

Selenium in fish and invertebrates in Mud Slough (North) downstream of SLD discharge (Site D): Since 1996, subsurface drainwater has been discharged, via the GBP, into lower Mud Slough North, where selenium concentrations in small fish, such as mosquitofish, inland silversides (*Menidia beryllina*), red shiners, and fathead minnows, frequently have reached 10-15 µg/g (dwt) (Beckon *et al*. 2003). Immediately following the onset of the GBP in 1996, selenium concentrations in mosquitofish and silversides reached very high levels. Thereafter, from 1998 through 2005, selenium concentrations have stabilized at this site, with most composite samples having concentrations at GBP levels of concern for warmwater fish (4 - 9 µg/g selenium). The average selenium concentrations of fish composite samples in 1998 – 2003 and 2004 -2005 were 6.2 µg/g and 6.0 µg/g, respectively. Post-GBP fish tissue selenium concentrations were significantly higher than the pre-project average (4.0µg/g) (Beckon *et al.* 2008).

The average selenium concentration of composite samples of amphibian tadpoles (almost entirely bullfrog) collected from Site D in Mud Slough (North) from 2000 - 2005 was 4.4 µg/g (Beckon *et al.* 2008). Although there are no explicit GBP Ecological Risk Guidelines for amphibians (as diet), the Guidelines do include two media (invertebrates and vegetation) as diet (for birds). Those dietary Guidelines identify concentrations between 3 and 7 µg/g as being at a level of "**Concern**." This average concentration of selenium in tadpoles would fall within that level of concern as a dietary constituent and may be pose a risk to species sensitive to selenium contamination.

While loads of selenium into Mud Slough (North) from the GBP have declined substantially since the beginning of the GBP, selenium concentrations in invertebrates have increased. The average selenium concentration in composite invertebrates samples collected at this site in 2004 – 2005 was 4.0 µg/g, slightly higher than average of samples collected from the beginning of the Project to the end of 2003 (3.4 µg/g). All these tissue concentrations are above the GBP concern threshold (3 µg/g) for dietary exposure of fish and wildlife. The increase in selenium in invertebrates is likely due to an increase in the proportion of invertebrate samples being comprised of the Siberian shrimp, a species effective at accumulating selenium. As elsewhere in the Grassland area, Siberian freshwater shrimp appear to bioacccumulate selenium to higher levels than other aquatic arthropods (Beckon *et al.* 2008).

<u>Selenium in fish and invertebrates in Mud Slough (North) backwater of SLD discharge (Site I2):</u> Site I2 is a small, seasonally flooded backwater area fed by Mud Slough (North) and is located approximately 1 mile downstream from Site D. The concentrations of drainwater contaminants in mobile aquatic organisms collected at this site are less likely to be diluted effectively by feeding in nearby cleaner water (Beckon *et al.* 2008).

With the exception of two samples of threadfin shad, all composite samples of fish collected at Site I2 in 2004-2005 had concentrations of selenium at levels of concern (4-9 µg/g) or toxicity (>9 µg/g). The overall average selenium concentration in fish was 8.3 µg/g, close to the GBP Ecological Risk Guidelines toxicity threshold and significantly above the pre-project average (4.5 µg/g). As at Site D, selenium concentrations in fish at this site have not declined as selenium loads in the slough have decreased over the life of the GBP (Beckon *et al.* 2008).

Selenium concentrations in invertebrates sampled at this site were higher during 2004-2005 (5.6 µg/g) than the previous average in 1997-2003 (4.8 µg/g). The continued high and increasing concentrations of selenium in invertebrates at this site may be due in part to the invasion of the Siberian freshwater shrimp. Eleven of 29 invertebrate samples (38%) exceeded the GBP Ecological Risk Guidelines dietary toxicity threshold for birds that might forage on these invertebrates (7 µg/g selenium).

<u>Selenium in fish, amphibians and invertebrates in Salt Slough (Site F):</u> In the period 2004-2005, concentrations of selenium Salt Slough fish composite samples were generally below the GBP threshold of concern for warmwater fish (4 µg/g). Two composite fish samples collected at this site exceeded the 4 µg/g threshold of concern for warmwater fish (61 male mosquitofish 4.2 µg/g selenium; two black bullhead 4.9 µg/g selenium). The overall average selenium concentration of all composite fish samples for 1998 – 2005 was 2.6 µg/g, significantly less than the pre-GBP average of 6.7 µg/g (Beckon *et al.* 2008).

The average selenium concentration of composite samples of amphibian tadpoles (almost entirely bullfrog) collected in Salt Slough from 2000 - 2005 was 3.5 µg/g (range 2.51 - 7.50 µg/g), and was not significantly different from the average concentration of selenium in tadpoles collected from Site D in Mud Slough (North) below the SLD outfall (Beckon *et al.* 2008). Although there are no explicit GBP Ecological Risk Guidelines for amphibians (as diet), the Guidelines do include two media (invertebrates and vegetation) as diet (for birds). Those dietary Guidelines identify concentrations between 3 and 7 µg/g as being at a level of "**Concern**". If tadpole concentrations are viewed similarly as a dietary constituent, then 3.5 µg/g would fall within that level of concern and could pose a risk to wildlife.

In 2004 – 2005, selenium concentrations in most of the 19 composite invertebrate samples collected from Salt Slough remained within the range of concentrations associated with no known adverse effects (<3 µg/g) on wildlife that eat invertebrates. The only exceptions were two composite samples of Siberian freshwater shrimp (3.3 µg/g from 2004 and 4.2 µg/g from 2005). The mean concentrations of selenium in all invertebrate samples collected during 1998 – 2003 and 2004 – 2005 were 2.0 µg/g and 1.9 µg/g, respectively, which were significantly below the pre-GBP average of 4.4 µg/g (Beckon *et al.* 2008).

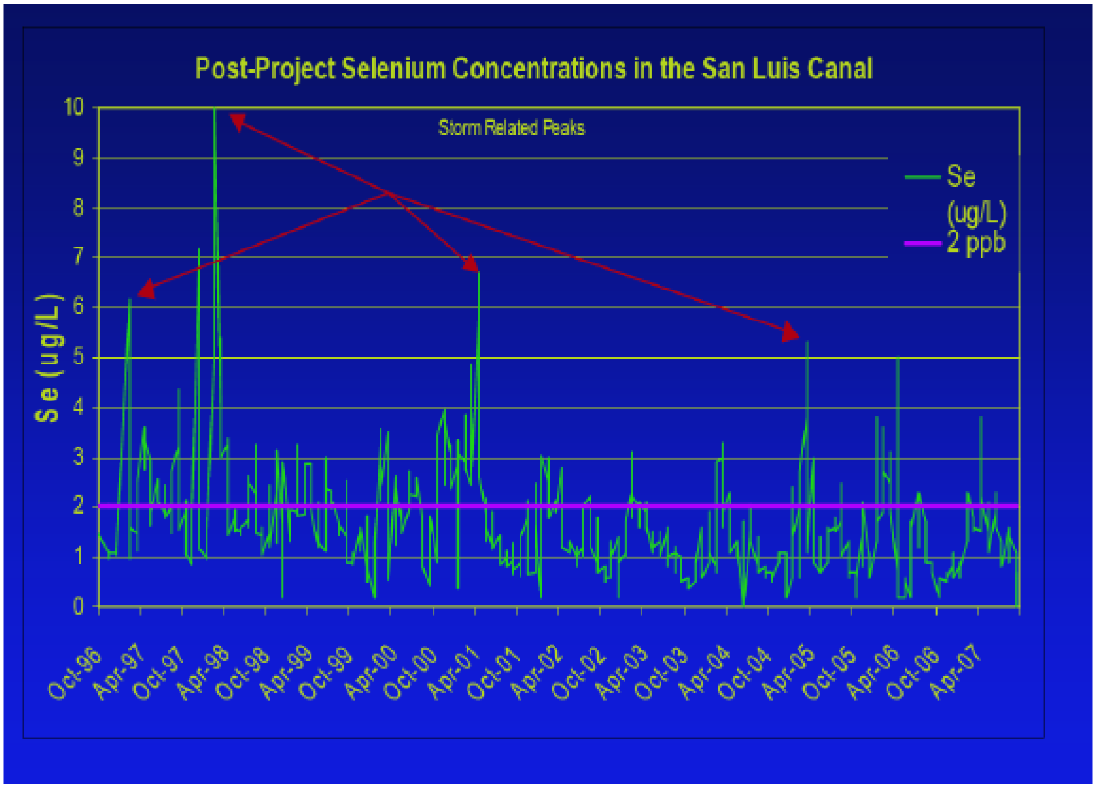
South Grasslands Wetland Supply Channels
Implementation of the GBP has significantly improved water quality in the Grasslands wetland channels (with the exception of Mud Slough North where drainage is routed to the San Joaquin River). Consequently, exposure of aquatic and aquatic-dependent wildlife to agricultural drainwater contaminants in the Grasslands wetlands and supply channels has been reduced. Beginning in 1985, agricultural drainwater no longer was applied directly to wetlands, but wetland water supply channels continued to be used periodically to convey agricultural drainwater through wetland areas to the San Joaquin River. Between 1985 and 1996, wetland supply channels in the GWD were used to convey both drainwater and fresh water. Through an agreement between the GWD and the surrounding agricultural districts, subsurface agricultural drainage entered the southern portion of the GWD through the Agatha Canal or the Camp 13 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 GBP.

The original agreement for use of the SLD (Use Agreement) dated November 3, 1995, allowed the Water Authority to use a portion of the SLD to convey agricultural drainwater through adjacent wildlife management areas to Mud Slough (North), a tributary to the San Joaquin River. The 1995 Use Agreement allowed for use of the SLD until September 30, 2001. The 2001 Use Agreement allowed continuation of the use of the SLD through December 31, 2009. With implementation of the GBP from 1996 through the present, most of the drainage from farmlands in and adjacent to the GDA was no longer conveyed in about 93 miles of Grasslands wetland supply channels.

By 2004 the GBP had been in operation for eight years, providing cleaner water in channels supplying Federal, State, and private wetlands upstream of the GBP discharge. Selenium concentrations in bird egg, fish and invertebrate samples from the South Grassland wetlands have declined compared with pre-project concentrations. Nonetheless, several studies have documented concentrations of selenium in wetland channel biota, especially in the south Grasslands that are within the GBP Ecological Risk Guideline level of "**Concern**" or (Beckon *et al*. 2007; Paveglio and Kilbride 2007). Ongoing risks of selenium toxicity in some biota of the South Grasslands wetland ecosystem is most likely due to: (A) recycling of a persistent reservoir of residual selenium, and (B) continuing input of additional selenium into the ecosystems. Existing selenium concentrations in biota in the area are most likely due to a continuing influx of selenium contamination that has not been fully abated in the area. Sources of ongoing selenium contamination in Grassland wetland channels include (1) continued contamination of the water supply in the DMC; (2) unregulated and unmonitored discharges of agricultural subsurface drainwater from nearby farmland into local ditches and canals that feed into the Grassland wetland supply channels; (3) and large storm events that can overwhelm the GBP channel, requiring that uncontrollable storm runoff be diverted into wetland supply channels (Beckon *et al*. 2007; Paveglio and Kilbride 2007; Eppinger and Chilcott 2002).

<u>Selenium water quality in the south Grassland Wetland Supply Channels:</u> The water quality objective for selenium in the Grassland wetland channels is 2 µg/L on a monthly mean basis (CVRQCB 1998). However, from an ecological standpoint, the weekly water concentrations collected as individual grab samples are more meaningful than a monthly mean of those concentrations because they more accurately represent the selenium concentrations in the water that the ecosystem is exposed to. Since the onset of the second use agreement for the GBP in September 2001 there have been consistent short-term pulses of selenium inputs into the Grassland wetland supply channels. For example, from September 2001 through June 2006 weekly water samples documented selenium levels above 2 µg/ in the Grassland wetland supply channels 23 times in Camp 13 Ditch, 14 times in Agatha Canal, 4 times in the San Luis Canal, and 14 times in the Santa Fe Canal (USBR *et al.,* GBP Monthly Monitoring Reports, September 2001 to June 2006). Typically, these exceedances of 2 µg/L are associated with heavy rainfall events and/or occur in the spring of each year (usually in March and/or April) as depicted in Figure 3 below, Post-Project Weekly Selenium Concentrations in the San Luis Canal (a wetland supply channel in the South Grasslands). The SWRCB included the Grassland Marshes (Grassland Wetland Supply Channels) on the 2006 303(d) list of impaired water bodies for California as a result of non-compliance with selenium water quality objectives and an existing TMDL for those channels (SWRCB 2007).

Figure 3. Weekly Selenium Concentrations in the San Luis Canal, 1996 – 2007 from Chilcott and Schnagl, 2008



<u>Sources of selenium in the Grasslands wetland supply channels - DMC sumps and check drains:</u> One of three sources of selenium in the Grasslands wetland supply channels has been identified to be supply water in the DMC (Eppinger and Chilcott, 2002). The major source of supply water to the Grasslands wetland channels and to the agricultural lands of the GDA is the DMC, via Mendota Pool and the CCID's Main Canal. Sources of selenium to the DMC include: groundwater pumping into Mendota Pool, recycling of San Joaquin River drainage into the federal pumps in the south Delta, flood flow and sediment loading from the Panoche and Silver Creek watersheds, and discharge from DMC subsurface drains and six shallow groundwater sumps (DMC sumps) owned by Reclamation and operated by the Water Authority in the FCWD (Pierson *et al.* 1987; Chilcott 2000; USBR 2008).

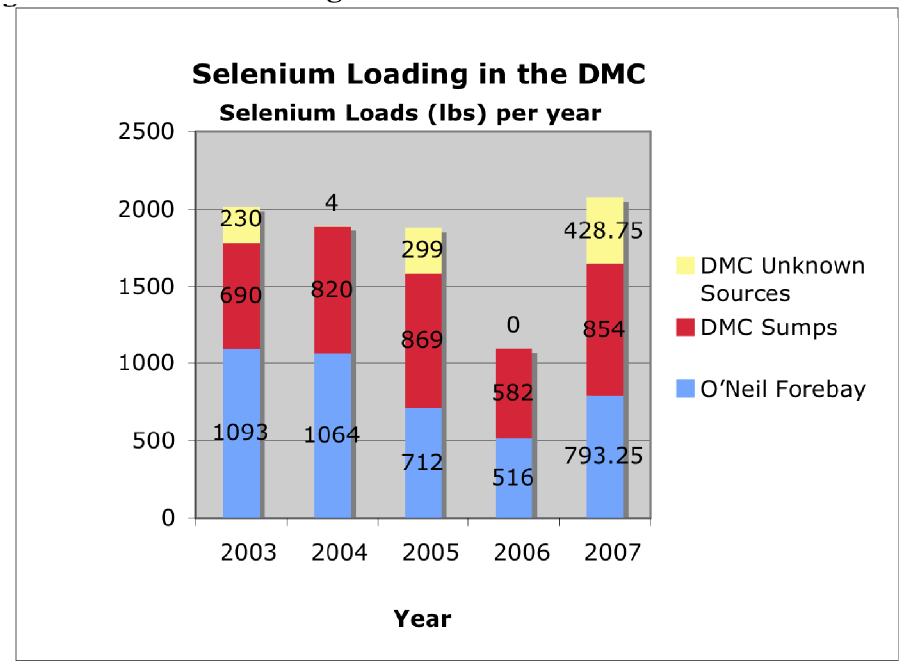
In the 1950s Reclamation installed check drains and the DMC sumps between Mileposts 99 and 110, parallel to the DMC, to collect small quantities of seepage water or surface runoff to prevent accumulation and possible damage to the canal bank or adjacent lands. Water collected in the subsurface drains is discharged into the DMC by the sumps through six drainage inlet structures.

Although flow from Reclamation's DMC sumps is relatively small (the cumulative volume of drainage from the six DMC sumps averages 3.3 acre-feet per day and 110 acre-feet per month from USBR 2008), selenium concentrations in discharged water have ranged from 57 - 2,100 µg/L between 1985 and 2000 (USBR April 2002). Reclamation monitoring data up to 1994 revealed water discharged from sump "K" exceeded California's hazardous waste threshold for selenium in water (1,000 µg/L) in one or more months sampled annually. Since 2003, selenium in water from DMC sump "K" was at or exceeded this State Hazardous Waste threshold for selenium on two separate dates (May 20, 2003 and April 26, 2006: source USBR DMC Water Quality Monthly Monitoring Reports).

CVRWQCB staff indicated a close correlation between selenium in DMC and CCID's Main Canal source water and selenium in wetland supply channels, during the non-flood water years of 1999 and 2000 (Eppinger and Chilcott 2002). This staff report noted that when the source water had elevated selenium concentrations (above 2 µg/L) a corresponding increase in selenium concentration was noted in the wetland water supply channels.

Since 2002, Reclamation has monitored the DMC sumps for selenium on a weekly basis. Reclamation water quality monitoring data from various points along the DMC from 2003 to 2007 indicate that between O'Neil Forebay and the Mendota Pool, from 582 to 1,283 pounds of selenium have been added to the DMC supply water annually (see Figure 4 below). Depending on the year, from 67 to 100 percent of that added load downstream of O'Neil Forebay is from the DMC sumps and the remainder of the added load is from unaccounted sources (e.g., DMC check drains) (USBR 2008).

Figure 4.



1 Selenium loads from Unknown Sources were calculated by subtracting the selenium loads from the DMC sumps and at O'Neil Forebay from the selenium loads at the DMC Terminus (MP-116.48 at Bass Ave). In the case of 2006, the input from Unknown Sources was a negative number, and therefore assumed to be zero.
2. For the month of September 2007 a monthly selenium load was not available for O'Neil Forebay. For the purposes of this analysis, a monthly load was calculated as the average of the monthly selenium loads at this location from September for the years 2003-2006.

<u>Sources of selenium in the Grasslands wetland supply channels - lands outside the GBP's Drainage Project Area:</u> As was noted in a CVRWQCB Report reviewing selenium concentrations in wetland water supply channels in the Grassland Watershed (Eppinger and Chilcott 2002):

> *"Two areas have been identified where agricultural subsurface drainage can enter wetland water supply canals from farmland not contained in the DPA [Grasslands Drainage Area]. One area is west of the wetland water supply channels and historically drained into the Almond Drive Drain. Since Water Year 1999, these discharges have been collected in the CCID Main Drain and diverted into the CCID Main Canal downstream of internal supply channels. Data for Water Years 1999 and 2000 is not available for the Almond Drain site.*
>
> *The second area where agricultural subsurface drainage can enter wetland water supply canals from outside the DPA is a triangle-shaped area of approximately 7,000 acres south of the Poso Drain (also known as the Rice Drain) and north of the DPA. This area historically drained into the Poso Drain, entering South Grassland Water District from*

> *the east. Three sites on the Poso (Rice) Drain were monitored for selenium during Water Years 1999 and 2000. Selenium concentrations at all three sites were above 2 ug/L a majority of the time, though a change in tail water management after June 1999 has apparently helped to reduce and stabilize concentrations…*
>
> *During Water Year 1999, selenium concentrations in the Poso Drain were highly variable with concentrations at the upstream Russell Boulevard site ranging from <2 ug/L to 39 ug/L and concentrations at the downstream site (Mallard Road) ranging from <2 ug/L to 24 ug/L…After June 1999, more tail water was discharged through the Rice [Poso] Drain at Russell…Mean selenium concentrations continued to remain above 2 ug/L at all the Rice Drain sites.*"

The GBP EIS/R in 2001 and the EIS/R for the GBP Extension in 2009 noted that the proposed action may include the addition of approximately 1,100 acres of farmland to the GBP's Drainage Project Area (DPA), found immediately adjacent to the DPA, south of the SLD and east of the Grassland Bypass Channel, that currently drain to wetland channels, in the area identified by Chilcott (2000) as the Poso Rice Drain Area. The FEIS/R for the GBP Extension (Appendix I) noted the following with respect to these lands that continue to discharge drainage directly into the Grassland wetland supply channels that are outside of the DPA:

> *"The GDA does not include the lands that are described, and they are not under the jurisdiction of the Grassland Basin Drainers (GBD). Additionally the GBD have no authority to compel these lands to become part of the GBP. However, the GBD will work with the landowners in the areas described to encourage management of drain waters that may contain selenium that is entering wetland supply channels and specifically will work with the 1,100 acres of lands that are identified as lands that "... could be annexed to the GDA."*

<u>Sources of selenium in the Grasslands wetland supply channels – heavy rainfall events:</u> Tile-drained farmlands in the GBP's Drainage Project Area southwest of the Grasslands wetland supply channels have proven to be susceptible to flooding during winter storm events from the Panoche/Silver Creek watershed in the Coast Range. These flood flows [40,000 acre-feet during 2-week periods associated with these storm events (SLDMWA 1997)] have been characterized by high selenium levels and loads. For example, selenium concentrations in flood waters from the Panoche/Silver Creek watershed ranged from 4 to 155µg/L during a February 1998 storm event (Chilcott 2000). Presser and Luoma (2006) estimated the cumulative selenium load from Panoche Creek during the *El Nino* Water Year of 1998 to be 8,045 pounds. Such flood flows have overwhelmed the GBP resulting in the diversion of selenium-contaminated water into the Grasslands wetland supply channels.

Since 1996, there also have been infrequent, short-term instances where agricultural drainage flows within the GBP have been diverted to Grasslands wetland supply channels during winter storm events. Since 1995, such events occurred in water years 1995, 1997, 1998 and 2005 and have resulted in significant spikes in selenium concentrations in the Grasslands wetland supply channels and selenium loading into the San Joaquin River (Presser and Luoma 2006, Grassland Area Farmers 2005). Releases of commingled stormwater and drainwater to the Grasslands wetland supply channels are predicted to occur at similar frequency under the proposed GBP Extension as compared to existing conditions.

The most recent heavy rainfall event in 2005 was described in a report submitted to Reclamation and CVRWQCB (Grassland Area Farmers 2005). As a result of heavy rainfall, commingled stormwater and drainage flows that normally would have been routed into the SLD were rerouted into the Agatha Canal in the south Grasslands. During the 2005 rainfall event, selenium concentrations in water from Agatha Canal were elevated over 2 µg/L for several weeks as denoted in Table 7 below.

Table 7. Flood Flows and Selenium Concentrations and Load into Agatha Canal, 2005.

Date	Flow (AF)	Selenium (µg/L)	Selenium (lbs)
2/16/2005	7	3.5	0.1
2/17/2005	75	4.5	0.9
2/18/2005	50	3.5	0.5
2/19/2005	44	26.5	3.1
2/20/2005	40	39.9	4.3
2/21/2005	40	43.8	4.7
2/22/2005	14	3.7	0.1
2/23/2005	0	44.4	0
2/24/2005	N/A	24.8	N/A
2/25/2005	N/A	24.2	N/A
2/26/2005	N/A	16.6	N/A
2/27/2005	N/A	14.8	N/A
2/28/2005	N/A	9.27	N/A
3/1/2005	N/A	5.1	N/A
3/2/2005	N/A	2.83	N/A

<u>Selenium in biota of the South Grasslands:</u> Two recent studies have documented selenium levels in biota from the south Grasslands wetland supply channels during implementation of the 2nd Use Agreement of the GBP (Beckon *et al.* 2007; Paveglio and Kilbride 2007). In the first study, the Service's SFWO, Environmental Contaminants Division, conducted a field investigation of sediment, aquatic invertebrates, bird eggs and fish from wetlands in the Grasslands area and analyzed these constituents for selenium from five areas that receive water from different or mixed water sources (Beckon *et al.* 2007). Sediments are thought to serve as an important reservoir of selenium contributing to long-term cycling of selenium in aquatic ecosystems long after influx of selenium has been stopped. The authors concluded that selenium concentrations

in sediments and invertebrates are likely due to a continuing influx of selenium contamination that has not been fully abated in the area. The study's findings included:

- *"Of the 62 avian eggs sampled, 6.5 percent exceeded the threshold of concern for avian eggs (6 µg/g dwt). Those four eggs ranged from 6.0 to 6.9 µg/g.*
- *Of the 74 whole body fish samples collected 27 (36.5 percent) exceeded the threshold of concern for selenium in warmwater fish (4 µg/g selenium). All 12 samples of striped bass (Morone saxatilis, all of them juveniles: 11 from Gadwall Canal at Santa Cruz Gun Club, and one from Camp 13 Ditch at Checkpoint 4) exceeded the threshold of concern for selenium in warmwater fish.*
- *Thirty-two samples of invertebrates were collected in the South Grasslands. Thirteen of these (40.6 percent, Figure 5) reached or exceeded the threshold of concern for invertebrates as diet for birds (3 µg/g dietary selenium). The most effective invertebrate bioaccumulators of selenium were European freshwater snails (Physa) and Siberian shrimp (Exopalaemon modestus). The latter is a recently introduced species that evidently bioaccumulates selenium more effectively than other aquatic invertebrates in the area, such as red crayfish, that it seems to be replacing."*

In the second study, the Service's Division of Natural Resources, Branch of Refuge Biology, Vancouver, WA, conducted follow-up collections during 2005 to determine selenium concentrations in aquatic birds after long-term use (20 years) of predominately freshwater for wetland management in the Grasslands (Paveglio and Kilbride 2007). The authors found the following:

> *"Selenium concentrations were higher for birds from the South Grasslands during 2005, which historically received more undiluted drainage water compared with the North Grasslands. Liver selenium concentrations for black-necked stilts from the South Grasslands were within ranges associated with the first incidence of reproductive impairment. Shovelers, coots, and black-necked stilts from the South Grasslands during 2005 were found to be significantly above the background level (at a 95% confidence level)…"*

Paveglio and Kilbride (2007) reported selenium concentrations in livers from northern shovelers collected in the south Grasslands (8.5 – 11 µg/g dry weight) that were comparable to levels associated with significantly reduced disease resistance and increased mortality in a controlled field experiment on mallard ducks (Hansen and Whiteley 1990; Whiteley and Yuill 1991). Paveglio and Kilbride (2007) concluded that selenium cycling within Grasslands wetlands likely is attributable to three factors: 1) historic use of agricultural drainage resulting in a reservoir of selenium in wetlands and supply channel sediments; 2) storm-water inflows; and, 3) unregulated inflows of subsurface drainage directly into wetlands or indirectly into their supply channels.

SJRIP Drainage Reuse Area

HT Harvey and Associates have conducted biological monitoring at the SJRIP drainage reuse area for the past 8 years. The most recent data are available from 2008 (HT Harvey and Associates 2009). As of 2008, approximately 3,873 acres of the original 4,000-acre SJRIP project site had been planted with salt- tolerant crops and irrigated with agricultural drainwater. An additional 1,901 acres acquired that year for future inclusion in the project, had not yet been planted with salt-tolerant crops or irrigated with agricultural drainwater.

The Negative Declaration (ND) for the SJRIP drainage reuse area adopted in September 2000 included provisions for wildlife monitoring capable of assessing project-related impacts to wildlife. Provisions were also included for the adaptation of mitigation measures if the monitoring program detected negative project-related impacts (HT Harvey and Associates 2009).

In 2008, habitat modifications combined with hazing precluded all but 6 recurvirostrid (black-necked stilt and American avocet combined) and 9 killdeer nest attempts on the 4,000-acre SJRIP project site. Panoche Drainage District initiated management practices to avoid and minimize impacts to nesting shorebirds in 2006, including hazing of shorebirds from the project site, modification of open drains to discourage shorebirds from using traditional nest sites, and installation of a pilot mitigation site to provide clean-water nesting habitat for shorebirds. As of 2008, a total of 6.8 miles of open drains have been filled, 2.5 miles of open drains have been netted, and 1.0 mi of drains have been re-contoured and reduced in size. Since 2006, breeding habitat comprising 50 acres of cultivated rice has been created for shorebirds. In 2008, 20 islands approximately 40-ft long and 7-ft wide were constructed within a 50-acre site irrigated with clean water. The islands were constructed to enhance the attractiveness and utility of the existing rice field for shorebirds by providing nesting habitat.

Water samples from the sources of drainwater used to irrigate the existing reuse area ranged from 43 to 761 µg/L selenium from 2003 to 2005 (H.T. Harvey and Associates 2009). Skorupa (1998) estimated an embryotoxicity threshold in water of 3-4 µg/L at drainage evaporation ponds for black-necked stilt eggs in the San Joaquin Valley at drainage evaporation ponds. Water at the SJRIP drainage reuse area is significantly above this embryotoxic threshold for water and would be expected to result in a high probability of reduced hatchability and increased probability of teratogenesis (embryo deformities) if nesting birds were to feed in this area (Skorupa 1998; USDOI 1998).

The SJRIP drainage reuse areas are used by a variety of avian species. Although winter surveys for birds have not been a focus of avian monitoring efforts at the SJRIP, the GBP has conducted winter surveys for mountain plover (*Charadrius montanus*) as required in the Service's 2001 biological opinion on the GBP. Mountain plovers have been observed at the SJRIP drainage reuse facility on several instances during the winter months (J. McGahan *in litt,* 2002; 2004).

In the SJRIP Phase I area (the area being irrigated with subsurface drainage), 38 avian species were observed between 22 April and 17 June 2008 (Table 8). Avian numbers were highest in late

May, when red-winged blackbirds were fledging young. The red-winged blackbird was the most numerous avian species observed on the project site. Fifteen species were either observed nesting, or were suspected of nesting, on the site based on observations of courtship behavior or young. Total bird numbers declined in June as fewer migrants were detected. Bird use at the newly acquired project lands was similar to bird use of the existing project, with a few notable differences (Table 9). Black-necked stilts and American avocets were absent from the newly acquired lands. Species that rely on riparian and marsh habitats such as the black phoebe (*Sayornis nigricans*), marsh wren (*Cistothorus palustris*), and Bullock's oriole (*Icterus bullockii*) were absent from the existing project site, but present within small narrow strips of marsh and riparian habitat present in drains and parallel to ditches within the newly acquired lands. Two species listed as "species of concern" by the state of California, the burrowing owl (*Athene cunicularia*) and the loggerhead shrike (*Lanius ludovicianus*), were observed nesting on the existing project site. Loggerhead shrikes, but not burrowing owls, were also present on the newly acquired lands. Swainson's hawks (*Buteo swainsoni*), which are listed as threatened by the State of California, were also observed on the project site. One Swainson's hawk nest was observed on the existing project site, and 4 more were found on the newly acquired lands. The nest on the existing project site (nest 2) and one of the nests on the newly acquired lands (nest 3) were abandoned within a week of being detected. The pair that abandoned nest 3 is likely the same pair that attended nest 5. Nests 1, 4, and 5 each fledged 2 young in 2008 (HT Harvey and Associates 2009).

Monitoring of selenium in avian eggs collected from the SJRIP Phase I area has found elevated selenium levels in both recurvirostrids (stilts and avocets) and killdeer. From 2003 to 2006, the annual geometric mean, egg-selenium levels from recurvirostrid eggs have ranged from a low of 15.3 µg/g (dwt) in 2004 to a high of 50.9 µg/g (dwt) in 2008. Annual geometric mean, egg-selenium levels from killdeer eggs ranged from a low of 12.5 µg/g (dwt) in 2003 to a high of 22.8 µg/g (dwt) in 2006 (Table 10). It is notable that the geometric mean, egg-selenium concentration in recurvirostrid eggs collected at the SJRIP Phase I area in 2008 (50.9 µg/g) exceeded all geometric mean selenium concentrations in recurvirostrid eggs collected at Kesterson Reservoir from 1983 to 1985 (Ohlendorf and Hothem 1994) as denoted in Tables 10 and 11.

The Service in 2009 provided comments to the USEPA on selenium criteria for at the Great Salt Lake, Utah, recommending that geometric mean selenium concentrations in avian eggs be no greater than 5 µg/g (dwt) to avoid potential "take" under the Migratory Bird Treaty Act (USFWS 2009). All the annual geometric mean, egg-selenium levels from killdeer and recurvirostrid eggs collected from the SJRIP Phase I area from 2003 to 2008, exceeded this 5 µg/g selenium toxicity threshold. Recurvirostrid eggs with the geometric mean selenium concentrations found at the SJRIP Phase I area would be expected to exhibit an increased probability of reduced hatchability and teratogenesis (Skorupa 1998). By comparison, the geometric mean selenium concentration of recurvirostrid eggs from the SJRIP mitigation site (a 50-acre parcel near the SJRIP drainage reuse area in rice cultivation) was 7.5 µg/g. Skorupa and Ohlendorf (1991) reported that normal background means for selenium in avian eggs extended up to about 3 µg/g. So, even the recurvirostrid eggs collected from the mitigation site show some degree of elevated selenium contamination above background levels.

Nine killdeer and 6 recurvirostrid nests were followed to completion on the project site in 2008. Six of the killdeer nests hatched and 3 were lost to predators. All 6 of the recurvirostrid nests were abandoned, which considering the age of the eggs is highly unusual and suggests some sort of disturbance was initiated that caused the nests to be abandoned (J. Skorupa, *in litt*., October 27, 2009). One recurvirostrid embryo contained a deformed, 17-day old embryo (missing eyes, malformed lower mandible and limbs).

Results of the Tiered Contaminant Monitoring Program (an environmental commitment of the 2001 GBP Biological Opinion) included geometric means of 1.90 µg/g selenium in vegetation (range 1.9-6.64 µg/g dwt) and 3.97 µg/g in small mammals (range 1.59-8.89 µg/g dwt on a whole body basis) collected from the project site. The selenium level detected in 2 vegetation samples and 10 small mammal samples exceeded the threshold of 3 µg/g (dwt) triggering the next level of monitoring in the Tiered Biological Monitoring Program, which is to monitor selenium levels in coyotes in 2009 to assess potential risk to San Joaquin kit fox. The data from the Tiered Biological Monitoring Program for 2009 are not yet available.

Table 8. Avian census results at the existing SJRIP Drainage Reuse Area site, 2008 (from HT Harvey and Associates 2009).

Species	April 22	May 06	May 13	May 27	June 03	June 17
Great blue heron	3	2	1			
Great egret	1		2	26	13	21
Snowy egret	3	6	2	17	9	11
Cattle egret			13	33	17	
Black-crowned night heron					2	
White-faced ibis				62	117	54
Mallard		2			2	
Northern harrier		1	2	2	1	2
Swainson's hawk		1	2	2		1
Red-tailed hawk	1	2	1	1	2	3
American kestrel	1	2	1	1	1	1
American coot		2				
* Killdeer	15	14	19	22	23	19
* Black-necked stilt	3	4	10	17	9	7
* American avocet	2	2				
Greater yellowlegs		2				
Whimbrel	62	13				
Long-billed curlew	6			8	121	77
* Mourning dove	21	22	15	17	6	8
* Barn owl	1	1	3	3	3	3
* Burrowing owl	5	11	9	8	8	9
* Western kingbird	17	22	24	25	29	28
* Loggerhead shrike	2	3	4	4	2	1
Common raven	2	11	7	39	61	44
* Horned lark	14	22	13	9	5	1
Northern rough-winged swallow	4	2	8	5	1	
Barn swallow	9	7	7	14	12	14
Cliff swallow	13	15	17	11	6	
American pipit	31					
Savannah sparrow	41	14	3			
* Song sparrow	4	5	5	6	4	3
* Red-winged blackbird	311	324	374	451	221	195
Tricolored blackbird		78				
* Western meadowlark	12	24	19	22	14	4
* Brewer's blackbird	21	18	33	34	36	19
* Brown-headed cowbird	10	17	19	15	24	22
* House finch	52	21	27	21	16	8
House sparrow	14	15	21	13	7	
Total	**681**	**685**	**661**	**888**	**772**	**555**

*Species for which evidence of nesting was observed this year.

Table 9. Avian census results at the SJRIP recently acquired project lands, 2008 (from HT Harvey and Associates 2009).

Species	April 22	May 06	May 13	May 27	June 03	June 17
Great blue heron	3	1	3	2		2
Great egret	4	25	1	1	3	7
Snowy egret	7	31	16	4		2
Cattle egret		56				
Black-crowned night heron	7	14	16	12	15	8
White-faced ibis	32	184	54	117		
Mallard		2	2		2	
* Northern harrier	1	2	1	2	2	2
* Swainson's hawk	4	5	4	5	7	7
Red-tailed hawk	1	1	1	1	1	
American kestrel	1		1	1	1	
Killdeer	4	3	6	6	7	8
Whimbrel	71	8				
Long-billed curlew					31	119
* Mourning dove	17	19	26	22	16	14
Great-horned owl		1	1	1	1	1
* Black phoebe	2	2	2	2	2	2
* Western kingbird	11	14	14	21	19	17
* Loggerhead shrike	9	11	13	20	14	14
Common raven	4	62	34	5	2	3
* Horned lark	7	9	10	8	6	6
Northern rough-winged swallow	6	4	7	2		1
Barn swallow	4	2	5	2	1	2
Cliff swallow		6	11	4		
* Marsh wren	3	5	6	5	6	4
American pipit	6	1				
Yellow warbler	2	1	1			
Savannah sparrow	39	29	5			
* Song sparrow	14	19	21	26	20	15
* Blue grosbeak	2	2	1	1	2	2
* Red-winged blackbird	261	308	341	394	381	372
Tricolored blackbird	238	29	14	71		26
* Western meadowlark	4	9	11	6	13	8
* Yellow-headed blackbird	10	8	12	15	14	10
* Brewer's blackbird	24	28	34	32	34	14
* Brown-headed cowbird	6	19	14	11	18	9
* Bullock's oriole	3	5	4	2	2	5
* House finch	31	42	44	41	48	29
House sparrow	11	7	9	12	7	
Total	**849**	**974**	**745**	**854**	**675**	**709**

*Species for which evidence of nesting was observed this year

Table 10. Geometric Mean Egg-selenium concentrations (µg/g dwt) from Panoche Drainage District's SJRIP Drainage Reuse Area, 2003-2008 (data from HT Harvey and Associates 2009).

Species	2003	2004	2005	2006	2007	2008
Killdeer	12.5	13.1	15.9	22.8	17.1	12.6
Recurvirostrids	39.0	15.3	35.3	23.0	19.2	50.9
Red-Winged Blackbirds	5.9	6.0	N/A	8.8	8.1	6.8

Table 11. Geometric Mean Egg-selenium concentrations (µg/g dwt) from Kesterson Reservoir, 1983-1985 (data from Ohlendorf and Hothem, 1994).

Species	1983	1984	1985
Killdeer	N/A	33.1	46.4
Recurvirostrids	16.1	20.9	34.6
Red-Winged Blackbirds	N/A	6.0	N/A

Mercury in the Grassland Watershed

In 1987, mercury was identified as a potential substance of concern in agricultural drainage water from the west side San Joaquin Valley and was assigned to the highest priority rank (Hansen and Morehardt 1987). The San Joaquin Valley Drainage Program identified mercury as a substance of concern that warrants further attention (Moore *et al.* 1990). Elevated concentrations of vanadium, chromium, and mercury have also been observed in the shallow groundwater in the San Luis Unit (Deverel *et al.* 1984 cited in USBR 2005b).

Water quality sampling of the DMC sumps in the FCWD from 2002 through 2007 by Reclamation has documented elevated concentrations of total mercury in the sump water currently being pumped into the DMC. Total mercury in water from the DMC sumps has ranged from 200 ng/L to 3,000 ng/L and is currently being pumped into the DMC upstream of Mendota Pool (USBR 2008).

Eighteen miles of Panoche Creek (from Silver Creek to Belmont Avenue) and the San Joaquin River (from Bear Creek to the Delta Boundary) are listed on the 2006 Clean Water Act section 303(d) List of Water Quality Limited Segments for mercury impairment (SWRCB 2007). 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 principal finding of a CalFed Mercury Study in the San Joaquin Basin is that Mud Slough contributes about 50 percent of the methylated mercury at Vernalis (legal boundary of the Delta) but only 10 percent of the water volume during the non-irrigation season (September to March) (Stephenson *et. al.*, 2005).

Preliminary methyl mercury water data collected from the vicinity of the SLD was provided to the Service in a letter from Dr. Chris Foe, staff scientist of the CVRWQCB in 2005 (Foe 2005). In that letter Dr. Foe noted, "*Regional Board staff has been monitoring methyl mercury concentrations in the San Joaquin watershed for the past two years to identify sources and to characterize concentrations and loads. The highest concentrations in the Basin occur in Mud Slough downstream of the inflow from the San Luis Drain (GBP monitoring site D). Methyl mercury loads in Mud Slough are sufficiently high that they may account for 40-60 percent of the Vernalis load during non-irrigation season. Similar calculations have not been made for the irrigation season as the amount of water removed and returned to the River by water agencies and others is not known. However, Mud Slough concentrations and loads remain high suggesting that the Slough is still a significant source of River methyl mercury. The non-irrigation season loads imply that Mud Slough is responsible for about half the methyl mercury accumulating in fish in the main stem San Joaquin River in winter. The source of the methyl mercury in Mud Slough is not known.*" Table 12 summarizes the preliminary methyl mercury concentrations for the San Joaquin River at Vernalis, and for Mud Slough at site D and the SLD.

Dr. Foe concluded that, "*The results suggest that methyl mercury concentrations at all three sites are elevated and may constitute a health hazard to wildlife consuming local fish. Methyl mercury mass balance calculations have not yet been made for Mud Slough. Regional Board staff has commenced a mass balance study to better define the primary source(s) of methyl mercury in Mud Slough.*"

Table 12. Summary of unfiltered methyl mercury concentrations (ng/L) in the Grassland Bypass portion of the San Luis Drain, Mud Slough at Site D and San Joaquin River at Vernalis (from Foe 2005).

Date	San Luis Drain at Site B	Mud Slough at Site D (downstream of GBP San Luis Drain outfall)	San Joaquin River at Vernalis
6/14/05	0.302	0.671	0.235
7/13/05	0.648	0.769	0.218
8/9/05	1.150	1.430	0.226
9/12/05	0.846	1.070	0.062

In a separate study of avian eggs at an evaporation pond in Westlands Water District (just upslope of the GBP agricultural lands), mercury was found to be elevated above toxic levels in some of the eggs collected. In 2002 the Service's Sacramento Fish and Wildlife Office, Environmental Contaminants Division, randomly sampled nine black-necked stilt eggs at the Britz-Deavenport evaporation pond. The mercury concentrations in those eggs ranged from 0.74 to 3.1 µg/g (dwt), with a median value of 1.2 µg/g (J. Skorupa *in litt*., January 7, 2009.; Service unpublished data). Based on data for mallards reported in Heinz (1979), the putative toxic threshold for mercury in avian eggs is 3 µg/g dry weight. In 2002, two of the nine eggs (22 percent) sampled at Britz-Deavenport contained $\geq$ to 3 µg/g (dwt) mercury. The source of the mercury exposure was not determined.

Other Water Quality Constituents of Concern in the Grasslands Watershed

The SWRCB included Mud Slough (North) on the 303(d) list of impaired water bodies for Electrical Conductivity (Proposed TMDL 2008), and Pesticides (Proposed TMDL 2019). In addition, the SWRCB included Salt Slough on the 303(d) list of impaired water bodies for upstream from confluence with San Joaquin River) for Boron, Chlorpyrifos, Diazinon, and Electrical Conductivity (SWRCB 2007).

SPECIES BASELINES

Giant Garter Snake

Status of Populations in the Grasslands wetlands and Mendota Pool*:* 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. As recently as the late 1970's and perhaps early 1980's, a relatively small acreage of habitat in and around the northern portions of the Mendota Wildlife Area (WA) and to a lesser extent, Mendota Pool, supported a robust population of giant garter snakes. However, flooding during the winter of 1985-1986, presence of predatory fish, vehicular mortality, and disturbance and persecution by fishermen and recreationists, apparently has depleted population levels at this former stronghold (J. Brode, pers. comm., 1992; G. Hansen, pers. comm., 1992; R. Hansen, pers. comm., 1992). In the North and South Grasslands, 24 records in the California Natural Diversity Data Base, all prior to 1976, delimited a formerly extensive complex of occupied suitable habitat, probably the largest regional population in the San Joaquin Valley since the reclamation of the Tulare and Buena Vista lakebeds. A recent history of selenium and salinity contamination throughout this area and absence of any giant garter snake sightings in much of its historic range in the Grasslands indicates this population is at risk (USFWS 1993). In many areas, the restriction of suitable habitat to water canals bordered by roadways and levee tops renders giant garter snakes vulnerable to vehicular traffic and vegetation maintenance practices. The Final Rule to list the giant garter snake as threatened concluded that threats to this population are imminent and severe (USFWS 1993). Recent survey data indicate that giant garter snakes are still extant in one locality within the San Joaquin (e.g., Volta WA and Los Banos Creek), but may be nearing extirpation in previously inhabited areas (e.g., South Grasslands and Mendota Pool) (Hansen 2008a and 2008b).

Surveys conducted by Hansen in 1986-87 of 38 previously occupied localities and by Beak in 1992 of 7 localities did not detect any giant garter snakes (Hansen 1988; Beak 1992 as cited in USFWS 1993). 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 WA, 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 (USGS) 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 NWR, three were caught at the Volta State WA, 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 CDFG out of the Los Banos Wildlife Area and were performed according to USGS 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 WA. Fifteen snakes were captured in Los Banos Creek, and eleven at Volta State WA. 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 CDFG surveys in 1999, M. Paquin of the USGS 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 GBP but continues to be impacted by selenium-contaminated drainage.

In 2001, CDFG continued surveys for giant garter snake the publicly and privately owned lands in the Grasslands Ecological Area and at the Volta WA in Merced County, as well as the Mendota WA and Alkali Sink Ecological Reserve in Fresno County. As a result of this effort, fourteen snakes were captured in the Mendota WA and one in the Southern Grasslands Ecological Area. Five of the fourteen snakes captured in one waterway of the Mendota WA and the one snake captured in the South Grasslands had cyst-like lumps on their bodies (Dickert 2002; 2005).

In 2003, CDFG performed visual searches for giant garter snakes on private properties as well as on the China Island, Volta and Los Banos WAs. Trapping resulted in the capture of 29 giant garter snakes, all from the Volta WA (an area with no history of selenium contamination from subsurface agricultural drainage water). Eleven of the captured snakes had lumps on their bodies that were suggestive of a parasitic nematode infection. CDFG estimated the population size of giant garter snakes in the Volta Wasteway to be 45 (Dickert 2003).

In 2004, CDFG conducted visual surveys along roads in the Volta WA and private land within the Grassland Resources Conservation District. No giant garter snakes were seen or captured during these visual surveys. In addition, CDFG in 2004 continued trapping for giant garter snakes in the Volta WA. That trapping effort yielded 13 individual garter snakes, four of which had visible external cysts (Sloan 2005).

A parallel trapping effort conducted throughout the San Luis NWR complex during 2004 did not detect any giant garter snakes (Williams et al. 2004). Trapping was conducted again by CDFG in 2006 at Mud Slough (South) and Volta, resulting in 7 giant garter snakes captured within the Volta Wasteway: none were captured at Mud Slough (South) (CDFG 2006a).

In 2006, E. Hansen conducted surveys at fifty unique locations in the Grasslands Ecological Area, including GWD and the Agatha Canal in the South Grasslands. That trapping effort yielded eight individual giant garter snakes, seven caught in Los Banos Creek (upstream of Kesterson NWR and no history of selenium impairment) and one individual caught in the South Grasslands at the Agatha Canal, just a few miles north of the proposed expansion of SJRIP drainage reuse area of the Panoche Drainage District (Hansen 2007).

In 2007, E. Hansen established thirty-one traplines south of the San Joaquin River at areas of historical giant garter snake occurrence along the Los Banos Creek and Santa Fe Grade corridors, San Luis NWR complex, the of privately owned wetlands situated within GWD and Mendota WA. In South GWD (south of Highway 152), traplines were established in Poso Canal, Agatha Canal, and Bennett Drain. Within North GWD (north of Highway 152), traplines were established within West Side Ditch, Los Banos Creek, Mosquito Ditch (northern end of the Volta Waste Way), Salinas Service Ditch, Ingomar Drain, Hollister Drain, Eagle Ditch, and San Luis Spillway Ditch. Although one giant garter snake was captured in South GWD a historically occupied locality at the junction of Agatha Canal and Poso Drain during 2006, none were captured in 2007. Traplines were established within the San Luis, Blue Goose, Freitas, Kesterson, and West Bear Creek units of San Luis NWR complex but did not result in giant garter snake encounters despite their proximity to historical occurrences. Four giant garter snakes were captured in all. Of these four giant garter snakes, one was captured twice, constituting a decrease from 33 capture events in 2006 to 5 capture events in 2007 despite the increase in trapping effort. Two of the four snakes captured in 2007 were marked previously in 2006. All the snakes were encountered along the Los Banos Creek corridor between the San Joaquin River and the City of Los Banos within the Salinas Service Ditch, Mosquito Ditch, Hollister Drain, and Eagle Ditch (Hansen 2008a).

In 2008, E. Hansen established ten 50-trap transects and placed along the Los Banos Creek corridor within the GWD (which was trapped in 2006 and 2007), the Mendota WA (which was trapped in 2007), the Volta WA (which was last trapped in 2006 by the CDFG), and within the GBP's SJRIP drainage re-use area newly acquired lands (just south of the South Grasslands wetlands). Twenty two traplines were established in total with 38,339 trap days accrued (13,913 in the Los Banos Creek corridor; 13,900 at Mendota WA; 7,889 at Volta WA; and 2,637 in the SJRIP drainage reuse area). Nineteen individual giant garter snakes (10 males and 9 females) were captured in 36 total capture events; eight individuals were captured more than once. Of these nineteen snakes, three were captured in the Los Banos Creek corridor within the GWD, one was captured in Fresno Slough at the Mendota WA (the only giant garter snake encountered at Mendota WA after two consecutive years of intensive trapping effort), and fifteen were captured within the Volta WA. No giant garter snakes were captured in the GBP's SJRIP drainage reuse area (Hansen 2008b). A summary of garter snake surveys from 1995 to 2008 in the Grasslands/Mendota Pool vicinity is presented in Table 13 below.

Table 13. Summary of the recent giant garter snake surveys in the Grasslands and Mendota Vicinity.

Year	Mendota Pool	Grassland wetlands	Volta WA	Los Banos Creek	Reference
1995	2	2 (1 road kill, one visual)[1]	Not sampled	Not sampled	Hansen 1996
1998	Not sampled	1[2]	3	7	Wylie 1998
1999	Not sampled	3 (1 live capture, 2 road-kills)[3]	8	6	Beam *et al.* 1999
2000	Not sampled	2[4]	0	Not sampled	Sparks 2000
2001	14	1[5]	0	Not sampled	Dickert 2002; 2005
2003	Not sampled	0[6]	30 live, 1 dead	0[7]	Dickert 2003
2004	Not sampled	0[8] (visual surveys only)	13	Not sampled	Sloan 2005
2006	Not sampled	0[9]	7	Not sampled	CDFG 2006a
2006		1[10]	Not sampled	7	Hansen 2007
2007	0	0[11]	Not sampled	4	Hansen 2008a
2008	1	Not sampled	15	3	Hansen 2008b

[1] South Grasslands south of the city of Los Banos.
[2] South Grasslands near Canal 1, south of Highway 152.
[3] Live snake captured near Agatha Canal in South Grasslands. One road kill found on Santa Fe Grade Road, and the other road kill on Mallard Road near Agatha Canal in South Grasslands.
[4] Klamath duck club adjacent to Mud Slough (South) south of Los Banos Wildlife Area, south of Henry Miller Road and north of Highway 152.
[5] South Grasslands in Canal 1, south of Highway 152.
[6] Trapping conducted at Los Banos WA.
[7] Trapping conducted at China Island WA near drainage impacted Mud Slough (North).
[8] Visual surveys conducted in both North and South Grasslands.
[9] Trapping conducted at Los Banos WA.
[10] Junction of Agatha Canal and Poso Drain.
[11] Trapping conducted throughout the San Luis NWR Complex and the South Grasslands.

Considering the many, intensive surveys that have been conducted by qualified biologists since the mid-1970's in the San Joaquin Valley, a very low number of individual giant garter snakes have been documented. 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. Table 14 shows a comparison of recent giant garter snake trapping success in the Sacramento Valley versus the San Joaquin Valley. This data indicate that San Joaquin Valley giant garter snake trapping success is at least an order of magnitude below Sacramento Valley trapping success.

Table 14. Recent Giant Garter Snake Trap Success Info in Sacramento Valley versus San Joaquin Valley (from E. Hansen *in litt*., November 5, 2009; Hansen 2007, 2008a, 2008b).

Region	Site	Year	Trap Days	Individuals Captured	Catch Per Unit Effort (Individuals/Trap Day)
Sacramento Valley					
	Natomas	2006	63,400	235	0.0037
	Basin	2007	63,216	202	0.0032
	American	2006	22,850	48	0.0021
	Basin	2007	8,807	20	0.0023
	Badger	2008	5,736	179	0.0312
	Creek	2009	8,320	235	0.0282
San Joaquin Valley					
	N. and S.	2006	22,810	8	0.0004
	Grasslands	2007	19,407	4	0.0002
		2008	13,913	3	0.0002
	Volta WA	2008	7,889	15	0.0019
	Mendota	2007	12,376	0	0
	WA	2008	13,900	1	0.00007

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 are likely contributing to the decline. Threats affect giant garter snakes within otherwise suitable habitat and include interrupted water supply and poor water quality (Hansen 1996). The consistent absence of giant garter snake sightings from certain previously occupied localities indicates the apparent extirpation or dramatic population declines of several former populations. Outside the Sacramento Valley, giant garter snakes currently occur only in low numbers;

population strongholds do not appear extant due to limited quality and extent of available habitat (such as is the case in Mendota Pool).

Factors Affecting Species Environment within the Action Area: The overall status of the giant garter snake has not improved since its listing (USFWS 2006a). The small numbers of giant garter snakes found may reflect continued degradation of wetland habitat and the abundance of invasive predators. Low numbers of giant garter snakes in the San Joaquin Valley place these populations at high risk of extinction (USFWS 2006a). The Five-Year Review of the giant garter snake found that by far the most serious threats to the snake continue to be loss and fragmentation of habitat from urban and agricultural development and loss of habitat associated with changes in rice production. Activities such as water management that are associated with habitat loss are also of particular concern because they exacerbate the losses from development and from loss of rice production. Populations range-wide are largely isolated from one another and from remaining suitable habitat. Without hydrologic links to suitable habitat during periods of drought, flooding, or diminished habitat quality, the snake's status will decline (USFWS 2006a).

The Final Rule to list the giant garter snake summarized the following factors as affecting the giant garter snakes: Factor A) destruction, modification or curtailment of historic habitat or range; Factor B) overutilization for commercial, recreational, scientific, or educational purposes; Factor C) disease and predation; Factor D) inadequacy of existing regulatory mechanisms; Factor E) other natural or manmade factors affecting its continued existence including contaminants, water management and water transfers (USFWS 1993). The most significant threats to giant garter snakes in the Grasslands/Mendota vicinity include changes in agricultural cropping patterns, changes to wetlands management in public and private wetlands, lack of summer water habitat, predation, harassment associated with recreational activities, water transfers and exchanges, lack of flood control, contaminants in wetland water supplies, and climate change.

<u>Changes in agricultural cropping patterns between Grasslands and Mendota:</u> The period immediately preceding the listing of the giant garter snake included California's 1987-1992 statewide drought – (California Department of Water Resources 2008 at cdec.water.ca.gov). This, coupled with low rice production (USDA-NASS Quick Stats – Rice at www.nass.usda.gov), likely contributed to the declines in giant garter snake populations that led to the listing of the snake as a threatened species. For a wetland-dependent species like the giant garter snake, drought or drought-like conditions are a serious threat to the long-term survival and recovery of the species.

As a result of increasing water costs and water transfers out of the area, there has been a regional reduction in agricultural acreage planted in rice near the vicinity of the Grasslands wetlands. This impairs or obstructs connectivity of populations of giant garter snakes in the south Grasslands with other known populations (e.g., Mendota, Volta). Data from County of Fresno County Annual Crop Reports show that the acreage planted in rice in Fresno County has declined by more than 60% since 1988 (Table 15 below) (crop reports available at: http://www.co.fresno.ca.us/DepartmentPage.aspx?id=33743). The most significant reduction in rice acreage has occurred since 2005. The reduction in rice acreage is likely due to the implementation of two separate transfer programs of the San Joaquin River Exchange Contractors Water Authority (SJRECWA) (a 10-Year and a 25-Year Program) that utilize in part land fallowing and changes in cropping patterns to free up water to be transferred to other districts in the Water Authority (USBR and SJRECWA 2007; USBR 2004a). A more detailed description of these transfer programs is found later in this Environmental Baseline section. The acreage dedicated to growing rice in Fresno County is found predominately in the SJRECWA Service Area (i.e., the districts CCID and FCWD). The districts of the SJRECWA have the most reliable contracted water supply south of the Delta especially during dry or below normal water type years (USBR 2004a). The Service concluded that the Ten-year transfer program would be "not likely to adversely affect" giant garter snakes (USFWS 2006b, Service File No. 06-I-1131) based on the assumption that the transfer program would adhere to a list of ten criteria, including the following, "*8. There will be no loss of listed species habitat as a result of these transfers*." Reclamation completed a FONSI/FEA for the 25-year transfer program involving the San Joaquin Exchange Contractors in 2008. The FONSI concluded,

> "*No habitats other than agricultural habitat would be affected; these particular habitats do not provide usable habitat, even for those few species that may utilize agricultural lands to some degree…Fallowing of lands for the purpose of making water available for transfer will be fallowed on a temporary, rotational basis and will be in accordance with applicable law and policy and would be subject to disking for pest control, which will neither create nor remove any habitat for special-status species.*"

The draft Recovery Plan for giant garter snakes concluded that maintenance of rice cultivation is important to the continued existence of the species. In addition, the Recovery Plan proposes recovery tasks to protect rice lands, to develop methods to assure water deliveries to support giant garter snakes, and to develop programs to promote maintenance of historic cropping patterns that benefit the snake (USFWS 1999). As was noted in the Drought Water Bank and Environmental Water Account biological opinion's (Service File Nos. 08-F-1596-1 and 03-F-0321, respectfully), fallowing of rice fields reduces the amount and availability of habitat, including summer water for the snake. Fallowing results in diminished prey availability by reducing the amount of flooded rice fields that act as seasonal marshes to produce high numbers of tadpoles, frogs and mosquitofish. Effects associated with reduced available summer water and rice field habitat also include displacement of individual giant garter snakes from familiar habitat areas and result in giant garter snakes foraging over a wider area. Giant garter snakes may move to other areas of suitable habitat, but will encounter increased mortality from vehicles, exposure to temperature extremes, predation, and human disturbance while migrating to new areas. Fallowing of rice fields will not only temporarily remove habitat, but will also have adverse effects on reproduction, recruitment, and survival of the snake that will continue to affect giant garter snake populations well beyond the project time frame. The reduced habitat available and more widely dispersed prey and habitat resources will cause snakes to either be displaced or move over a much wider area to meet their habitat needs resulting in increased mortality from predation and roadkills and increased competition with other giant garter snakes for limited resources.

Table15. Acreage in Rice Production in Fresno County Over the Past 20 years: 1988-2008 (from County of Fresno Annual Crop Reports)

Year	Acreage in Rice Production	Difference from 1988 Rice Acreage	Percent Change in Rice Acreage since 1988
2008	2800	-4,200	-60%
2007	2690	-4,310	-62%
2006	3590	-3,410	-49%
2005	5450	-1,550	-22%
2004	6600	-400	-6%
2003	5180	-1,820	-26%
2002	5790	-1,210	-17%
2001	5620	-1,380	-20%
2000	6160	-840	-12%
1999	5800	-1,200	-17%
1998	5800	-1,200	-17%
1997	5400	-1,600	-23%
1996	5800	-1,200	-17%
1995	6500	-500	-7%
1994	6200	-800	-11%
1993	7200	+200	+3%
1992	5700	-1,300	-19%
1991	5700	-1,300	-19%
1990	6200	-800	-11%
1989	6100	-900	-13%
1988	7000	---	---

<u>Changes in wetlands management in the Grasslands</u>: Clusters of giant garter snakes occur on State and Federal refuges managed for wildlife purposes; however, some management actions may not benefit the giant garter snake habitat or its prey base (Dickert 2005; Paquin *et al.* 2006). Giant garter snakes require water during the active phase of their life cycle in the summer; however, some refuge areas are managed to provide water for waterfowl during the winter and spring months, and are drained during the summer months (Paquin *et al*. 2006). Summer aquatic habitat is essential because it supports the frogs, tadpoles, and small fish on which the giant garter snake preys. However, permanent water that provides suitable giant garter snake habitat generally supports populations of largemouth bass or other non-native fish that prey upon giant garter snakes.

A reduction of wetland habitat during the driest part of the year may have substantial impact on the survival of giant garter snake populations in the San Joaquin Valley (Paquin *et al*. 2006). For example, Beam and Menges (1997) evaluated historic wetland management practices on State WAs and private duck clubs in the Grasslands Wetlands and concluded that several historic changes in landscape may be linked to the observed decline in giant garter snakes in this region. Changes in the landscape that did not favor giant garter snakes included: (1) wetland management techniques that did not provide summer water, (2) use of contaminated agricultural drainwater on wetland areas, and (3) lack of flood control. In the early 1970's management of State WAs and private duck clubs in the Grasslands in western Merced County changed from wet summer landscape management to dry summer management in which wetlands were drained in mid to late March, irrigated in early May and left dry until late August or early September (Beam and Menges, 1997). Prior to the mid-1970's, many private duck clubs included management for cattle on irrigated pasture. This type of land management required early summer flooding of pastures and frequent irrigation throughout the summer, and provided summer water in canals, sloughs, and other water conveyance systems throughout the Grasslands Area.

Maintaining pastures in summer for cattle grazing required regular irrigation and flooding of pastures (Paquin *et al.* 2006). However, in the mid-1970's, private duck clubs were encouraged to change their focus to moist-soil management (Beam and Menges 1997). This led to a change from water grass production (*Echinochloa* species) production to moist-soil management for swamp timothy (*Heleochloa schoenoides*) and smartweed (*Polygonum* species) and resulted in earlier spring irrigation and decreases in summer water in the Grassland Wetlands. These land management changes used less water overall, while benefitting waterfowl, shorebirds, and wading birds. However, the resulting loss of summer water habitat coincided with observed declines of giant garter snake populations in the Grassland Wetlands (Beam and Menges 1997; Hansen 1988; Hansen 1996; Paquin *et al.* 2006). The changes in the seasonal availability of water have apparently resulted in the decline of what G. Hansen (1980) once considered a widespread giant garter snake population in the Grasslands region.

Although wetland habitat exists on private waterfowl hunting clubs and wildlife refuges, reduction in summer availability of aquatic habitat in the public and private wetlands of the Grasslands may result in movement of giant garter snakes to suboptimal habitats such as channels with predatory non-native fishes, or into nearby drainage contaminated areas of the SJRIP drainage reuse area. Telemetry studies of giant garter snakes in the Sacramento Valley have shown that individuals of this species can move up to 5 miles over a few days in response to dewatering of habitat (Wylie *et al*. 1997).

<u>Constraints to summer water availability:</u> Summer water for wetlands in the private duck clubs of the Grasslands is provided from Incremental Level 4 refuge water supplies. Incremental Level 4 is that amount of refuge water up to and above Level 2 supply that would be needed to fully implement optimal habitat management practices on the refuge and is the supply that is used in the Grasslands for permanent and semi-permanent wetland habitat management in the spring and summer. Section 3406 (d) of the CVPIA mandated that full Level 4 refuge water supply needs would be met by 2002 (http://www.usbr.gov/mp/cvpia/3406d/3406d.html#3406d).

Yet, each year has become a challenge to acquire Incremental Level 4 water supplies from willing sellers on the spot market. Since 2002, Incremental Level 4 deliveries to the private duck clubs in the Grasslands have routinely fallen short of the 55,000 acre-foot (AF) quantity mandated by CVPIA to be provided. In FY 2008, roughly 33% of Incremental Level 4 supplies were acquired (~18,000 AF). In FY 2007, roughly 44% of CVPIA mandated quantities were acquired (~24,000 AF) (D. Garrison, *in litt*., USFWS, Region 8 Refuge Water Acquisition Specialist, June 30, 2009). Reclamation typically announces availability of Incremental Level 4 supplies as late as August reducing the likelihood that summer water habitat will be made available on the private duck clubs of the Grasslands (pers. comm. K. Forrest, Refuge Manager, San Luis NWR Complex, June 13, 2007). These land management changes and reduced availability of summer water has coincided with the apparent declines of giant garter snake populations in the Grasslands (Beam and Menges 1997, Hansen 1988; Hansen 1996; Paquin *et al*. 2006).

It is anticipated that if full Incremental Level 4 refuge supply was provided, the majority would be applied on CVPIA refuges and duck clubs in the San Joaquin Valley throughout the spring and summer period. This water would be used to manage several types of habitats, including riparian zones and deeper hemi-marsh with a mix of open water and emergent vegetation, which would provide reliable, diverse, and high-quality summer water habitat for the giant garter snake (D. Garrison*, in litt*., December 3, 2009). Reclamation analyzed the delivery of full Level 4 refuge water supplies for the San Joaquin River Basin in the Final EA/IS for Refuge Water Supply, Long-term Water Supply Agreements (USBR 2001). In that document, Reclamation identified that Level 4 deliveries to public and private wetlands in the San Joaquin River Region would result in an additional 6,240 acres of permanent ponds, 57,680 acres of seasonal marshes, and 7,700 acres of watergrass and smartweed habitats, an increase of 31,600 acres over the No Action Alternative acreage.

Mendota WA has a water supply contract for 27,593 AFY (Contract Level 2 supply). However, full Incremental Level 4 water supply, needed for optimal management of the wildlife area, requires 29,650 AFY. Mendota WA is currently not meeting their Incremental Level 4 water needs due to conveyance and water availability constraints (USBR 2007).

<u>Predation:</u> Giant garter snakes are also threatened by the presence of some exotic species. Examinations of gut contents confirm that introduced bullfrogs will feed directly on juvenile GGS throughout their range (Dickert 2003; Wylie *et al.* 2003c). While the extent of this predation and its effect on population recruitment is poorly understood, estimates based on preliminary data from a study conducted at Colusa NWR suggests that 22% of neonate giant garter snakes may succumb to bullfrog predation (Wylie *et al*. 2003c). Although not quantified, it has been suggested that bullfrog densities in San Joaquin Valley might exceed those in the Sacramento Valley by an order of magnitude (J. Beam, pers. comm. in Hansen 2008a). Other studies of bullfrog predation on snakes have documented bullfrogs ingesting other species of garter snakes up to 80 cm (31.5 inches) long, resulting in a depletion of this age class within the

population which experienced alternating resurgence and decline coinciding with fluctuations in the local bullfrog population (Bury and Wheelan 1984).

Introduced predatory game fishes such as black bass (*Micropterus* spp.), striped bass (*Morone saxatilis*), sunfish (*Lepomis* spp.), and channel catfishes (*Ictalurus* spp.) likely prey on giant garter snakes and compete with them for smaller prey (Hansen 1988, USFWS 1993). Giant garter snakes appear absent from features supporting permanent populations of these species (USFWS 2006a). Observations made during fish kills and episodic drying of ditches and canals throughout the Grasslands Area suggests that the composition and population structure of potential predatory fishes in the San Joaquin Valley may differ from those noted in the rice growing regions of the Sacramento Valley (Hansen 2007). Striped bass frequently exceeding 3-5 pounds are common to all permanent ditches and drains observed throughout the Grasslands Area waterways. Striped bass are not observed where giant garter snakes persist in rice growing regions in the Sacramento Valley (Hansen 2006). In addition to striped bass, channel catfish and black bass from 2-8 pounds are not uncommon in the Grasslands waterways. In rice growing regions in the Sacramento Valley, irrigation systems are dried down at the end of each growing season, preventing predatory fish from becoming large enough to consume giant garter snakes. Because much of the water conveyance infrastructure in San Joaquin Valley is also used to divert tile and surface drainage and to provide water for overwintering waterfowl, the water conveyance infrastructure in San Joaquin Valley is typically wet year-round. Subsequently, unlike their counterparts in rice growing regions to the north, predatory fishes in San Joaquin Valley likely grow through multiple seasons and attain larger sizes. Because much of the available wetlands in the Grasslands Area are drained for moist soil management during the snake's active season, they are likely forced to inhabit the permanent drainages and waterways that form the foundation of the irrigation system, perhaps exposing them to elevated rates of predation by these larger fish (Hansen 2008a).

<u>Lack of flood control</u>: Tile-drained farmlands in the GBP's DPA southwest of the Grasslands wetland supply channels have proven to be susceptible to flooding during winter storm events from the Panoche/Silver Creek watershed in the Coast Range. These flood flows [40,000 acre-feet during 2-week periods associated with these storm events (SLDMWA 1997)] have been characterized by high selenium levels and loads. For example, selenium concentrations in flood waters from the Panoche/Silver Creek watershed ranged from 4 to 155µg/L during a February 1998 storm event (Chilcott 2000). Presser and Luoma (2006) estimated the cumulative selenium load from Panoche Creek during the *El Nino* Water Year of 1998 to be 8,045 pounds. Such flood flows have overwhelmed the GBP resulting in the diversion of selenium-contaminated water into the Grasslands wetland supply channels. For more information on the selenium-associated effects from flood events, see <u>Contaminants in wetland water supplies</u> later in this Environmental Baseline section.

<u>Canal maintenance</u>: Maintenance activities associated with irrigation canals and wetland conveyance ditches can harm, harass, injure and kill giant garter snakes. Such activities include: (1) de-silting, (2) excavation and re-sloping of ditches and channels, (3) deposition of ditch and

canal spoils materials on adjacent property, (4) placement of fill material within the canal, and (5) control of vegetation in and around canals, ditches, and drains by mowing and other measures (USFWS 2006a).

Further, the flood control practice of lining streams and canals with large and extensive quantities of concrete or rock riprap, and conversion of dirt-lined to concrete-lined canals can be detrimental to the habitat elements essential to giant garter snakes (USFWS 2000b; 2006). Though giant garter snakes have been observed to use riprap to thermoregulate, large quantities of riprap eliminate a natural thermal mosaic, may be composed of material that degrades and pollutes water, or may be installed in conjunction with ground cloth that is impermeable to rodents thereby preventing rodent burrowing.

Harassment associated with recreational activities: The Five-Year Review for the giant garter snake noted that snakes are likely to avoid areas that are routinely disturbed and will actively move out of areas that are subject to repeated disturbance (USFWS 2006a). As snakes move out of areas that are subject to repeated disturbance, they are subject to increased risks of injury and mortality from predation and vehicles (Wylie *et al.* 1997, E. Hansen pers. comm. 2006). Collection of crayfish (*Procambarus clarkii*) for human consumption from roadside canals and rice fields disturbs giant garter snakes and may also alter their behaviors, making them more vulnerable to associated threats, for example, injurious or lethal strikes from automobiles. As urban development increasingly encroaches on remaining giant garter snake habitats, increasing disturbance to the snake and its behavior patterns are expected to occur (USFWS 2006a).

Water transfers affecting the Grassland wetland supply channels: Two transfer programs (the SJRECWA 10-year transfer project and 25-Year Transfer/Groundwater Pumping Project) have been implemented over the last few years that can directly impact flow and indirectly impact water quality in the Grassland wetland supply channels. Further, since these transfer programs were implemented beginning in 2005, rice acreage has declined by more than 50% in the area between the Grassland wetlands and Mendota (County of Fresno Annual Crop Reports: http://www.co.fresno.ca.us/DepartmentPage.aspx?id=33743). This change in agricultural cropping pattern further reduces or eliminates connectivity between formerly robust populations of giant garter snake, resulting in further isolation and susceptibility to extirpation.

San Joaquin River Exchange Contractors 10-Year Transfer Project (Service File No., 04-I-2162): In 2004, Reclamation finalized an EIS/R on the SJRECWA 10-year Transfer Program (SJRECWA EIS/R; USBR 2004a). This program allows for the transfer of up to 130,000 AFY of substitute water annually to several potential agricultural, municipal and wetland users for a period of 10 years. The project develops up to 130,000 AF of water during non-critical years, with up to 80,000 AF of water made available through conservation (including tailwater recovery) and groundwater (up to 20,000 AF) and up to 50,000 AF of water made available through crop idling/temporary land fallowing. During critical years, up to 50,000 AF of water may be made available through crop fallowing, and no water is to be made available from conservation/tailwater recovery and groundwater resources.

The 10-year Transfer Project has the potential to degrade water quality in the Grassland wetland supply channels by reducing the quantity and timing of tailwater discharges into those channels. Tailwater is surface drainage from the agricultural lands of the SJRECWA and is generally good quality and low in selenium. Functionally, tailwater has served to dilute subsurface drainage discharges that are high in selenium. Modeling of the effects of the preferred alternative in the SJRECWA EIS/R for this project estimated up to a 47 percent flow reduction in Mud Slough (South) and Salt Slough during the late spring and dry and below normal water years. The largest reductions in flow would occur during April (36 percent) and May (47 percent) as shown in Table 6-5 of the EIS/R for this project (USBR 2004a). The Final SJRECWA EIS/R did not compare the frequency of such flow reductions between the "with project" and "without project conditions". The effect of reduced flows in Mud and Salt Sloughs on selenium concentrations in these channels was likewise not analyzed (pers. comm. Steve Leach, Senior Biologist, URS Corporation, March 6, 2006). We anticipate that a reduction of tailwater flows combined with continued selenium inputs in the Grassland wetland could result in higher selenium concentrations and potentially a greater frequency of occurrence of water quality objective exceedances in these channels.
San Joaquin River Exchange Contractors 25-Year Transfer/Groundwater Pumping Project: (Service File No., 07-I-1580): In 2008 the SJRECWA and Reclamation implemented a 25-year transfer program involving up to 20,000 AFY by means of groundwater substitution and conservation/rotational crop fallowing. Based on the groundwater analysis (Appendix A of the EA/IS, USBR and SJRECWA, 2008), the action includes a maximum groundwater pumping regime of 15,000 AFY. The groundwater-pumping project consists of up to 15 new wells (and 5 existing wells) located in FCWD and the Camp 13 area of CCID; adjacent to the CCID's Main and Outside Canals and the DMC, and downslope of and adjacent to the SJRIP drainage reuse area of the GBP. The groundwater is pumped from the upper aquifer above a depth of 350 feet (above the Corcoran clay) but below the drainage impaired shallow groundwater, blended with surface water deliveries into two CCID canals (Outside and Main) to ensure adequate water quality for irrigation needs, and then delivered downstream for agricultural use and refuge water supplies. The pumped groundwater is substituted for CVP surface water delivery primarily from the DMC (USBR and SJRECWA, 2008).

As denoted in the EA/IS for this project, groundwater substitution (pumping groundwater in the drainage impacted area of FCWD and CCID) will likely reduce quality (increase total dissolved solids) of water delivered to Grasslands wetlands and refuges. Effects of groundwater degradation and associated effects to downstream refuge water quality were not adequately addressed in the EA/IS for this project. Further, this transfer program utilizes land fallowing or tailwater recapture and canal lining for up to 5,000 AFY which could likely have an added effect (beyond what was considered in the 10-year transfer program EIS/R) on reducing dilution flows in the Grassland wetland channels resulting in further water quality degradation (increases in selenium, boron, and salt concentrations) in those waters (USFWS 2007c).

<u>Groundwater Pump-ins and Exchanges affecting Mendota Pool</u>: Several projects have been approved and implemented that allow groundwater to be pumped into the Mendota Pool to be exchanged with an equivalent amount of CVP contract supply that is used elsewhere (Meyers Groundwater Banking Project, Mendota Pool 10-Year Exchange Agreement, and the Tranquility Irrigation District/San Luis Water District Groundwater Exchange Program). These groundwater exchanges result in a cumulative increase in total dissolved solids in the southern portion of the Mendota Pool and water supplies of the Mendota WA. As noted by CDFG in a comment letter on the Meyers Groundwater Banking Project, (dated March 18, 2005), "*The water to be extracted from Meyers Groundwater Bank Exchange would be more saline and contain different minerals than that present within the Delta-Mendota Canal/Mendota Pool/Fresno Slough system. This extracted water could degrade existing water quality within the Mendota Pool system, particularly if the banked water is returned to the Fresno Slough during dry or critically dry years as planned. The Project appears to exchange high quality delta water for water that would be degraded as a result of integration with the impaired groundwater in MFWB vicinity. The EA states that Mendota Pool is included in the "2002 Clean Water Act Section 303(d) List of Water Quality Limited Segments [for salinity]," and that the salinity in Mendota Pool is "generally acceptable for both agriculture and aquatic life." Any actions that further impair the water quality of Mendota Pool should be avoided due to the potential impacts on aquatic life and the terrestrial species that depend on this biota. The DEA/IS evaluates potential impacts such as entrainment to the giant garter snake (Thamnophis gigas). However, if water and soil salinity increases in the Mendota Wildlife Area a result of this Project, this could result in indirect impacts to the giant garter snake population present in the MWA*."

Meyers Groundwater Banking Project: In 2007, Reclamation finalized an EA and implemented an Exchange Contract for the Meyers Groundwater Banking Project. Meyers Farm has irrigated farmland within San Luis Water District (SLWD) and an annual contractual entitlement for up to 8,000 AF of CVP water, depending on the annual water supply forecast. In order to increase reliability of the water supply and irrigate existing crops, Meyers Farm implemented a water bank near the Mendota Pool to store water for use during dry years (USBR 2007b). Banking water for later extraction and use enables the investment in permanent crops by assuring an irrigation supply in the inevitable water short years in the San Joaquin Valley.

The Meyers Groundwater Banking Project (Meyers GWB) involves storage and exchange of CVP water facilitated by water banking, including: (1) storage of CVP water in a bank located within the SWRCB authorized CVP place-of-use, but outside the SLWD service area boundary; and (2) delivery of this water to Meyer's Farm lands in SLWD after it has been extracted from the bank and exchanged with Reclamation for a like amount of water delivered via the San Luis Reservoir. The bank is a privately owned facility located east of the Fresno Slough branch of Mendota Pool on land leased from Spreckels Sugar Company near Mendota, in western Fresno County, California. The bank would divert and store available surface water during winter months (Kings River flood flows) in a shallow aquifer adjacent to Mendota Pool. The bank would also store CVP water (comprised of carry-over CVP water allocated to Meyers Farm and CVP water acquired from other sources). At a later date, based on hydrological conditions and demand, a like volume of CVP water (less five percent) would be pumped from the bank and returned to Mendota Pool for exchange with Reclamation in the following manner: (1) extracted water would be delivered to end users who divert water from Mendota Pool, and (2) Reclamation would exchange the water pumped from the bank for a like amount of water to be delivered to Meyers Farm in SLWD via the San Luis Reservoir and San Luis Canal.

In 2005 Reclamation made a "no effect" determination for listed species from this project and did not request consultation with the Service. None of the project features were evaluated by the Service for listed species impacts. In the 2005 EA the project included the following features:

- 3-4 ponds formerly used by the Spreckels Sugar Processing Facility to the east of Fresno Slough and south of the San Joaquin River for recharge and extraction;
- 2 ponds formerly used by Spreckels to be used as settling basins;
- construction of a 34-acre Westside Storage Pond (west of the Slough, south of the city of Mendota and west of Highway 180) to detain floodwater from the Kings River and a 36" diameter pipeline to connect the storage pond with Mendota Pool/Fresno Slough;
- 2 Recharge Ponds (south of the San Joaquin River and east of the Mendota Pool/Fresno Slough) comprising 35 acres;
- A rock-lined ditch and 10" diameter pipeline to connect these recharge ponds with the recharge ponds located in the Spreckels facility;
- Several undefined "channels" connecting ponds with Mendota Pool, pumps, meters, fish screens, and a 48" buried pipeline.

Surveys for giant garter snakes were done at only a portion of the project features, in the vicinity of the recharge ponds north of the Spreckels ponds and east of Mendota Pool/Fresno Slough. No giant garter snakes were observed; however, survey protocols for giant garter snake surveys (e.g., methods used, time of year surveys were conducted) were not disclosed in the EA for this project (USBR 2005a, Appendix D). Impacts from the Meyers GWB to giant garter snake could include: disturbance of habitat for construction of facility features (e.g., ponds, pipelines, pumps, ditches); operations of the GWB (e.g., rapid drawdown of water in storage or recharge ponds); and increased concentrations of total dissolved solids in the water in Fresno Slough/Mendota Pool.

Mendota Pool 10-Year Exchange Agreement: In 2004, Reclamation approved a 10-year project (based on similar 1-year programs conducted in 1999, 2000, 2001, and 2002) that allows the project proponents (Mendota Pool Group [MPG]) to pump up to 31,000 AF of non-CVP groundwater per year into the Mendota Pool from adjacent wells in southwestern Madera County in exchange for up to 25,000 AFY of CVP water delivered to other lands within the CVP-San Luis and Westlands Water Districts. The project proponents can pump a maximum of 269,600 AF of groundwater for transfer over a ten-year period from wells located adjacent to the Mendota Pool into the Mendota Pool. The maximum allowable quantity of water to be pumped in a given year would depend on whether the year is classified as wet (0 AFY), normal (up to 31,600 AFY), or dry (up to 40,000 AFY). However, no more than 25,000 AFY of water can be exchanged with Reclamation (the federal action); the remaining water is exchanged with other users around the Mendota Pool. MPG Transfer pumping is conducted over a maximum of 9 months each year, between March 1 and November 30.

Tranquility Irrigation District/San Luis Water District Groundwater Exchange Program 2009 through 2011: In August 2009, Reclamation proposed to approve an exchange of groundwater pumped from the Tranquility Irrigation District (TQID) well field of up to 6,000 AF for the balance of this water year (2009-2010) and up to 8,000 AF next water year (2010-2011). This groundwater would be pumped into the TQID distribution systems connected to either the Fresno Slough Main Canal or the Tranquility Main Canal and then diverted to spill into the neighboring Fresno Slough which flows into the backwaters of Mendota Pool. There the water would be exchanged with Reclamation for water that would otherwise be delivered to CVP contractors (Exchange Contractors and/or other CVP contractors).

<u>Contaminants in wetland water supplies - selenium</u>: As noted earlier in this section, implementation of the GBP has significantly improved water quality in the Grasslands wetland channels (with the exception of Mud Slough North where drainage is routed to the San Joaquin River), and reduced salt and selenium loading to the San Joaquin River. Consequently, exposure of aquatic and aquatic dependent wildlife to agricultural drainwater contaminants in the Grasslands wetlands and supply channels has been reduced. However, as was discussed earlier in this Environmental Baseline section, several studies have documented concentrations of selenium in some samples of Grassland wetland channel biota (invertebrates, fish and bird eggs), especially in the South Grasslands, that are at the level of "**Concern**" as defined by the GBP Ecological Risk Guidelines, and/or within the lower range associated with toxicological effects in sensitive species (Beckon *et al*. 2007; Paveglio and Kilbride 2007).

The most significant source of selenium in water in the South Grasslands wetland supply channels continues to be runoff from heavy rainfall events. As was noted earlier, since 1995 such events occurred in water years 1995, 1997, 1998 and 2005 and have resulted in significant spikes in selenium concentrations in the Grasslands wetland supply channels and selenium loading into the San Joaquin River (Presser and Luoma 2006, Grassland Area Farmers 2005). Selenium bioaccumulates rapidly in aquatic organisms and a single pulse of selenium (>10 µg/L) into aquatic ecosystems could have lasting ramifications, including elevated selenium concentrations in aquatic food webs (Besser *et al.* 1993; Graham *et al.* 1992; Maier *et al*. 1998; Nassos *et al.* 1980; Hamilton 2004). Besser *et al*. (1993) reported that within 24-hours waterborne treatment levels of 100 µg /L selenium in the form of selenite and selenate bioaccumulated to greater than 40 µg/g in algae and 8-15 µg/g in daphnids (both extremely dangerous levels of food web selenium for higher trophic level consumers). Graham *et al.* (1992) also documented rapid bioaccumulation from waterborne spikes of selenium and much slower elimination of that selenium from the food web. Based on standard acute toxicity testing, Nassos *et al.* 1980 concluded that, "… *organisms can concentrate Se* [selenium] *several hundred times the level in the water within a period of 24 h*." Maier *et al*. (1998) documented that a brief pulse of selenium of about 10 µg/L in a Sierra Nevada stream for less than 11 days (selenium was 10.9 µg/L at 3 hrs post-treatment and at < 1 µg/L when next measured 11 days post-treatment) resulted in elevated invertebrate selenium concentrations of > 4 µg/g (composite invertebrate samples collected before application of the selenium pulse to the treatment area contained 1.67 µg/g selenium (dry weight)). Maier *et al.* found that the invertebrate food web was still contaminated at > 4 µg/g 12 months after selenium treatment when the monitoring ended even though water concentrations were < 1 µg/L.

Selenium effects on giant garter snake in the South Grasslands: Very little information is available on the effects of selenium on snakes, and no studies to date have looked specifically at the effects of selenium in giant garter snakes. The relative sensitivity of giant garter snakes to selenium is a crucial uncertainty. In the absence of data regarding selenium toxicity in the snake, the Service must assume on behalf of the species, that the giant garter snake is sensitive to selenium.

Studies on the effects of selenium on snakes have found that they accumulate selenium from ingesting seleniferous prey, ultimately resulting in maternal transfer of potentially toxic quantities of selenium to their offspring (Hopkins *et al.* 2004) and in higher rates of metabolic activity than snakes from uncontaminated sites (Hopkins *et al.* 1999). Unrine *et al*. 2006 noted that squamate reptiles (such as giant garter snakes) generally do not secrete an albumin layer, as do birds, crocodilians, and turtles. These findings suggest that in fish, amphibians, and squamate reptiles, selenium may be transported through serum to the egg from the liver as vitellogenin, whereas in birds, crocodilians, and turtles, additional oviductal contributions of selenium occur postovulation (Unrine *et al.* 2006). Therefore, a dietary selenium toxicity threshold, rather than an egg concentration threshold, is believed to be the most applicable for assessing selenium effects to giant garter snakes (J. Skorupa, *in litt*., September 29, 2009). Hamilton (2003) and Lemly (1996a) in extensive reviews of the scientific literature on selenium toxicity thresholds for freshwater fish recommended a toxicity threshold of 3 µg/g (dwt) in diet to be protective of growth and reproduction and we adopt this selenium threshold for our analysis on giant garter snakes. Further, although there are no explicit GBP Ecological Risk Guidelines for the diet of snakes, the existing Guidelines do include two media (invertebrates and vegetation) as diet (for birds) (Table 5). Those dietary Guidelines identify concentrations between 3 and 7 µg/g as being at a level of "**Concern**" providing further evidence that 3 µg/g serves as a suitable dietary toxicity threshold for the giant garter snake.

It could reasonably be argued that dietary selenium values in the 3 – 5 µg/g range would only be mildly toxic, even to a sensitive species of snake (based on bird and fish surrogates). However, a key feature of selenium toxicity is that sensitive species have extremely steep exposure-response curves (e.g., Heinz *et al.* 1989; Skorupa 1998; Lemly 2002; Seiler *et al.* 2003). Once an environment has been pushed over a toxic threshold, only a relatively minimal incremental increase in contamination is required to cause very substantive population levels of poisoning. For example, 5 µg /L is identified as a toxicity threshold in water in Table 5 GBP Ecological Risk Guidelines. Yet, field examples have shown that very nominal increases in water concentrations of selenium above 5 µg /L can lead to catastrophic changes in an ecosystem. At

Belew's Lake, a man-made reservoir in North Carolina contaminated by coal-fly ash waste, 16 species of fish were extirpated in a freshwater environment with only 10 µg /L selenium. Although cleanup efforts were able to reduce the waterborne concentration of selenium to less than 1 µg /L, a full decade after cleanup, concentrations of selenium in sediment, invertebrates, and fish ovaries were still slightly to moderately elevated (Skorupa 1998). Substantial evidence suggests that once selenium has entered biotic pathways, it is very efficiently recycled over time (Lemly 1997; Skorupa 1998; Presser and Luoma 2006). Skorupa (1998) concluded that in some systems, the peak waterborne concentration of selenium in a freshwater system may be more relevant to assessing environmental risk than longer term averages. This point may be especially relevant to the GBP Extension and the Grassland wetland supply channels.

Selenium is first and foremost a reproductive toxicant (both a gonadotoxicant and a teratogen); the degree of reproductive damage determines whether populations are adversely affected (Luoma and Presser 2009). Complete reproductive failure can occur with no observable toxic effects on the adults (Gillespie and Baumann, 1986; Woock *et al.,* 1987; Heinz *et al.,* 1987,1989; Coyle *et al.*1993). Roe *et al.* (2004) reported that an alligator living and nesting at a mildly selenium-contaminated site, and averaging 7.5 mg Se/kg in its eggs had consistently low hatching success of those eggs. The most sensitive species of birds begin to have egg hatchability problems when eggs get up to about 6-7 mg Se/kg (Skorupa 1998; USDOI 1998) and fish begin to have larval survival problems when their eggs get up to about 10 mg Se/kg (midpoint of a 7-13 mg selenium/kg threshold range; see USDOI 1998). The only reporting in the literature on the reproductive toxicity related to selenium in a reptile (alligator) is very comparable to what has been observed in fish and birds (USDOI 1998; Roe *et al.* 2004). Thus, it is justified to use either a fish- or a bird-based dietary risk threshold for giant garter snakes, and both those thresholds are 3 mg /kg selenium (J. Skorupa, *in litt*., November 6, 2009).

It has become very common in the selenium technical literature to use dietary concentrations (rather than timed mass loads per body weight) as a surrogate for "dose" in risk assessments and water quality standards development (e.g., see Utah's 2008 development of a site-specific selenium standard for the Great Salt Lake at: http://www.deq.utah.gov/Issues/GSL_WQSC/selenium.htm). Dietary concentration (as surrogate for dose) approach has been successfully used in selenium risk assessments because the risk in question is usually oviparous reproductive toxicity, thus selenium concentrations in eggs are what control risk and a large proportion of the selenium that ends up in eggs is mobilized exogenously directly from the diet, not endogenously from maternal tissue stores of selenium. Consequently, there is usually a very tight relationship between maternal dietary exposure (as a dietary concentration) and resulting egg selenium concentrations. Furthermore, across taxa, that diet to egg relationship stays within fairly narrow bounds (roughly a transfer factor of about 1 to 3 for field collected data) (J. Skorupa, *in litt*. December 1, 2009).

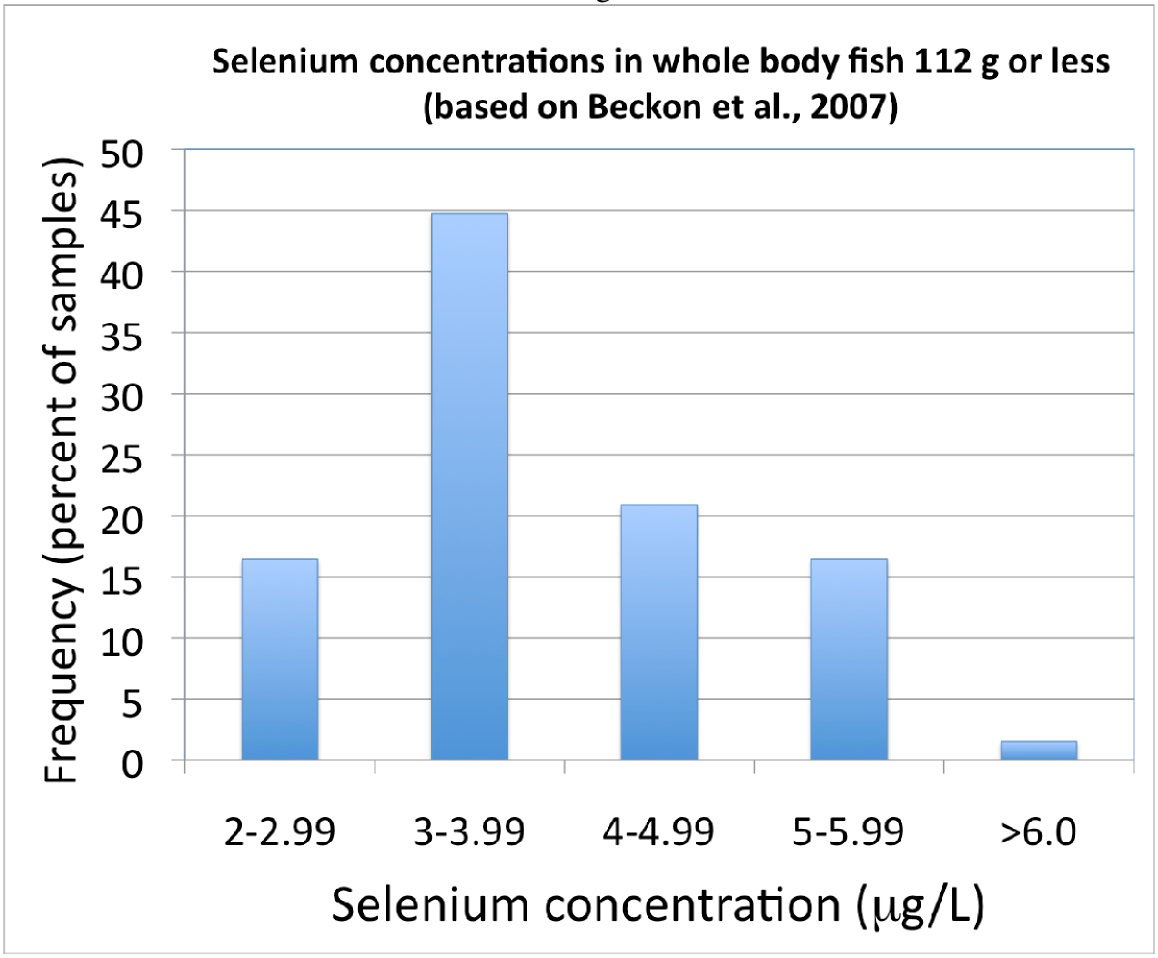
Snakes feed infrequently compared to birds or fish, but when they do feed they gorge. For birds, the selenium in the egg is determined by the selenium content of the hen's diet in the 2-5 days prior to ovulation. Assuming this is similar for snakes, then an egg could get a super dose of selenium if one of the snake's infrequent, but massive, meals (i.e., greater than long term "average" selenium load) occurs just prior to ovulation (J. Skorupa, *in litt*. December 1, 2009).

Data from Beckon *et al.* 2007 (from a study documenting selenium concentrations in biota of the South Grasslands wetland supply channels during the operations of the GBP under the 2nd Use Agreement), indicate that 78.4% of the seventy four whole body fish sampled and 40.6% of the thirty-two samples of invertebrates sampled exceeded the 3 µg/g dietary threshold. A bar plot depicting the selenium concentrations in whole body fish of 112 g or less (assumed to be the appropriate size for a giant garter snake), from Beckon *et al.* 2007, is presented in Figure 5. The average selenium concentration in western mosquitofish, a documented prey item of the giant garter snake, was 4.0 µg/g in this study. The average selenium concentration in striped bass (*Morone saxatilis)*, all of them juveniles (and of the appropriate size to be dietary items for snakes ranging from 32 to 55 grams in size), was 4.87 µg/g in this study.

The most effective invertebrate bioaccumulators of selenium were European freshwater snails (*Physa*) and Siberian freshwater shrimp with mean selenium concentrations of 5.6 µg/g and 5.75 µg/g (dwt), respectively (Beckon *et al.* 2008). Since it appeared in the lower Sacramento River in 2000, Siberian freshwater shrimp populations have exploded in rivers upstream of the Delta (Hieb *et al*. 2002). By 2003 this exotic shrimp became one of the most common invertebrate species seined as part of the GBP biological sampling efforts (Beckon *et al.* 2008).

Giant garter snakes feed primarily on aquatic prey such as fish and amphibians (USFWS 1999). Although, it is unknown if giant garter snakes consume invertebrates, bullfrogs (a known food choice of the snake) do consume crayfish and are likely to consume the exotic Siberian freshwater shrimp. Unrine *et al.* 2007, studying bioaccumulation of trace elements in amphibians relative to other small aquatic organisms in a contaminated wetland, concluded that amphibian larvae accumulated the highest concentrations of most trace elements, possibly due to their feeding ecology. As part of the Beckon *et al.* 2007 study, a single 12 g bullfrog tadpole (a prey item of giant garter snakes) collected from Geis Ditch at Sierra Gun Club MP4 had a selenium concentration of 5.8 µg/g, well above the 3 µg/g dietary toxicity threshold of concern for the snake.

Figure 5.



Lemly (1996b) developed an aquatic hazard assessment procedure that sums the effects of selenium on various ecosystem components to yield a single characterization of overall hazard to aquatic life. A hazard rating is determined for each of five ecosystem components (water, sediment, invertebrates, fish eggs, and bird eggs) based on where the highest concentration of selenium in the samples fall on the hazard scale. Because the Lemly index is based on maximum concentrations, it is sensitive to data "outliers". However, it remains the best selenium hazard index available at this time (Beckon *et al.* 2008). The intervals for the final hazard characterization are based on scores for the individual components, thus they are not a simple average or midpoint. The rational for this is that three distinct routes of exposure are possible for selenium (water, planktonic food-chain, detrital food-chain). Based on field evidence, Lemly (1996) concluded that the hazard from all three together should be greater than if each is considered separately. The Lemly selenium hazard assessment is intended to gauge the potential for certain levels of selenium impact in an ecosystem. Local impacts will depend on a host of environmental factors that affect selenium speciation, uptake, and cycling.

A selenium hazard assessment of the South Grasslands wetland supply channels using the Lemly (1996) methodology is presented in Table 16. This table is consistent with the Lemly methodology in that it uses the highest concentration of selenium for each medium. Selenium concentration in fish eggs are estimated from a whole-body concentration using the conversion factor (fish egg selenium = fish whole-body selenium x 3.3) recommended in Lemly (1996b). This hazard assessment reveals an overall hazard score of 20, which equates to a "High" hazard. High hazard denotes an imminent, persistent toxic threat sufficient to cause complete reproductive failure in most species of fish and aquatic birds (Lemly 1996b). A high hazard may not be occurring at present in the south Grasslands, vis-a-vis total reproductive failure and community collapse, but the High hazard rating does indicate that the ecosystem is on the brink and could get worse rapidly if conditions change even slightly (owing to the steepness of the selenium toxicity curve, increases in selenium from flood events, droughts, etc.) and that actions should be taken to reduces selenium levels (D. Lemly, *in litt*., November 17, 2009).

A more conservative hazard assessment analysis of the South Grasslands is presented in Table 17. This table uses averages of the environmental components. Although the Lemly index is intended to be applied to maximum concentrations in each component, this Table is presented for comparison purposes only. The assessment in this table reveals an overall hazard score of 14, which equates to a "Moderate" hazard. As defined by Lemly, moderate indicates a persistent toxic threat of sufficient magnitude to substantially impair, but not eliminate reproductive success. Some species will be severely affected while others will be relatively unaffected (Lemly 1996b). Applying the Lemly index conversion factor to the average selenium concentration from wholebody fish tissue data of samples 112 g or less (assumed to be the appropriate size for a giant garter snake) collected in the South Grasslands by Beckon *et al*. (2007) reveals an estimated fish egg concentration of 12.81 µg/g, equivalent to a moderate hazard in this medium. Given the fact that giant garter snakes forage on fish and tadpoles, and these media are the most selenium-impacted of the media sampled in the South Grasslands, it is reasonable to conclude that the giant garter snake is likely adversely affected by selenium by their diet in this area.

Table 16. Data set for aquatic hazard assessment of maximum selenium concentrations in the South Grasslands based on Lemly Hazard Assessment Methodology (1996b).

Environmental Media	Selenium concentration	Sample location	Sample type	Evaluation by Component Hazard	Hazard Score
Water[1]	44.4 µg/L	Agatha Canal	grab sample	High	5
Sediments[2]	1.7 µg/g	Geis Ditch @ Sierra Gun Club	3 – 5 cm	Minimal	2
Invertebrates[3]	8.3 µg/g	Gadwall Canal @ Santa Cruz Gun Club	Siberian Prawn	High	5
Fish eggs[3,4]	20.5 µg/g	Geis Ditch @ Sierra Gun Club	Inland silverside	High	5
Bird eggs[3]	6.9 µg/g	Elsie Geis Gun Club	Mallard	Low	3
Total for site				High	20

[1]Grab sample from Agatha Canal, February 23, 2005, from Grassland Area Farmers 2005.
[2]Sediment sampled from Geis Ditch at Sierra Gun Club. Data from Beckon *et al.* 2007.
[3]Data from Beckon *et al.* 2007.
[4] Fish egg selenium = fish wholebody selenium x 3.3.

Table 17. Data set for aquatic hazard assessment of average selenium concentrations in the South Grasslands adapted from the Lemly Hazard Assessment Methodology (1996b).

Environmental Media	Selenium concentration	Evaluation by Component Hazard	Hazard Score
Water[1]	<1-12.1 µg/L	Overall average is Low Occasional average is High	3
Sediments[2]	1.7 µg/g	Minimal	2
Invertebrates[3]	3.12 µg/g	Low	3
Fish eggs[3,4]	12.81 µg/g	Moderate	4
Bird eggs[3]	3.23 µg/g	Minimal	2
Total for site		Moderate	14

[1]Monthly mean water quality for Agatha Canal, 2001 – 2007, from GBP monthly monitoring data reports.
[2]Sediment sampled from Geis Ditch at Sierra Gun Club. Data from Beckon *et al.* 2007.
[3]Data from Beckon *et al.* 2007.
[4] Fish egg selenium = fish wholebody selenium x 3.3.

Selenium effects on giant garter snake in the North Grasslands: Average selenium concentrations of biota collected in Mud Slough (North) and Salt Slough are summarized in Table 18. Tadpoles collected in Mud Slough (North) and Salt Slough were found to have concentrations above the 3 µg/g GBP Ecological Risk Guidelines for dietary toxicity. Average concentrations of selenium in fish composite samples collected from all sampling locations in Mud Slough (North) also exceeded the 3 µg/g dietary toxicity threshold. Concentrations of selenium in composite samples of invertebrates exceeded the dietary toxicity threshold of 3 µg/g at Mud Slough Sites D and I2 only. The maximum concentration of selenium for an invertebrate sample from Mud Slough was 12.7 µg/g for a composite sample of Siberian freshwater shrimp taken at site I2 in 2005 (Beckon *et al.* 2008). Although giant garter snakes are not extant in Mud Slough (North), selenium contamination in the food chain could preclude re-establishment of the snake in this waterway.

By contrast, none of the composite fish or invertebrate samples exceeded 3 µg/g in Salt Slough. Although the overall average selenium concentration of all composite fish samples in Salt Slough for 1998 – 2005 (2.6 µg/g) did not exceed the 3 µg/g dietary toxicity threshold, composites of two fish species were well above this threshold of concern (mosquitofish 4.2 µg/g; black bullhead 4.9 µg/g).

Table 18. Summary of average selenium concentrations of composite invertebrate, fish and tadpole samples collected from Mud Slough and Salt Slough (from Beckon *et al.* 2008).

Location	Invertebrates	Fish	Tadpoles
Mud Slough (Site C)	1998-02: 1.7 µg/g 2003-05: 2.3 µg/g	1998-03: 3.58 µg/g 2004-05: 3.10 µg/g	N/A
Mud Slough (Site D)	1997-03: 3.4 µg/g 2004-05: 4.0 µg/g	1998-03: 6.2 µg/g 2004-05: 6.0 µg/g	2000-05: 4.4 µg/g
Mud Slough (Site I2)	1997-03: 4.8 µg/g 2004-05: 5.6 µg/g	1998-03: 8.1 µg/g 2004-05: 8.3 µg/g	N/A
Salt Slough (Site F)	1998-03: 2.0 µg/g 2004-05: 1.9 µg/g	1998-05: 2.6 µg/g	2000-05: 3.5 µg/g

Conclusion on selenium effects to giant garter snake: These data indicate that under current baseline conditions, dietary selenium concentrations in the South Grasslands still poses a risk to growth, reproduction and survival of giant garter snakes. Further, contamination in the food chain in the North Grasslands, specifically Mud Slough (North) could preclude re-establishment of the snake in the vicinity of this waterway.

<u>Contaminants in wetland water supplies - salinity in wetland water supplies</u>*:* The Final Rule to list the giant garter snake (USFWS 1993) noted that elevated salinities of waters in the Grasslands due to a sodium sulfate based salt also have been documented at deleterious levels in resident fishes and amphibians (Ohlendorf *et al*. 1986, 1988; Saiki *et al*. 1992), the major food source of giant garter snakes. Many species of fish and amphibians cannot survive in saline waters (M. Jennings, herpetologist, pers. comm., 1993; Ruibal 1959, 1962). Cumulatively, threats to this formerly large regional population operate in combination with the other decimating factors described herein, in contributing to the imperilment of the species.

San Joaquin kit fox

Status of Populations in the Vicinity of the Action Area

One of the three core kit fox populations identified in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* is located west of the action area. The Ciervo-Panoche Natural Area of western Fresno and eastern San Benito Counties is located more than 160 kilometers (100 miles) northwest of the other two core populations (Carrizo Plain, and western Kern County). Ciervo-Panoche has significant numbers of foxes, and large expanses of land are in public ownership. It has been estimated that the Ciervo-Panoche area contains 312 square kilometers of suitable habitat (slope < 10%) on public land, and over 600 square kilometers of suitable habitat in private ownership (Haight *et al*. 2002). The Ciervo-Panoche area also experiences a different environmental regime compared to the other two core populations. Preliminary metapopulation viability analyses indicate that recovery probabilities for the kit fox increase if a population is maintained in this area, apparently because of its different environmental regime (USFWS 1998). The configuration of these three core populations (Ciervo-Panoche, Carrizo Plain and western Kern County) also allows for their connectivity by grazing lands. Kit foxes occur at varying densities in the areas between the core populations (e.g., Kettleman Hills), providing linkages between core populations, and also probably with smaller, more isolated populations in adjacent valleys. Satellite populations near the action area include populations in western Madera County, Santa Nella, and Pleasant Valley.

Spatial distribution of the kit fox has become increasingly fragmented since listing. The number of occurrences from survey efforts appears to have declined in recent years. Although survey efforts have likely varied over the years in some areas, kit fox sightings have declined in areas with ongoing surveys. Both loss of habitat and habitat fragmentation have continued throughout the range of the kit fox. By 2006, kit fox were determined to be largely eliminated from the central portion of the San Joaquin Valley. San Joaquin kit fox presence on the west side of the valley is primarily limited to a relatively narrow band of suitable habitat between the

Coast Range foothills and Interstate 5. Within this narrow band, constriction of available habitat and occurrence of barriers such as the San Luis Reservoir, the California Aqueduct, the DMC, and several high traffic roads, potentially limit movements of the kit fox (Clark *et al*. 2007a), especially in the northernmost portion of the band, where only one kit fox sighting was confirmed between 1996 and 2006 (Clark *et al*. 2002; Clark *et al*. 2003a, b; B. Cypher and J. Constable, ESRP, *in litt*. 2006).

Knowledge of the kit fox's status in the action area is limited by the lack of systematic large-scale surveys. Recent surveys of specific parcels of public lands in the action area suggest that the kit fox is either absent, occurs only intermittently, or occurs at extremely low densities (Smith *et al*. 2006; B. Parris, Biologist, San Luis NWR, *in litt*. 2007). The San Luis NWR recorded a high of 22 kit fox in 1985, with subsequent observations averaging between 5 and 6 until 2000 when fox were no longer observed at the refuge (Parris *in litt*. 2007, 2008). Smaller groupings and isolated sightings of kit fox were also recorded from other parts of the San Joaquin Valley floor near the action area, including Madera County and eastern Stanislaus County (Williams 1990, as cited in Service 1998). In eastern Merced County, within the northeastern portion of the kit fox's historic range, kit fox have been observed on several occasions within ranchlands and in orchards, leading biologists to conclude that a small subpopulation is likely to exist within the area, although surveys conducted on a small percentage of the habitat have been largely unsuccessful in detecting the fox (Orloff 2002). Some researchers have concluded that the kit fox currently has relatively low abundance, that the kit fox might be absent in portions of their historic range, and that robust kit fox populations occur in only a few locations, which is a pattern that decreases overall population viability and increases risk of local extinction (Smith *et al*. 2006). In summary, monitoring of kit fox subpopulations has indicated that the occupied range of the kit fox in and adjacent to the action area is contracting and increasingly fragmented, and that kit fox have likely disappeared from areas of extant habitat within the central and northern portions of their historic range.

Amount of Habitat Currently Available

Highly suitable habitat, consisting of arid scrub and grassland habitats with relatively sparse vegetative cover and slopes under five percent, was found to be highly fragmented with many patches either too small or too isolated to support viable kit fox populations, while medium suitable habitat, consisting of somewhat more dense cover and/or slopes between five and fifteen percent, was found primarily to support only intermittent kit fox populations (Cypher *in litt*. 2009). This habitat modeling (Cypher *in litt*. 2009) indicates that very little highly suitable habitat remains on the San Joaquin Valley floor. Additional studies have estimated the acreage of extant habitat available in specific areas. For example, Cypher *et al*. (2007) estimated that in western Fresno, Kings, and Merced Counties, under 6,000 acres of suitable and 21,000 acres of suboptimal habitat remained within the 600,000-acre San Luis Unit, a water service unit of the CVP (Cypher *et al.* 2007).

These studies highlight the importance of large, relatively level tracts of natural habitat having good drainage, appropriate plant communities, and the appropriate prey base in sustaining the kit fox populations (Jensen 1972; Cypher *et al*. 2001; Koopman *et al*. 2001). Although kit fox may forage at the borders of agricultural lands, in general agricultural practices appear to preclude the long-term occupancy of agricultural lands by kit fox (Cypher *et al*. 2005b; Warrick *et al*. 2007). Continuing land conversion for agriculture and development has reduced the amount of habitat available to the kit fox in the San Joaquin Valley (Kelly *et al.* 2005). The Service is not aware of any information that quantifies the current range-wide acreage of extant suitable and/or sub-optimal kit fox habitat, although a range-wide suitability model is in development (S. Phillips *in litt*. 2009).

Factors Affecting Species' Environment in the Vicinity of the Action Area

Loss of habitat: At the time that the San Joaquin kit fox was listed, the conversion of native habitat to agriculture and industrial development was considered to be the primary threat to San Joaquin kit fox populations (Laughrin 1970, Morrell 1975). The loss and modification of habitat due to agricultural conversion, infrastructure construction, and urban development remains the largest threat to the kit fox. Since listing, the Service has identified additional potential threats to kit fox habitat, including habitat alterations due to oil extraction and mining activities, changes in wildfire prevalence, and increased variation in precipitation and prevalence of droughts. The proposed siting of solar facilities in kit fox core, satellite, and linkage areas is an emerging threat that has the potential to substantially affect kit fox population viability, as discussed below under solar development.

Habitat loss and modification due to agricultural conversion: The conversion of natural lands to agriculture continues to be a threat on private lands on the western side of the San Joaquin valley floor in areas where agriculture has been extended west to the base of the foothills since the 1960s (Kelly *et al*. 2005). Large blocks of suitable habitat that support kit fox do remain in the Panoche and Pleasant valleys in the foothills slightly to the west of the action (Cypher *et al*. 2007); however, including both these areas and the western uplands of Fresno County, there were only 5,559 acres of suitable habitat, and 20,543 acres of sub-optimal habitat remaining by 2007 (Cypher *et al*. 2007). On the western edge of the San Joaquin Valley in this area, continuing agricultural development also threatens kit fox movement, as natural habitat has narrowed to less than a mile in width, particularly where creeks intersect I-5 (Cypher 2006). On lands lying to the east of I-5, there are only very scattered habitat fragments that are too small to support any kit fox families (Cypher *et al*. 2007). In recent years, the cessation of irrigation on drainage-impaired lands is facilitating conversion of other lands to permanent crops (e.g., orchards and vineyards) on the west side of the valley. In the Westlands Water District, more reliable water allocations, water freed up through land retirement, and drip irrigation systems have apparently allowed the increase in permanent crops. Between 1993 and 2004 the number of acres planted in orchards and vines in the District more than doubled to greater than 64,000 acres (Westlands Water District 2004), but the portion of this acreage converted from natural lands is not known. Conversion to permanent crops may improve permeability somewhat for the kit fox, but it will also increase incentives to keep lands in agriculture (Cypher 2006).

Unauthorized conversions to agriculture include known destruction of potential kit fox saltbush habitat (Krise *in litt.* 2006). During the period since construction of the CVP, the addition of agricultural customers that were not covered under State permits for CVP water has resulted in the unauthorized agricultural conversion of 45,390 acres of land, including 23,165 acres of alkali scrub habitat in western Fresno County (SWRCB 2000). Findings by the SWRCB resulted in the requirement that Reclamation provide encroachment mitigation under their State water rights permit for a portion, but not all, of the converted scrub habitat (USBR 2004b). To date Reclamation has protected 2,256 acres of alkali scrub habitat, which includes 1,231 acres within Fresno and San Benito Counties. An additional 8,140 acres of alkali scrub is being restored through the Land Retirement Demonstration Project (LRDP) at Atwell Island and Tranquility, in Tulare, Kings, and Fresno Counties (Doug Kleinsmith, USBR, *in litt*. 2009). Approximately 12,000 acres of alkali scrub habitat remains to be acquired to comply with this SWRCB requirement (Doug Kleinsmith, USBR, *in litt*. 2009).

In Merced County (adjacent to the action area), over 5,000 acres of grazing lands were converted to orchards and irrigated pasture between 2004 and 2006 (California Department of Conservation 2006). In eastern Merced County, croplands (row crops, orchards, and vineyards) had been concentrated on floodplains and lower alluvial terraces of the valley, until recently. However, since the early 1990s there has been a rapid eastward expansion of orchards and vineyards into terrace lands previously used only for grazing, which has largely eliminated this native habitat between the Merced River and the Stanislaus County line (Vollmar 2002). This conversion to agriculture in and adjacent to the action area threatens potential kit fox linkages in remaining grassland habitat along the eastern side of the valley and may threaten the small numbers of kit fox thought to occur within eastern Merced County (CNDDB 2008).

Habitat loss and modification due to urbanization: Loss and modification of habitat to urban development within the Action Area continues to be a threat to the kit fox. The population of the City of Los Banos in western Merced County has grown by 34 percent between 2000 and 2006 (U.S. Census Bureau 2008a). Between 2004 and 2006, growth in this area resulted in increased housing densities and in the conversion of over 200 acres of irrigated farmland and grazed lands to urban development (California Department of Conservation 2008). Growth in the area surrounding Los Banos and the nearby town of Santa Nella presents another threat to kit fox habitat in the narrow corridor of upland habitat at the western edge of the Central Valley (HT Harvey and Associates 2004). Additional development proposed near the DMC in this area (Pau *in litt*. 2002) would serve to isolate remaining kit fox habitat from extant dispersal habitat along the canal. Although urban growth may have been scaled back temporarily since the onset of the recent housing slump, these proposed urban developments are indicative of the threats to the kit fox within this portion of its range.

On the eastern side of the kit fox's range adjacent to the action area, uplands in eastern Merced County appear to be part of a large corridor of habitat along the eastern margin of the San Joaquin Valley that may be important to the recovery of the kit fox. Service files document that development pressure is increasing in this area in association with the new University of California, Merced campus.

Habitat loss, modification, and fragmentation due to construction of solar facilities: Within the Ciervo-Panoche core area, two large, utility-scale, solar farms that will cover approximately 11,000 acres of valley floor habitat in the Panoche and Little Panoche Valleys (essentially all flatland habitat), are being proposed. Consultation between project proponents and State and Federal wildlife agencies has not yet been completed , but preliminary maps of the proposed projects suggest that most suitable habitat in the area would be developed, leading to a significant restriction of the kit fox's range (Vance, CDFG, *in litt*. 2009).

Habitat loss, modification, and fragmentation due to construction of infrastructure:
At least one new transportation project having potentially significant unavoidable adverse impacts to wildlife, including the kit fox, is expected to be constructed the length of the San Joaquin Valley. To date, the effects of the proposed California High Speed Train have only been addressed at the programmatic level (California High Speed Rail Authority and U.S. Federal Railroad Administration 2005); however, potential routes are expected to traverse important linkage areas between satellite and core populations, resulting in additional loss of habitat in these areas (California High Speed Rail Authority and U.S. Federal Railroad Administration 2005). The proposed California High Speed Train is expected to increase fragmentation of remaining habitat by presenting both a physical and a mortality barrier to kit fox movement due to high train speeds and frequent train travel (California High Speed Rail Authority and U.S. Federal Railroad Administration 2005).

Roads and canals are present within the Action Area that can impact the kit fox. I-5 and the California Aqueduct extend the length of the Valley, acting as barriers to dispersal in the Ciervo-Panoche core areas, and to dispersal within and/or between numerous satellite areas in San Joaquin, Stanislaus and western Merced counties. The California Aqueduct and I-5 act as barriers to kit fox dispersal. The DMC extends for 117 miles along the west side of the Valley, also potentially inhibiting kit fox movement between satellite and core areas. Additional likely barriers to movement within the action area and between satellite areas include State Routes 152 and 33, Highways 4 and 99, and the East-Side, Columbia, Main, and Outside Canals, along with numerous local canals.

<u>Selenium exposure at the SJRIP drainage reuse area:</u> As was described in the Project Description, most of the target lands for the SJRIP drainage reuse area have been permanently acquired (6,230 acres) out of 6,900 acres planned (GBP FEIS/R). The SJRIP regional reuse facility has been partially constructed, and an expansion of the 4,000-acre facility by 2,900 acres was approved by Panoche Drainage District on August 21, 2007 (Panoche Drainage District 2007). Planting of salt-tolerant crops at the SJRIP reuse area such as alfalfa, pasture, and bermuda grass provides a low-horizon habitat that can be 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 SJRIP drainage reuse area from applied drain water to plants to prey animals to foxes.

No studies to date have identified the relative sensitivity of foxes or San Joaquin kit foxes to selenium contamination in the diet. The most closely related surrogate species for which toxicity data are available is the domestic dog (*Canis familiaris*), which is in the same family (Canidae) as the kit fox. Domestic dogs exposed to 7.2 µg/g dietary selenium suffered adverse effects, including reduced appetite and subnormal growth (Rhian and Moxon, 1943). Dogs exposed to 20 µg/g dietary selenium in this study suffered much more severe histopathological effects, and eventual mortality. The 7.2 µg/g concentration represents a Lowest Observed Adverse Effects Concentration (LOAEC); and therefore, the actual toxicity threshold for domestic dogs is some unknown amount below this value.

While no definitive extrapolation can be made from the dog LOAEC regarding a toxicity threshold for the kit fox, it is reasonable to conclude that such a kit fox threshold would at least be on the same order of magnitude. The potential for selenium bioaccumulation by small mammals at reuse areas is dependent on a variety of factors, such as the type of crop grown, the biology of the particular species, and the selenium concentration in the applied drainwater, and cannot at this time be definitively predicted for the SJRIP drainage reuse area. However, recent contaminant monitoring of biota collected from the SJRIP reuse area provide data with which to evaluate the potential for food chain bioaccumulation, and the risk to kit foxes foraging at this site.

HT Harvey and Associates began small mammal sampling in 2008 at the SJRIP drainage reuse area. That effort yielded the capture of 8 deer mice (*Peromyscus maniculatus*), 7 house mice (*Mus musculus*), and one western harvest mouse (*Reithrodontomys megalotis*) within the portion of the SJRIP Reuse Area that has been receiving drainage water since 2001 (existing project facility). Of those samples, 31.3% were at or above the LOAEC for selenium in dogs (e.g., 7.2 µg/g). It is likely that any kit foxes foraging at the SJRIP drainage reuse area would be exposed to elevated levels of selenium through ingestion of the resident mammal prey species.

EFFECTS OF THE PROPOSED ACTION

This section includes an analysis of the direct and indirect effects of the proposed action and any interrelated and interdependent activities on the giant garter snake and San Joaquin kit fox. It also includes a discussion on effects of the project on migratory birds, although the Service is only providing this in the Opinion as information that may be relevant to Reclamation with regard to Migratory Bird Treaty Act. It is not intended as part of the formal consultation for this project on listed species.

This Opinion analyzes the reasonably foreseeable effects of implementation of the renewal of the GBP from January 1, 2010 to December 31, 2019 as described in the Project Description of this opinion. It is assumed that all conservation measures and environmental commitments described in the Project Description of this Opinion will be implemented in the manner and schedule described. It is also assumed that Reclamation and the Water 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. As noted in the Preamble of this Opinion, the treatment and disposal element of the GBP Extension is not included in this consultation. Reclamation

and the Water Authority will have to complete separate ESA consultation before a treatment and disposal element of the GBP Extension is implemented.

Effects Overview

We expect the GBP to have two main categories of effects to the listed species evaluated for this Opinion: toxicity from contaminant transport and exposure, and, on a relatively small scale, ground disturbance and habitat loss or degradation due to construction activities. Most of the discussion in our analysis of contaminants is about selenium, but the GBP may also move other contaminants from the GDA into Mud Slough (North) and the San Joaquin River. We have little information on amounts or timing of such compounds in waters conveyed by the GBP. The drain waters carry well-documented amounts of boron and salts. Both may be toxic to plants and animals at sufficient concentrations. Some limited information is available on mercury, suggesting that elevated concentrations of mercury are present in at least some drainage water in the GBP project area (DMC sumps). Further, limited sampling by the CVRWQCB suggests that discharges from the SLD into Mud Slough (North) could be a significant source of mercury loading to the San Joaquin River.

EFFECTS OF THE ACTION ON LISTED SPECIES

Giant Garter Snake

The effects of the GBP on giant garter snake fall into two categories: 1) drainage discharges that impact the south Grassland wetland supply channels, and, 2) construction and drainage management in the SJRIP drainage reuse area.

Sources of selenium in the South Grasslands Wetland Supply Channels

Implementation of the GBP has improved water quality in the Grasslands wetland channels (with the exception of Mud Slough North), and reduced salt and selenium loading to the San Joaquin River. As a result, exposure of aquatic and aquatic-dependent wildlife to agricultural drainwater contaminants in the Grasslands wetlands and supply channels has been reduced since the onset of the GBP. However, selenium concentrations in biota in the Grassland wetland ecosystem have not reached background levels (indicative of full ecosystem recovery), and for some species are still above levels of concern. Ongoing risks of selenium toxicity in the area are most likely due to a continuing influx of selenium contamination that has not been fully abated in the area. The sources of these selenium inputs to the Grassland wetlands are from both the GBP and outside the GBP Project Area.

The extension of the GBP is not expected to improve water quality in the wetland supply channels of the Grasslands beyond what has already been attained during the two previous GBP implementation periods. The sources of selenium in the wetland supply channels will likely continue at levels comparable with what was described in the **Environmental Baseline** of this Opinion. None of the ongoing sources of selenium contamination in the wetland supply channels will be addressed by the GBP. As identified by the CVRWQCB, the sources of selenium inputs to the Grassland wetland channels include:

1. DMC sumps and check drains;
2. Lands outside the GBP's Drainage Project Area that continue to discharge drainage directly into the wetland channels; and,
3. Heavy rainfall events that result in the diversion of highly selenium contaminated floodwaters into the Grassland wetland channels.

Of these three sources, the agricultural lands participating in the GBP contribute to #1 and #3 above, and are discussed in more detail as project effects below. With respect to # 2 above, although the GBP has attempted to incorporate lands to the north of the existing project area that continue to discharge drainage into the wetland supply channels, neither the GBP nor Reclamation have the authority to require that these lands participate in the Project (GBP FEIS/R). As a result, these lands have yet to be included in the GBP, and barring any future requirements of the CVRWQCB, are assumed to not participate in the GBP during the life of this project (through 2019).

<u>DMC sumps</u>: A small quantity of highly contaminated subsurface drainage is discharged directly into the DMC CVP supply water from six shallow groundwater sumps owned by Reclamation and operated by the Water Authority in the FCWD (a district which participates in the GBP). The FEIS/R for the GBP Extension notes that, "*These sumps were installed under a long-term commitment by Reclamation to mitigate for drainage impacts in the unlined portion of the Delta-Mendota Canal resulting from its construction and operation. The DMC sumps provide a benefit to Central Valley Project operations generally and are separate from the Grassland Bypass Project.*" Although the DMC sumps are not explicitly included as part of the GBP, they are located within the GDA (i.e., the agricultural lands that participate in the GBP), and are thus for the purposes of this consultation, considered a part of the selenium loading that enters into and affects the Grassland wetland supply channels from the GBP. From 2003 to 2007 the DMC sumps contributed from 582 to 854 pounds of selenium into the DMC supply water per year.

Reclamation in 2009 appropriated funds to develop and construct the modification of the DMC sumps by building new discharge pipelines for each sump and rerouting the discharge into the GBP's regional drainage system. However the GBP BA noted, "*At this time, however, the funding and design of this activity is too speculative to incorporate into the project description.*" Further, the FEIS/R noted, "*any agreement to reroute the sumps for disposal through the*

Grassland Bypass Project must address Reclamation's responsibility for treatment and disposal of this additional subsurface drainage water and how this reduction fits into the respective obligations under the Regional Board's salt, boron and selenium TMDLs." Because an agreement between Reclamation and the Water Authority to dispose of this drainage in the SJRIP reuse area has not yet been negotiated, it is presumed for the purposes of this consultation that drainage sump water from the DMC sumps will continue to be discharged into the DMC during the life of this project.

<u>Heavy rainfall events</u>: Tile-drained farmlands in the GDA southwest of the Grassland wetland supply channels have proven susceptible to flooding during winter storm events. These flood flows have been characterized by high selenium levels and loads. Such flood flows, commingled with subsurface drainage from the GDA, have overwhelmed the capacity of the SLD to handle these flows, resulting in the GBP drainers diverting this selenium-contaminated stormwater and GBP drainwater into the Grasslands wetland supply channels. Diversion of flood flows comingled with GBP drainwater into the Grassland wetland supply channels is a significant source of selenium contamination in these waters. As has been documented in the scientific literature, an acute pulse of selenium in water, such as occurs in the Grasslands during a heavy rainfall event, can have lasting ramifications in the ecosystem, including elevated concentrations in aquatic food webs (Besser *et al.* 1993; Graham *et al.* 1992; Maier *et al*. 1998; Nassos *et al.* 1980; Hamilton 2004). It is assumed that releases of commingled stormwater and drainwater to the Grasslands wetland supply channels will continue to occur at a similar frequency under the proposed GBP Extension as compared to existing conditions.

Effects of selenium in the South Grasslands wetland supply channels: As was described in the Environmental Baseline of this Opinion, dietary selenium concentrations in the south Grasslands still pose a risk to growth, reproduction and survival of giant garter snakes even though much of the agricultural drainage water that historically was discharged into the Grassland wetland supply channels is now shunted into the SLD. Selenium concentrations in biota in South Grasslands wetland channels are not expected to change significantly from baseline conditions over the life of the Project.

Very little published literature is available on the effects of selenium on snakes, and no studies to date have identified the relative sensitivity of giant garter snakes to selenium contamination in the diet. In the absence of such data, the Service must assume on behalf of the species, that the giant garter snake is sensitive to selenium. As was described in some detail in the E**nvironmental Baseline** of this Opinion, for the purposes of the analysis of selenium effects on giant garter snakes, we adopt a 3 µg/g (dwt) toxicity threshold in the diet to be protective of growth and reproduction. This concentration is consistent with what has been established for birds and fish as a threshold of toxicity in the diet to be protective of growth and reproduction (Lemly 1996a; USDOI 1998; Hamilton 2003).

Data from Beckon *et al.* (2007) indicated that almost 80% of the whole body fish and 41% of the invertebrates sampled in the south Grasslands wetland channels exceeded the 3 µg/g dietary threshold. An aquatic hazard assessment procedure (that sums the effects of selenium on various ecosystem components to yield a single characterization of overall hazard to aquatic life) was employed for the south Grasslands (see Environmental Baseline section for detailed evaluation of this assessment). That assessment revealed an overall hazard score of 20, which equates to a "High" hazard, denoting an imminent, persistent toxic threat sufficient to cause complete reproductive failure in most species of fish and aquatic birds (Lemly 1996a). A high hazard may not be occurring at present in the south Grasslands, vis-a-vis total reproductive failure and community collapse, but the High hazard rating does indicate that the ecosystem is on the brink and could get worse rapidly if conditions change even slightly (owing to the steepness of the selenium toxicity curve, increases in selenium from flood events, droughts, etc.) and that actions should be taken to reduces selenium levels (D. Lemly, *in litt*., 2009).

Given the fact that giant garter snakes forage on fish and tadpoles, and these taxa are the most selenium-impacted of the biota sampled in the south Grasslands, it is reasonable to conclude that the giant garter snake is likely adversely affected by selenium in their diet from this area. Among vertebrates, reproductive toxicity is one of the most sensitive endpoints; however birds and fish seem to have substantially lower thresholds for reproductive toxicity than placental mammals (USDOI 1998). Selenium is first and foremost a reproductive toxicant (both a gonadotoxicant and a teratogen); the degree of reproductive damage determines whether populations are adversely affected (Luoma and Presser 2009). It is assumed that for reptiles (such as the giant garter snake) reproductive impairment is among the most sensitive response variables to selenium contamination (USDOI 1998). Therefore, adverse effects to giant garter snakes from dietary exposure to selenium in the aquatic food chain of the south Grasslands are likely to take the form of impaired reproduction.

Effects of Selenium from the GBP on the North Grasslands Wetland Supply Channels
Although giant garter snakes are not currently extant in either in Mud Slough (North) or Salt Slough in the North Grasslands, snakes historically have occupied portions of the North Grasslands (USFWS 1993a; Hansen 2008a). However, where there may be suitable habitat for giant garter snake in the North Grasslands, particularly in Mud Slough (North), selenium contamination in the food chain could preclude re-establishment of the snake in this waterway. Tadpoles collected in Mud Slough (North) and Salt Slough were found to have concentrations above the 3 µg/g dietary toxicity threshold. Average concentrations of selenium in fish composite samples collected from all sampling locations in Mud Slough (North) also exceeded the 3 µg/g dietary toxicity threshold. Concentrations of selenium in composite samples of invertebrates exceeded the dietary toxicity threshold of 3 µg/g at Mud Slough Sites D and I2 only. The maximum concentration of selenium for an invertebrate sample from Mud Slough was 12.7 µg/g for a composite sample of Siberian freshwater shrimp taken at site I2 in 2005.

Concentrations of selenium in composite fish and invertebrate samples collected from Salt Slough were generally below the 3 µg/g level of concern. However, composites of two individual fish species were well above the dietary toxicity threshold for the snake (mosquitofish 4.2 µg/g; black bullhead 4.9 µg/g) (Beckon *et al.* 2008). Further, average selenium concentrations of amphibian tadpoles collected from Salt Slough from 2000-2005 was 3.5 µg/g and were not significantly different from selenium concentrations in tadpoles collected from Mud Slough (North) below the SLD outfall (Beckon *et al.* 2008). Concentrations in biota in Mud Slough (North) and Salt Slough are not expected to change significantly from baseline conditions over the life of the Project.

<u>Conclusion of Effects of the GBP to Giant Garter Snakes in the Grassland Wetland Supply Channels</u>: Selenium concentrations in biota in South Grasslands wetland channels are not expected to change significantly from baseline conditions over the life of the Project. Concentrations in biota in Mud Slough (North) and Salt Slough are not expected to change significantly from baseline conditions over the life of the Project. Given the fact that giant garter snakes forage on fish and tadpoles, and these taxa are the most selenium-impacted of the biota sampled in the North and South Grasslands wetland channels, it is reasonable to conclude that the giant garter snake is likely adversely affected by selenium in their diet from this area.

SJRIP Drainage Reuse Area
Construction of facilities may impact giant garter snake habitat in Phase II of the SJRIP drainage reuse area (e.g., installation of a subsurface drainage collection system). 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 of this Opinion to avoid and minimize negative effects to giant garter snake.

Surveys for giant garter snakes in the newly acquired lands for the SJRIP drainage reuse area did not result in confirmation of presence of snakes on these lands (HT Harvey and Associates

2007). Nonetheless, use of the drainage canals and open ditches in the SRJIP drainage reuse area to convey highly-contaminated drainwater, especially in the newly acquired lands just south of the Grassland wetlands, could result in take of giant garter snakes from exposure to selenium contamination in water and diet. The Service bases this conclusion of effect on the following:

- Close proximity of a known population of snakes in the south Grasslands to the proposed SJRIP expansion area;
- Ability of snakes to move several miles in response to dewatering of habitat;
- Limited availability of summer water habitat in the south Grasslands;
- SJRIP newly acquired lands includes an area of 1,600 acres that was cultivated as rice as recently as 2005, just to the south of Agatha Canal where giant garter snakes have been trapped;
- Open ditches conveying selenium contaminated drainage to the SJRIP expansion area in the summer could serve as an attractive nuisance to snakes; and,
- Netting of ditches will be insufficient to prevent access by giant garter snakes.

Water samples from the sources of drainwater used to irrigate the existing SJRIP drainage reuse area ranged from 43 to 761 µg/L (parts per billion (ppb)) selenium from 2003 to 2005 (HT Harvey and Associates 2009). It is unknown whether a suitable prey base for the giant garter snake (e.g., fish or frogs) is established in the ditches of the drainage reuse area. However, as was documented in the Biological Opinion for the SLDFR (Service File No., 06-F-0027), local mosquito abatement personnel have stocked mosquitofish into open drainwater canals in the San Joaquin Valley (J. Seay, pers. comm. 2006). Because mosquitofish are extremely tolerant to salinity, it is reasonable to assume that they are present in the SJRIP drainage reuse canals. Therefore, potential exists for adverse effects to giant garter snakes from dietary exposure to selenium in the aquatic food chain of the SJRIP drainage reuse area. Adverse effects to the snake would likely manifest as some form of impaired reproduction.

<u>Conclusion of Effects of the SJRIP to Giant Garter Snakes</u>: The diet of garter snakes is principally comprised of fish, frogs and tadpoles. The potential exists for selenium to bioaccumulate in the food-chain of the garter snake at the SJRIP site from drain water conveyed in open ditches and drains. Conversion of open drainage ditches to closed pipes and burial of open drainage ditches no longer needed over the life of the project is expected to gradually decrease the dietary exposure of snakes to selenium within the SJRIP drainage reuse area.

Effects of mercury

It is unknown the extent or severity of mercury contamination in the Grasslands, nor the degree to which the GBP contributes to the existing mercury contaminant baseline. What is known is that elevated concentrations of mercury are showing up in drainwater in the GBP project area: total mercury in water from the DMC sumps has ranged from 200 ng/L to 3,000 ng/L and is currently being pumped into the DMC upstream of Mendota Pool (USBR 2008). The CVRWQCB sampled methyl mercury in water collected from the SLD and Mud Slough (North) and reported the highest concentrations in the Basin occur in Mud Slough downstream of the inflow from the SLD (GBP monitoring site D). Methyl mercury loads in Mud Slough (North) are sufficiently high that they may account for 40-60 percent of the Vernalis load during non-irrigation season (Foe 2005).

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 principal finding of a CalFed Mercury Study in the San Joaquin Basin is that Mud Slough (North) contributes about 50 percent of the methylated mercury at Vernalis (legal boundary of the Delta) but only 10 percent of the water volume during the non-irrigation season (September to March) (Stephenson *et. al.*, 2005).

In light of the fact that some drainage sump water in the GBP Drainage Project Area (i.e., DMC sumps) and the SLD contains elevated levels of mercury, a more comprehensive reconnaissance survey of the extent of mercury contamination from subsurface drainage and other sources is the warranted.

San Joaquin Kit Fox

Given the current proximity of known kit fox occurrences relative to the action area, the size of kit fox home territories (including the typical extent of nightly foraging movements), and the dispersal range of juvenile kit foxes, it is likely that kit fox foraging and dispersal activities will extend into and through areas used as GBP project facilities such as drainage conveyance/collection systems, the SJRIP drainage reuse area, and any site(s) where future treatment/disposal technologies are implemented.

Kit fox dens, although not commonly found in the intensively managed agricultural areas found in the action area, may currently exist at low densities in these areas. Kit foxes may also attempt to recolonize lands that have been retired from surface-water irrigation in the GDA (e.g., 9,515 acres in Broadview Water District). Broadview Water District remains within the sphere of influence of the Grassland Drainage Authority. Any drainage generated from any irrigation with groundwater or from rainfall will be managed by the Grassland Area Farmers (GBP FEIS/R page 4-14).

The potential adverse effects on the San Joaquin kit fox from all the various GBP features include: both temporary and permanent loss of kit fox foraging and denning habitat; disturbance from construction-related activities; disturbance and/or direct injury resulting from the destruction of natal dens when occupied fields are disced or ripped; and toxicosis from consuming selenium-contaminated prey in and around the SJRIP drainage reuse area.

SJRIP Drainage Reuse Area

As was described in the Project Description, most of the target lands for the SJRIP drainage reuse area have been permanently acquired (6,230 acres) out of 6,900 acres planned (GBP FEIS/R). The regional reuse facility has been partially constructed, and an expansion of the 4,000-acre facility by 2,900 acres was approved by Panoche Drainage District on August 21, 2007 (Panoche Drainage District 2007). The Service believes there is habitat within the SJRIP drainage reuse area suitable for kit fox foraging, and due to the fact that the SJRIP reuse area is adjacent to nearby open space habitats (the newly acquired lands of the SJRIP lie directly south of the private wetlands in the south Grasslands), the Service believes it is reasonably likely that kit foxes will forage in the reuse area. Although the newly acquired lands of the SJRIP are agricultural lands that represent less than optimal habitat for kit foxes, it is likely that kit foxes in the vicinity of the action area will travel onto and through GBP Project lands (B. Cypher *in litt*., December 15, 2009). While reuse areas may provide a different vegetative cover than the previously grown crops, it is unlikely that they would reduce the available kit fox prey base or provide even lower quality kit fox habitat conditions. Therefore, the Service does not consider the construction of reuse areas to be a physical loss of existing kit fox habitat.

The nature and extent of effects to the kit fox associated with operation of the 6,900 acres of the SJRIP drainage reuse area cannot be fully predicted, but likely would be limited to the potential risk of selenium bioaccumulation and subsequent toxicosis through ingestion of resident prey species. Selenium, applied to the SJRIP drainage reuse area via agricultural drainwater, will enter the food chain through uptake by plants and soil invertebrates. Selenium will likely then be bioaccumulated by seed- and invertebrate-eating organisms, which represent typical kit fox prey. Selenium levels in all biotic and abiotic (i.e., soil and water) components of the food web can be expected to be substantially greater at the reuse area than in adjacent lands, due to the direct application of contaminated drainwater as the irrigation source for reuse facility vegetation. Therefore, any kit foxes foraging at these reuse sites will likely be exposed to elevated selenium levels through their diet, presenting a substantial risk of selenium toxicosis.

<u>Selenium in small mammals collected from Kesterson</u>: The history of Kesterson Reservoir in the 1980's provides some relevant background information on potential effects of selenium to the San Joaquin kit fox in the event of exposure to drainage water contaminants in the project area. Paveglio and Clifton (1988) sighted kit foxes 39 times in 108 night surveys in the Kesterson Reservoir area between September 1986 and August 1988. They trapped and radio-tagged two kit foxes within one mile of Kesterson Reservoir. They found that kit foxes frequently used the SLD road, which formed the eastern boundary of Kesterson Reservoir. The California vole was the most important component of the diet of kit foxes in the Kesterson area (Paveglio and Clifton 1988). Small mammals were collected at Kesterson Reservoir in 1984, including California voles (Clark 1987). Selenium concentrations of 13 and 33 µg/g were found in California voles at Pond 2 in Kesterson Reservoir, and an average selenium concentration of 10 µg/g in California voles collected at all ponds of the reservoir. Selenium concentrations in voles collected from Kesterson Reservoir were up to 522 times greater as compared to the reference site at the Volta WA. Liver selenium levels of 2 coyotes collected from Kesterson Reservoir were 12.5 and 19.6 µg/g, within the range associated with chronic selenium toxicosis in domestic dogs (12.5 to 43.3 µg/g). Selenium levels in the blood of coyotes were 20 times higher than in coyotes collected from control sites (Paveglio and Clifton 1988).

The 1,280 acre Kesterson Reservoir was dewatered and low-lying areas were filled with clean top-soil in the late 1980's converting a primarily aquatic habitat to an upland habitat considered more suitable for kit fox. Selenium concentrations in small mammals collected from Kesterson post-closure revealed that most mean whole body concentrations were near or exceeded the LOAEC for domestic dogs (CH2MHill 1999).

Selenium effects of drainage reuse: Kit foxes forage over large areas of grasslands and cultivated fields. Exposure to selenium through the diet may occur if a significant portion of a kit fox's home range overlaps the SJRIP area, which would increase the potential that this species would encounter and ingest selenium-contaminated prey. Kit foxes are likely to venture into the reuse area for a variety of reasons, including dispersal behaviors, search for cover habitat, foraging events, etc. While in the reuse area, kit foxes are likely to consume typical prey items. In addition, it is reasonable to assume that prey items originating within the reuse area will spend some part of their time outside the boundary of this area (*e.g.*, small mammals residing along inside edge of reuse area with home ranges that extend beyond boundary, insects that may move in and out of reuse area). Therefore it is also reasonable to assume that any kit foxes present along the outside of the reuse area are likely to be exposed to selenium-contaminated prey. Kit fox populations are found in the Panoche Hills and east of the San Joaquin River (Harris 2000).

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 SJRIP drainage reuse area from applied drain water to plants to prey animals to foxes.

The most closely related surrogate species for which selenium toxicity data are available is the domestic dog (*Canis familiaris*), which is in the same family (Canidae) as the kit fox. Domestic dogs exposed to 7.2 µg/g dietary selenium suffered adverse effects, including reduced appetite and subnormal growth (Rhian and Moxon, 1943). Dogs exposed to 20 µg/g dietary selenium in this study suffered much more severe histopathological effects, and eventual mortality. The 7.2 µg/g concentration represents a LOAEC; and therefore, the actual toxicity threshold for domestic dogs is some unknown amount below this value.

Although no studies to date have quantified the relative sensitivity of San Joaquin kit foxes to selenium contamination in the diet, and while no definitive extrapolation can be made from the dog LOAEC regarding a toxicity threshold for the kit fox, it is reasonable to conclude that such a kit fox threshold would at least be on the same order of magnitude. The potential for selenium bioaccumulation by small mammals at reuse areas is dependent on a variety of factors, such as the type of crop grown, the biology of the particular species, and the selenium concentration in the applied drainwater, and cannot at this time be definitively predicted for the SJRIP drainage reuse area. However, recent contaminant monitoring of biota collected from the SJRIP reuse area, as well as contaminant monitoring of biota from reuse areas at other sites in the San

Joaquin Valley, provide data with which to evaluate the potential for food chain bioaccumulation and the risk to kit foxes foraging at this site.

Chesemore *et al.* (1990) studied selenium accumulation in six different reuse areas in Fresno and Kings Counties from 1987 through 1989. All six of the reuse areas were planted primarily with eucalyptus trees, with sub-plantings of Casuarina trees. Irrigated crops generally surrounded the reuse areas, with some parcels in some years abutting fallowed lands. In addition, several of the plantations were adjacent to or very near evaporation ponds. Four of the reuse areas were irrigated with saline water from the west side of the San Joaquin Valley, while the other two served as controls, and were irrigated with water from the east side of the Valley. Small mammals, primarily deer mice, as well as insects and amphibians were collected from all sites in 1989 and tissues were analyzed for selenium.

Selenium concentrations in deer mice collected from the control site reuse areas averaged 0.36 µg/g (dwt). In contrast, the concentration in deer mice collected from three of the west-side reuse areas averaged 1.17 µg/g (arithmetic mean), while the average concentration from the fourth reuse area was 6.8 µg/g. This latter reuse area, the Peck site, had selenium concentrations significantly higher than the other three west side sites and so was excluded from the overall average. The concentration range for the Peck side was from 3.1 to 8.9 µg/g. In addition to sampling mammals, both amphibians and insects were collected from the agroforestry sites and analyzed for selenium. One composite sample of two Western toads (*Bufo borealis*) revealed a selenium concentration of 22.3 µg/g, the highest tissue concentration recorded during the study. Insects, a mix of Coleopterans and Orthopterans, had an average selenium concentration of 1.53 µg/g, with a range of 0.30 to 4.20 µg/g.

HT Harvey and Associates began small mammal sampling in 2008 at the SJRIP drainage reuse area. That effort found that 31.3% of the small mammals sampled were at or above the LOAEC for selenium in dogs (e.g, 7.2 µg/g). Geometric mean selenium concentrations in small mammals collected from the SJRIP drainage reuse area are presented in Table 19 and are compared with small mammal selenium concentrations collected from drainage reuse areas near Mendota (discussed further below).

The CDFG conducted contaminant monitoring at agroforestry sites (a form of drainage reuse areas) in western Fresno County. Their biological monitoring confirmed that such facilities are capable of introducing elevated selenium concentrations into the food chain, bioaccumulating in small mammal species inhabiting these habitats (CDFG, 2006). Summary values from one such site (the Mendota Agroforestry Plot, formerly known as Murrieta Farms) are presented in Table 19 below.

The Mendota Agroforestry Plot is located on the Panoche Fan alluvial deposit in western Fresno County, and received drainwater from Westlands Water District for the purposes of reducing agricultural drainwater volume. The site is known to be "very attractive to wildlife (resident and migratory birds, raptors, upland game birds, bats, and other small mammals, canid predators) providing what is certainly an 'island habitat' in an urban/agricultural landscape" (CDFG, 2006). Selenium concentrations in groundwater at this site were measured between 590-2,050 µg/L in 1996 (Herbel *et al.* 2002).

The data from the SJRIP and Mendota Agroforestry drainage reuse areas provide clear evidence that at least some of the deer mice and other small mammals in fields treated with selenium-contaminated drainwater can bioaccumulate elevated levels of selenium, relative to fields irrigated with non-contaminated water (as reported by Chesemore *et al.* 1990). The data also provide clear evidence that selenium concentrations in the exposed biota can approach and exceed a documented LOAEC for a canid species. Based on the above, it is likely that any kit foxes foraging at the SJRIP drainage reuse area would be exposed to elevated levels of selenium through ingestion of the resident mammal prey species.

Table 19. Selenium Residues (µg/g dwt) in tissues of Potential Kit Fox Prey Collected from the Mendota Agroforestry Site and the SJRIP Drainage Reuse Areas (from CDFG 2006, and HT Harvey and Associates 2009).

Site	Year	Species	Tissue	Geometric Mean [Se] µg/g (dwt)	Minimum	Maximum	n
SJRIP Reuse Area (existing site)	2008	House mouse	whole body	4.68	1.73	8.61	7
SJRIP Reuse Area (existing site)	2008	Deer mouse	whole body	3.65	1.59	8.89	8
SJRIP Reuse Area (existing site)	2008	Western harvest mouse	whole body	2.47	---	---	1
Mendota Agroforestry	1998	California vole	whole body	3.46	3.3	3.7	3
Mendota Agroforestry	1997-1998	Deer mouse	liver	7.20	1.1	68.0	58
Mendota Agroforestry	1997-1998	Ornate shrew	whole body	10.23	9.2	57.9	9

<u>Prey densities at drainage reuse areas</u>: In addition to contaminant effects, operation of reuse areas as a form of managed cropland potentially could increase the attractiveness of the sites to foraging kit foxes over current land management (e.g**.,** cotton, row crops, fallowed lands). Attractiveness of a site to kit foxes depends on the vegetative cover, which influences both foraging success and predator avoidance, and prey abundance. The potential reuse area crops anticipated for GBP include a variety of perennial grasses, legumes, grains, and some tree varieties in appropriate areas. With these crop types, the reuse areas may have a relatively high

density of small mammals, such as deer and house mice. For example, Chesemore *et al.* (1990) found that densities of small mammals (e.g**.,** deer mice, a prominent kit fox prey species) varied with vegetation type on various croplands and agroforestry plots (Table 20)**.** The agroforestry plots in this study were operated as drain water reuse areas, and were planted primarily with eucalyptus trees. While these eucalyptus plantations differ from the perennial grasses, legumes, and grains anticipated for reuse area crops under GBP implementation, the small mammal densities serve as an illustrative comparison between reuse areas and traditional irrigated crop production lands.

Deer mouse density estimates for four of the eucalyptus plantations in the Chesemore *et al.* study (1990) ranged from 139 - 282 animals per hectare, while the other two sites had lower estimates of 22 and 27animals per hectare. In contrast, deer mouse density estimates for four crop types ranged from 32 animals per hectare in cotton, to 72 animals per hectare in alfalfa. Fallowed land produced the lowest density estimate of 13 animals per hectare. Based on these data, the Service believes it is likely that reuse areas would allow for a more abundant prey base than what would be typical under either current irrigated crop production or under fallowing.

Table 20. Estimated Densities of Small Mammals Associated with Various Types of Vegetation (from Chesemore *et al.* 1990).

Species/Vegetation	Density (Estimated Numbers per 2.4 Acres)
Deer Mice	
Alfalfa	72
Sugar Beets	71
Tomatoes	42
Cotton	32
Fallow	13
Agroforestry Plots (Eucalyptus Trees)	22 - 282
House Mice	
Alfalfa	55
Sugar Beets	43
Tomatoes	25

Therefore, based on the likelihood of kit foxes traveling inside and just outside the reuse area, the high potential for a greater abundance of kit fox prey at the reuse area, and food chain bioaccumulation of selenium at this site, the Service anticipates that kit foxes will suffer some degree of toxicosis resulting from ingesting selenium-contaminated prey at the SJRIP drainage reuse area. Depending on the extent and concentration of food chain bioaccumulation at the site, the level of anticipated toxicosis could range from reduced appetite and subnormal growth to adverse histopathological effects and mortality. As indicated in the project description of this opinion, a tiered contaminant monitoring program will continue to be implemented with recommendations from the Service to detect potential selenium exposure to San Joaquin kit foxes at the SJRIP drainage reuse area (Panoche Drainage District 2007).

<u>Reduction in Range in the Action Area</u>: Kit foxes were recorded in the late 1980s in the areas near the San Luis Reservoir, Merced County (Briden *et al*. 1992), at the North Grasslands and Kesterson National Wildlife Refuge areas on the Valley floor, Merced County (Paveglio and Clifton 1988; Parris *in litt*. 2007). At the San Luis NWR, a high of 22 kit fox were observed in 1985, with subsequent observations averaging between 5 and 6 until 2000 when fox were no longer observed at the refuge (Parris *in litt*. 2007, 2008). It is unknown why the kit fox has presumably become extirpated from the North Grasslands.

<u>Conclusion of Effects of the SJRIP to Kit Fox</u>: Planting of salt-tolerant crops such as alfalfa, pasture, and bermuda grass in the SJRIP drainage reuse area is likely to provide a low-horizon habitat that could be used by San Joaquin kit foxes and their prey. The diet of kit foxes is principally based on seed-eating nocturnal rodents, but also includes significant numbers of other herbivorous species (e.g., birds and insects). The potential exists for selenium to bioaccumulate in the food-chain of the San Joaquin kit fox at the SJRIP site from applied drain water to plants to prey animals to foxes.

Although surveys in 2007 by HT Harvey and Associates for kit fox did not detect active dens in the SJRIP reuse (HT Harvey and Associates 2007), kit fox may still be present or may move into the area in the future. The project site is well within the current range of the San Joaquin kit fox. The presence of farming within and around the project site does not preclude its use by kit fox. Given the fact that selenium concentrations in some of the small mammals collected from the SJRIP site exceeded the LOAEC in dogs, the Service believes that take of San Joaquin kit fox is reasonably likely to occur at this site from bioaccumulation of selenium in their prey.

EFFECTS OF THE ACTION ON MIGRATORY BIRDS

As was documented in the Environmental Baseline section of this Opinion, the SJRIP drainage reuse area has proven very attractive to migratory birds. For example, the most recent SJRIP wildlife monitoring report by HT Harvey and Associates (2009) documented almost 40 avian species using the drainage reuse area between April and June 2008, and nearly half of those showed evidence of nesting at or near the reuse area. In addition to avian reproductive activity at reuse facilities, there are concerns associated with foraging by migratory avifauna (particularly sensitive species) during non-breeding seasons. Mountain plovers have been observed at the SJRIP drainage reuse facility on several instances during the winter months (J. McGahan *in litt,* 2002; 2004).

Although habitat modifications combined with hazing were implemented in 2008, monitoring of selenium in avian eggs collected from the SJRIP Phase I area has found elevated selenium levels in both recurvirostrids (stilts and avocets) and killdeer. All the annual geometric mean, egg-selenium levels from killdeer and recurvirostrid eggs collected from the SJRIP Phase I area from

2003 to 2008, exceeded a 5 ppm selenium toxicity threshold (recommended by the Service to EPA for protection of avian eggs at the Great Salt Lake Utah) (USFWS 2009). From 2003 to 2006, the annual geometric mean, egg-selenium levels from recurvirostrid eggs have ranged from a low of 15.3 ppm (dwt) in 2004 to a high of 50.9 ppm (dwt) in 2008. Annual geometric mean, egg-selenium levels from killdeer eggs ranged from a low of 12.5 ppm (dwt) in 2003 to a high of 22.8 ppm (dwt) in 2006. Recurvirostrid eggs with the geometric mean selenium concentrations found at the SJRIP Phase I area would be expected to exhibit an increased probability of reduced hatchability and teratogenesis (Skorupa 1998). One recurvirostrid embryo contained a deformed, 17-day old embryo (missing eyes, malformed lower mandible and limbs).

The contaminant data from the 2008 contaminant monitoring report indicate that concentrations of selenium in several taxa are significantly elevated and could result in harm or take of wildlife. Panoche Drainage District does manage a 50-acre parcel in rice cultivation as a mitigation wetland to compensate for loss of shorebirds due to elevated selenium exposure at the reuse area. However, the monitoring data indicate that a wider array of species is using and potentially being impacted by selenium in the SJRIP drainage reuse area.

Migratory birds are expected to continue to be exposed to selenium contamination at the SJRIP drainage reuse area over the life of the Project. Further, the extent of the contamination is likely to increase as the SJRIP newly acquired lands are brought on-line to be irrigated with drainage water. Adverse biological effects from selenium contamination in birds can 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 and Hothem 1995; O'Toole and Raisbeck, 1998).

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.

Giant Garter Snake

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 Delta, intrusion of brackish water, continuing or future non-Federal diversions of water, continuing or future non-Federal water transfers, flood flow releases, and other changes in water management that may affect giant garter snake habitat.

2. Continuing and future discharges into surface waters occupied by the snake including non- point source runoff (e.g., discharges from agricultural lands north of the GDA that continue to discharge directly into the Grassland wetland supply channels and stormwater runoff from lands upslope of the GDA that overwhelm the capacity of the SLD and result in discharges directly into the wetland supply channels), runoff from overgrazed rangelands (such as from the Panoche Creek upper watershed), runoff from high-density confined livestock production facilities, municipal stormwater runoff, and illegal, release of contaminated ballast and spills of oil and other pollutants into enclosed bays, non-permitted discharges, and point source discharges (State-permitted).

3. Changes in precipitation patterns associated with climate change and drought. The Five Year Status Review for the giant garter snake noted that the dependence upon permanent wetlands means water availability is important to survival and recovery of this species. In a state where wetland habitat is maintained by managed water regimes, competing interests may preclude consistent and timely delivery of water to sustain suitable habitat. Drought conditions will place additional strains on the water allocation system (USFWS 2006). Where giant garter snake persist on only marginal habitat, the addition of drought conditions is likely to result in high rates of mortality in the short term with the effects of low fecundity and survivorship persisting after the drought has ceased (E. Hansen pers. comm., 2006). It is unknown how resilient giant garter snake populations will be to severe climactic conditions.

   Western North America's climate is predicted to change within the 21st century due to increasing concentrations of greenhouse gases (carbon dioxide, methane, nitrous oxide, and others) in the global atmosphere from burning fossil fuels and other human activities (Cayan *et al.* 2005, DWR 2008; EPA Global Warming webpage http://yosemite.epa.gov). The potential impacts on California's wetland ecosystems from climate change are large (DWR 2008; Lenihan *et al.* 2003). The projected changes, which include warming trends and changes in precipitation, may affect Sierra Nevada rivers and watersheds, which in turn influence the habitat of the giant garter snake located in the valleys downstream. Even modest changes in warming could result in a reduction of the spring snowpack, earlier snowmelt, more runoff in winter with less runoff in spring and summer, more winter flooding, and drier summer soils (Cayan *et al.* 2005). Although the specific effects of climate change on the giant garter snake are unknown, the effects of increased winter flooding could expose the giant garter snake to additional flooding during aestivation and reduced summer water during the snake's active period. Isolated habitat that now supports occurrences of the snake may not continue to provide suitable habitat during variations in weather and flood patterns. If no corridors to other more suitable habitat (refugia) exist, affected snakes may not survive (USFWS 2006). This scenario is similar to what has already occurred to the populations in the former Buena Vista, Kern, and Tulare Lakes in the lower San Joaquin Valley (USFWS 1993). However, in these cases, the cause of the fragmentation and habitat loss was land conversion to agricultural use rather than from climate change. These populations were extirpated after the lakes and wetlands were reclaimed (dewatered) for agriculture and dams were constructed on their contributing rivers.

Snowmelt currently provides an annual average of 15 million acre-feet of water, slowly released between April and July each year. Much of the state's water infrastructure was designed to capture the slow spring runoff and deliver it during the drier summer and fall months. Projections by CDWR (2008) which are based upon historical data and modeling, indicate that the Sierra snowpack will experience a 25 to 40 percent reduction from its historic average by 2050. Climate change is also anticipated to bring warmer storms that result in less snowfall at lower elevations, reducing the total snowpack. Warming temperatures, combined with changes in rainfall and runoff patterns will exacerbate the frequency and intensity of droughts. Regions that rely heavily upon surface water (rivers, streams, and lakes) could be particularly affected as runoff becomes more variable, and more demand is placed on groundwater. Climate change will also affect water demand. Warmer temperatures will likely increase evapotranspiration rates and extend growing seasons, thereby increasing the amount of water that is needed for the irrigation of many crops, urban landscaping and environmental water needs. Reduced soil moisture and surface flows will disproportionately affect the environment and other water users that rely only on annual rainfall such as non-irrigated agriculture, livestock grazing on non-irrigated rangeland and recreation (CDWR 2008).

The California Climate Change Center evaluated climate change impacts on water supply and agricultural water management in California's western San Joaquin Valley, and potential adaptation strategies. This study evaluated the potential implications on water management of twelve climate change scenarios. The consideration of these scenarios revealed a common theme that suggested increasing agricultural demands in the Sacramento and San Joaquin valleys may lead to increased stress on the management of surface water resources and, potentially, to overexploitation of groundwater aquifers. Further, the model results suggest that water shortages may be felt more acutely in the western San Joaquin Valley and Tulare Basin as Delta exports become more constrained (Joyce *et al*. 2009). Generally, climate change models outputs indicate that the Central Valley will be warmer in the future, but are indeterminate as to whether precipitation will increase or decrease (e.g., Dettinger 2005). Thus, the climate change bookends include drier and wetter possibilities, but do not include cooler futures relative to current conditions. Dettinger (2005) noted, "*In the midst of our uncertainties, however, current (climate model) projections exhibit some key commonalities that demand near-term attention from California's resource management communities: (1) even the most benign of the projected climate-change scenarios are sufficient to significantly alter the California's landscape, hydrology, and land and water resources, and (2) those alterations are likely to become significant within roughly the next 25 years*".

4. Changes in land management practices including shifts in agricultural cropping patterns, plowing, discing, grubbing, logging, wildland fire and land management practices

including 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.

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

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

7. Predation by native and non-native fish and wildlife.

San Joaquin Kit Fox

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. There is a trend toward an increase in the number of acres in Westlands Water District planted in permanent crops (orchards and vineyards) (Phillips 2006b; Westlands Water District 2004-2005), particularly on the western, non-drainage-impaired portion of the district (Phillips 2006b). The number of acres planted in permanent crops in Westlands Water District has doubled from 1993 to the 2004-2005 water year (Westlands Water District 2004-2005). From 2003-2005, the number of acres planted in permanent crops rose by over 15%**,** with an almost 8% decrease in the number of acres planted with field crops (Westlands Water District 2004-2005). San Luis Water District, a participating district in the GBP, has converted all agricultural lands in the district to permanent crops (M. McIntyre, ACWA Conference, Sacramento, 5.21.2009). This shift in cropping patterns to permanent crops can be expected to affect the San Joaquin kit fox. With a trend toward permanent crops on the west side, which is where most of the more suitable habitat remains in the vicinity of the action area (B.L.Cypher, pers. comm.; 2006), there is expected to be a decrease in the acreage of land fallowed at any one time. Although orchards and vineyards have a somewhat higher value to kit foxes than annual crops (Cypher 2006), both permanent and annual crops are less likely than fallowed lands to support the preferred prey of kit foxes (kangaroo rats) and they do not allow kit foxes as much visibility to detect potential predators. Permanent crops are not fallowed. Thus, a trend toward less fallowing on the western side can potentially have adverse cumulative effects on the San Joaquin kit fox, by reducing habitat value. This is of greatest concern in the areas where Little Panoche Creek, Panoche Creek and Cantua Creek intersect

Interstate 5, because the available movement corridor for kit foxes is already reduced to a strip less than 0.5 miles in width (Cypher 2006). In these areas, kit foxes have very little room to move between the northern and southern portions of their range, because to the immediate west, the steeper land of the Coast Range provides little or no suitable habitat (B.L.Cypher, pers. comm.; 2006).

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

3. Pesticide use and rodent control, blading, mowing, trenching, installation and repair of structures, roads, fences, and utilities, and other activities routinely conducted on farm and ranch lands in the vicinity of the GBP. Such actiities may affect San Joaquin kit fox by disrupting foraging, eliminating prey or kit fox refugia, or favoring species that compete with or prey upon kit fox. Most pesticides and many of the rodenticides (SGARs) have not been consulted on with the Service by the USEPA. Pesticides of all types, including herbicides and rodenticides, are 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 USEPA for use on rangelands, and these may be sprayed directly on upland species habitat.

4. Additionally, effects may occur from changes in land use and management, human population growth, recreational disturbances, vandalism, road kills, off-road vehicle use, chronic disturbance, noise, disturbances from domestic dogs and equestrian uses.

Conclusion

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 GBP and execution of the third Use Agreement for use of the SLD, as described, is not likely to jeopardize the continued existence of the giant garter snake and the San Joaquin kit fox.

The status of the species and environmental baseline both describe the poor status of the giant garter snake population in the San Joaquin Valley and region of the GBP. As we have described, there are many factors that contribute to the snakes' depressed population and this situation would continue without this project because most of them are outside the scope of the GBP (see **Cumulative Effects and Environmental Baseline**). Adverse effects that are outside the scope of this project include implementation of water transfers as a result of CVPIA, recapture of tailwater and other water conservation measures, lack of funding for full implementation of Level 4 Refuge Water Supply, and lack of a global drainage solution for the Westside of the San Joaquin Valley. We expect that implementation of this project will gradually reduce exposure of giant garter snakes to selenium in drainage conveyances specifically associated with the SJRIP.

However, we do not expect that the Extension of the GBP will change existing levels of selenium contamination in the Grassland wetland supply channels. This will result in continued, elevated selenium concentrations in biota and adverse effects of selenium in giant garter snake diets.

The probability of kit foxes finding an abundant prey base adjacent to and in the SJRIP and, being exposed to elevated levels of selenium through their diet is relatively high. However, the numbers of kit foxes traveling onto reuse areas and thus exposed should be relatively low. It is anticipated that the tiered monitoring program will document these assumptions.

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)(l) 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. Related actions that are not covered by this opinion include but may not be limited to: treatment and disposal technologies that may be implemented as part of the GBP; the design, designation, and management of wetland mitigation lands for the proposed project; and management of lands retired within the sphere of influence of the GBP. Reclamation and the Water Authority 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.

The measures described below are non-discretionary, and must be implemented by Reclamation and/or the Water Authority 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 Water Authority 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

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) detection and tracking of all operations and maintenance activities that may result in take of giant garter snake is difficult. We anticipate that the amount of suitable giant garter snake aquatic and upland habitat that will be disturbed by construction of Project infrastructure and facilities will be small. We expect that conservation measures proposed by Reclamation will minimize the amount of take that may result from construction of Project infrastructure and facilities at the SJRIP drainage reuse area. As a result, we estimate that no more than one (1) giant garter snake may be harmed during construction of SJRIP drainage reuse facilities.

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 can also be 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 resulting from selenium exposure originating from discharges in the GDA during the period covered by this consultation, in the Grassland wetland supply channels and associated wetland habitat receiving water from those channels, and six miles of Mud Slough (North) from the SLD terminus to the confluence with the San Joaquin River.

San Joaquin Kit Fox

The San Joaquin kit fox is likely to be incidentally taken as a result of implementation of all the Project alternatives. Incidental take will be in the form of direct harm or mortality from selenium toxicosis as a result of foraging on selenium-contaminated prey at the SJRIP drainage reuse area.

The number of individual animals which may be subject to incidental taking from the SJRIP drainage reuse area cannot be definitively predicted for three reasons: (1) the number of animals which may use these Project areas for foraging or denning, during and after implementation, cannot be comprehensively determined, and (2) the amount of exposure to elevated levels of selenium from bioaccumulation in the kit fox food chain is dependent on a variety of factors and future conditions that cannot be predetermined (accessibility of reuse areas for kit fox, types of vegetation and vegetation management on reuse areas, and the selenium concentrations in water used to irrigate reuse area crops).

Based on our analysis presented in the **Environmental Baseline** and **Effects of the Action** sections, which describes how the majority of the Project area, both under current and proposed land management, may be considered suboptimal kit fox habitat and is not currently associated with kit fox "core" areas, we do not anticipate that large numbers of foxes are likely to be exposed to adverse effects from the management of the SJRIP drainage reuse area. However, because no estimate of the current kit fox population exists and there is no way to accurately determine what number of individuals or percentage of the population may currently exist in or travel onto GBP lands, the Service is providing an anticipated level of take based on certain assumptions concerning project configuration and kit fox ecology.

<u>Amount or Extent of Take from the SJRIP Drainage Reuse Area</u>*:* The SJRIP drainage reuse area for the GBP Extension is anticipated to reach 6,900 acres when fully implemented. Kit foxes, particularly juveniles dispersing from whelping dens in search of new territories, are likely to travel through the Project area and find foraging opportunities at the SJRIP drainage reuse area. Based on the analysis in the **Effects of the Action** section, we believe the probability of kit foxes finding an abundant prey base at these areas and being exposed to elevated levels of selenium through their diet is relatively high, although the numbers of kit foxes traveling onto reuse areas and thus exposed should be relatively low. Consistent with the amount of take authorized for San Joaquin kit foxes at drainage reuse areas in the SLDFR biological opinion, take of one individual fox per year is authorized for the GBP Extension. Monitoring for kit fox presence and use, and implementation of the tiered contaminant monitoring plan at the SJRIP drainage reuse area, as required by the Service's Terms and Conditions, will provide data by which these exposure estimates can be verified. If data indicate the number of individual foxes incidentally taken exceeds the anticipated numbers presented here, Reclamation may need to reinitiate consultation (see **Reinitiation-Closing Statement).**

Effect of the Take

The Service has determined that this level of anticipated take, from implementation of the GBP Extension, is not likely to result in jeopardy to the giant garter snake or the San Joaquin kit fox. The majority of the terrestrial portion of the action area is actively farmed lands that do not support large numbers of either of the species considered in this biological opinion (see **Environmental Baseline**). Each of these species is likely to be exposed to adverse effects from GBP implementation, SJRIP drainage reuse area construction and operation. Construction effects on giant garter snake will be minimized by implementation of the Service's standard avoidance and minimization measures. The effects of SJRIP implementation and operation on San Joaquin kit fox (through management of the SJRIP drainage reuse area) are not anticipated to be significant at the population level due to the low numbers of individuals expected to be exposed. At the local level, however, these effects have the potential to be significant, although not to a degree that would appreciably reduce the likelihood of survival and recovery in the wild.

Reasonable and Prudent Measures for the Giant Garter Snake

The following reasonable and prudent measures are necessary and appropriate to minimize the impact of implementation of the GBP Extension on giant garter snake:

I. All conservation measures, as presented in the Biological Assessment and as restated here in this Biological Opinion, shall be fully implemented and adhered to.

II. Minimize the incidental take of giant garter snakes resulting from construction activities associated with conveyance features of the SJRIP drainage reuse areas.

III. Minimize the incidental take of giant garter snakes resulting from exposure to selenium-contaminated drainwater that enters the Grassland wetland supply channels.

Terms & Conditions for the Giant Garter Snake

In order to be exempt from the prohibitions of section 9 of the Act, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

The following terms and conditions implement **Reasonable and Prudent Measure Number I** for the giant garter snake:

1. Reclamation will include a commitment in the GBP Extension ROD that all conservation measures in the project description of this Biological Opinion will be adhered to and implemented fully.

The following terms and conditions implement **Reasonable and Prudent Measure Number II** for the giant garter snake:

1. Reclamation will include in the GBP Extension ROD a commitment to apply for appropriate funding sources to be used for closure (piping or permanent closure) of all open conveyance ditches in the SJRIP. Such application will occur every year for the duration of the project or until such time as funding is received and

closure is completed. As funding is received, priority should be given to closure of ditches that reduce exposure to sensitive species to the greatest extent possible.

2. If, due to extenuating circumstances (i.e., availability and timing of funding), construction is necessary in SJRIP 1 (east of Russell Avenue) during the snake inactive period (October 1 – May 1), preconstruction notification will be provided by the Authority to the Service. A service approved biologist will survey proposed construction areas for potential snake aestivation habitat within 30 days prior to commencement of earthmoving activities. Any potential refugia will be hand excavated no sooner than 48 hours prior to construction. The Service approved biologist will remain on site and monitor earthmoving activities until construction is completed and have the authority to immediately halt work in the even a giant garter snake is found in the construction area. If a live snake is found during construction activities, the Service and the project's biological monitor will be immediately notified. The biological monitor, or his/her assignee, will halt construction in the vicinity of the snake. The snake will be monitored and allowed to leave the area on its own. The monitor will remain in the area for the remainder of the work day to make sure the snake is not harmed or, if it leaves the site, does not return. Escape routes for the snake should be determined in advance of construction and snakes should always be allowed to leave on their own. If a snake does not leave on its own within one working day, further consultation with the Service will be conducted.

3. Reclamation will include in the GBP ROD a commitment to work with the Service to refine the closure process in a manner that minimizes the potential for harm to aestivating giant garter snakes.

4. Reclamation will include in the GBP Extension ROD an assurance that the SJRIP reuse area will be maintained to prevent the occurrence of ponded water and emergent vegetation.

The following terms and conditions implement **Reasonable and Prudent Measure Number III** for the giant garter snake:

1. Reclamation will include as a commitment in the GBP Extension ROD to pursue all feasible means to provide full Incremental level 4 refuge water supplies in the Grasslands and Mendota areas.

   a. Within 3 months of the ROD for this project, Reclamation and the Service will convene a meeting with the San Luis NWR Complex, the Service's CVPIA Refuge Water Specialist, CDFG managers from Los Banos, Volta and Mendota WAs, Grassland Water District and easement holders from the Grasslands area. The objective of the initial meeting would be to initiate a process to ensure that a portion of the Incremental Level 4 water supply will be used to create summer water habitats that would benefit giant garter snakes in the form of riparian zones, marshlands with open water and emergent vegetation mosaic.

b. The intent of this collaborative process is to reach agreements with the various management entities voluntarily, and to enhance existing conditions by provision of summer water habitat that would benefit giant garter snakes. This could be achieved through side agreements for wetland easement lands but would not substantially alter existing wetland easement agreements. The Service expects that this effort will be completed well before the end of the 10 year term of the GBP Extension.

2. Reclamation will include a commitment in the GBP ROD to send a letter within six months of this Opinion, addressed to the Regional Water Quality Control Board, noting that 1) the Use Agreement, even after signature, allows for a certain number of acres and locations (as described in the Use Agreement) to be added to the GBP; 2) the effectiveness of efforts by Reclamation and GBP cooperating landowners to reduce agricultural drainage on a regional scale remains an even greater challenge to the extent that some lands remain outside of ongoing collaborative efforts in the GBP; and 3) Reclamation supports their voluntary participation.

3. Reclamation will include a commitment in the GBP Extension ROD that by October 1, 2012, subject to any necessary negotiation with the Authority and any required regulatory agencies, as appropriate, Reclamation and/or the Authority will complete the necessary infrastructure to route the drainage from the DMC sumps (described in the Environmental Baseline of this opinion) to the SJRIP drainage reuse area. Reclamation will negotiate with the Water Authority the necessary terms to include Reclamation's DMC sumps into the GBP and SJRIP facility reuse area.

4. Reclamation will include a commitment in the GBP Extension ROD that during the term of the 2010-2019 Use Agreement, storm flows from the GDA will be conveyed through the Grassland Bypass Channel and SLD under the existing storm event plan. No later than January 1, 2016, Reclamation and the Water Authority will begin development of a long-term storm water management program to address storm flows with the goal of having the long-term stormwater management program in place when the Use Agreement expires. Reclamation and the Water Authority will engage representatives of the CVRWQCB, San Luis NWR Complex, CDFG, GWD and other appropriate public agencies and interested parties in development of the post-use Agreement long-term water management program. In addition, throughout the term of the Use Agreement, Reclamation and the Water Authority will collaborate in any other ongoing

process with appropriate public agencies and interested parties to develop a plan that identified measures to control or bypass around the wetland supply channels storm water flows arising outside the GBD (i.e, from Panoche/Silver Creek)

Reasonable and Prudent Measures for the San Joaquin Kit Fox

The following reasonable and prudent measures are necessary and appropriate to minimize impact of implementation of the GBP on San Joaquin kit fox.

I. **All conservation measures, as presented in the Biological Assessment and as restated here in this Biological Opinion, shall be fully implemented and adhered to.**

II. **Minimize the effect on the species of incidental take of kit foxes resulting from exposure to selenium-contaminated prey originating in the drainage reuse areas.**

Terms & Conditions for the San Joaquin Kit Fox

In order to be exempt from the prohibitions of section 9 of the Act, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

The following terms and conditions implement **Reasonable and Prudent Measure Number I** for the San Joaquin kit fox:

1. Reclamation will include a commitment in the GBP Extension ROD that all conservation measures in the project description of this Biological Opinion will be adhered to and implemented fully.

The following terms and conditions implement **Reasonable and Prudent Measure Number II** to minimize the effect on San Joaquin kit fox of the incidental take associated with implementation of the SJRIP drainage reuse area:

1. Reclamation will include a commitment in the GBP Extension ROD to implement a process whereby suitable kit fox habitat is permanently protected and maintained to compensate for the loss of habitat associated with the boundary of the SJRIP drainage reuse area.

    a. The exact amount of compensation habitat will be commensurate with the amount of reuse area determined on an annual basis to be unsuitable due to contamination of the kit fox's prey base, starting with those reuse areas already in place in 2009 and recalculated annually as additional reuse area acreage is added throughout the life of the Use Agreement. The impact area will be calculated by determining the area of interface between the reuse area and adjacent habitat, extending for fifty yards from the boundary line in both directions. This interface zone is based on the likelihood of kit fox prey (*e.g.*, small mammals, large insects) moving outside the boundary of the reuse areas and on kit foxes venturing inside the reuse areas to forage.

b. Habitat compensation will include a 151-acre parcel of undisturbed native lands, owned by the Panoche Drainage District (PDD), a member of the Authority, adjacent to and south of the South Grassland wetland supply channels. The PDD and the Authority will commit to setting this parcel aside within the first year after receiving this signed biological opinion. The parcel will be protected in perpetuity using a process that includes a conservation easement held by a Service-approved third party, a Service-approved management plan, and an endowment to fund annual management tasks identified in the management plan.

c. Reclamation and the Authority will meet with the Service on an annual basis to review the monitoring data and discuss appropriate compensation. This annual meeting will occur after the annual wildlife reporting has been compiled, starting in March 2010. Compensation habitat will be set aside at a ratio to be determined based on data from the Tiered Monitoring Program, and may be phased in over the duration of the project (see 1.d below). If the monitoring documents selenium concentrations in coyote hair that are < 5 µg/g dry weight (Level of Concern), then no compensation habitat will be required. If the monitoring documents selenium concentrations in coyote hair ≥ 5 µg/g, indicative of potential for adverse effects (*i.e.*, Level of Concern), but ≤ 10 µg/g (*i.e.*, 10 µg/g Toxicity Threshold), the ratio will be 0.5:1 (compensation habitat : reuse area interface zone). If the monitoring documents selenium concentrations in coyote hair above 10 µg/g (*i.e.*, those indicative of adverse reproductive effects), then the ratio shall be 1:1 from that year forward. In addition, coyote blood samples that have concentrations of selenium < 1 mg/L shall not require compensation habitat. However, any coyote blood samples that show selenium concentrations above 1 mg/L shall act as the same trigger as the Toxicity Threshold for hair, *i.e.*, the compensation ratio shall be 1:1 from that year forward.

d. Documentation shall be provided to the Service demonstrating that all samples were obtained from coyotes captured from within or immediately adjacent to reuse areas in agricultural production and irrigated with drainwater. Coyote sampling shall not begin until the agricultural season is well under way, with sufficient vegetative growth to support small mammal prey populations.

e. Phasing will be done each year in increments of 10% of the total determined for that year based on the annual calculation of the amount of habitat degraded during the prior year (1.a.) and the appropriate rate based on Tiered Monitoring (1.b.) and will be provided within tweleve months of the detection.

2. Reclamation will include a commitment in the GBP ROD that Reclamation will establish a Memorandum of Understanding (MOU) with the Service for coordination in the development of the Tiered Monitoring Plan and any associated annual study plans. The Plan will be finalized no later than May 1 of each year. The MOU will also include the annual meeting to determine compensation for the effect or incidental take of kit foxes resulting from exposure to selenium-contaminated prey originating in the drainage reuse areas. The SJRIP Wildlife Monitoring Reports including the data from the tiered food chain monitoring program on the SJRIP shall be provided annually to the Environmental Contaminants and Endangered Species Divisions of Service's SFWO, and shall be made available to all interested parties by posting them on the Grassland Bypass Project's website where the other monitoring reports are posted: http://www.sfei.org/grassland/reports/.

Reporting Requirements

Reclamation must provide the Service's Endangered Species Division and Environmental Contaminants Division with annual reports that include: monitoring 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 2010, and annually thereafter through October 2019.

Injured San Joaquin kit fox or giant garter snake, must be cared for by a licensed veterinarian or other qualified person; dead individuals of any of these three listed species should be preserved according to standard museum techniques and held in a secure location. The Service and CDFG must be notified within one (1) working day of the discovery of death or injury to a San Joaquin kit fox, or giant garter snake that occurs due to project related activities or is observed at the project site. Notification must include the date, time, and location of the incident or of the finding of a dead or injured animal clearly indicated on a USGS 7.5 minute quadrangle and other maps at a finer scale, as requested by the Service, and any other pertinent information. The Service contacts are Deputy Assistant Field Supervisor, Endangered Species Program at the Sacramento Fish and Wildlife Office (916) 414-6600), and Scott Heard, Resident Agent-in-Charge of the Service's Law Enforcement Division at (916) 414-6660. The California

Department of Fish and Game contact is Julie Vance, Senior Environmental Scientist, at 1234 E. Shaw Ave., Fresno, California 93710, (559) 243-4014.

Reclamation and/or the Water Authority shall submit a post-construction compliance report prepared by the on-site biologist to the Sacramento Fish and Wildlife Office within sixty (60) calendar days of the date of the completion of construction activity. This report shall detail (i) dates that construction occurred; (ii) pertinent information concerning the success of the project in meeting conservation measures; (iii) an explanation of failure to meet such measures, if any; (iv) known project effects on the San Joaquin kit fox or giant garter snake, if any; (v) occurrences of incidental take of any San Joaquin kit fox or giant garter snake, if any; (vi) documentation of employee environmental education; and (vii) other pertinent information.

CONSERVATION RECOMMENDATIONS

Section 7(a)(l) of the Act 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 databases. We propose the following recommendations to promote the conservation status of the several federally-listed species in the project area:

Implement actions that benefit the recovery needs of the giant garter snake: Reclamation should work with the Service and CDFG to create, enhance and restore additional stable perennial (including summer) wetland habitat for giant garter snakes in the San Joaquin Valley so that they are less vulnerable to reductions in rice production in the vicinity of Grasslands and Mendota Pool. Provision of clean, reliable, level 4 refuge water supplies could provide additional permanent wetland habitat that would benefit giant garter snakes in furtherance of recovery objectives for the species in the San Joaquin Valley. The CVPIA (b)(1)other and the Central Valley Project Conservation Program (CVPCP), conservation grant programs, may be appropriate for such work.

Reclamation should assist the Service in the implementation of recovery actions in 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 snakes;

b. Protect habitat on private lands in the Mendota area for giant garter snakes;

c**.** Develop/update and implement management plans for Mendota, China Island, Los Banos, and Volta WAs for giant garter snakes; and

Implement actions that benefit the recovery needs of the San Joaquin kit fox: 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), including pursuing and funding opportunities that expand and connect existing natural land for San Joaquin kit fox in the Mendota area, Fresno County, with the Ciervo-Panoche Natural Area.

Manage retired lands to benefit listed species recovery needs: In accordance with the conservation measure for "strategic land retirement" in the SLDFR biological opinion, Reclamation and/or the Water Authority should work with landowners, in collaboration with the Service and other local resource agencies, to manage retired lands in a manner that maximizes benefits to listed species such as San Joaquin kit fox. This would allow Reclamation to meet its obligation to comply with section 7(a)(2) for both the SLDFR and San Luis Unit long-term contract renewal consultations. These consultations provide a unique opportunity for Reclamation to collaborate in the resolution of a significant resource issue of the southern San Joaquin Valley, selenium contaminated drainage, in a way that furthers important resource management goals of both Reclamation and the Service. There is need for evaluation and development of a broad scale landscape mosaic plan for the San Luis Unit and adjacent areas focusing specifically on habitat restoration and endangered species recovery goals. Such a plan could provide guidance to USDOI and Westlands' management efforts on existing retired lands, and guide the Service and Reclamation on evaluation and implementation of future actions in the area. To accomplish this, Reclamation should establish a team of Service and Reclamation staff to negotiate an acceptable land retirement strategy that would address listed species recovery needs.

Optimize SLDFR land retirement with related efforts to maximize benefit to recovery of threatened and endangered species: The Service recommends that Reclamation begin the planning phase for the objectives to further listed species recovery associated with land retirement as soon as possible. The Service further recommends that Reclamation, jointly with the SFWO, convene a drainage technical team under the larger San Joaquin Valley Recovery Team, and invite other interested parties and stakeholders to coordinate and integrate these recovery objectives in a practical manner with other related actions. As discussed in the Environmental Baseline section of this Opinion, an example of an action potentially related to land retirement is encroachment mitigation, a requirement of the SWRCB in their Decision D-1641 (dated March 2000). In D-1641 the SWRCB required in-kind mitigation for encroachment due to the application of CVP water outside the water rights permitted Place of Use for the CVP. As of this date, about 22,000 acres of alkali scrub habitat have yet to be acquired for this mitigation requirement. All of the encroachment of alkali scrub occurred within the San Luis Unit (primarily Westlands) and within the SLDFR project area. The SWRCB D-1641 directed Reclamation to complete this mitigation within ten years of the date of the Decision. Restoration of some of the drainage-impaired retired lands could be used to fulfill this mitigation requirement and could provide habitat that would support listed species such as San Joaquin kit fox.

Adopt a policy that maximizes land retirement (through all appropriate means) on drainage-impaired lands: To avoid and minimize risks and effects to listed species in the San Joaquin Valley, Reclamation should consider retiring from irrigation all drainage impaired lands in the San Luis Unit. This approach would maximize the elimination of drainage at its source and avoid associated adverse effects from drainage contamination in drainage reuse areas, in the Grassland wetland channels, Mud Slough (North) and the San Joaquin River. The Service in the Coordination Act Report for the SLDFR recommended that lands producing drainwater exceeding threshold levels for agricultural toxicants should either be retired from irrigated agriculture or the drainwater be disposed of in a manner that avoids wildlife contact, such as deep-well injection or treatment to render the drainage harmless to the environment (USFWS 2006b).

Expand focus of the SLDFR Mitigation Work Group to include listed species issues. If USDOI moves forward with implementation of the SLDFR ROD, as recent filings in federal court would indicate, Reclamation should expand the mitigation work group to address listed species issues of SLDFR planning that has yet be completed. SLDFR issues that have been deferred until a later date include: the preparation of mitigation monitoring and adaptive management plans; full discussion of risks associated with reuse facilities, mitigation and contingency measures; final siting and management planning for project facilities (including mitigation wetlands); and detailed cost estimation and framing of the feasibility analysis.

Ensure a funding source is available to pay for contingencies. Reclamation and the Water Authority should ensure that adequate funding is available for contingencies or adaptive management specific to listed species that arises over the period the GBP Extension is implemented. Such contingencies could include detailed contaminant monitoring to establish risk to San Joaquin kit fox use at reuse areas, or mitigation measures such as fencing of reuse areas or provision of clean wetland compensation habitat for migratory bird impacts at the SJRIP drainage reuse area. Reclamation should estimate and request adequate funding for contingencies that may be needed during the project life in the SLDFR feasibility and budgeting processes. Reclamation should also have contingency funding sources identified (such as acquisition of performance bonds) to enable immediate action to halt adverse effects if stepwise deterrence proves ineffective and prevent prolonged risk to listed species during a reinitiated consultation.

Ensure adequate funding for and quality of water supply for mitigation wetlands. If USDOI moves forward with implementation of the SLDFR ROD, as recent filings in federal court would indicate, to maximize benefit to listed species such as giant garter snake, Reclamation should seek allocation of firm, clean, contract water supply for mitigation wetlands. Sources of such water include reverse osmosis treated drainwater, water freed-up by land retirement, or CVP water contract assignments.

Include compliance with 2 µg/L selenium in Grassland wetland water supplies as a GBP performance criterion. As currently envisioned, the GBP project facilities will not be designed to capture and treat drainage generated from: (a) drainage contaminated runoff associated with heavy rainfall events, (b) the DMC sumps and check drains that discharge highly contaminated drainage water into the DMC, (c) and lands to the north of the GDA that still discharge drainage into the Grassland wetland supply channels within the (e.g., Poso and Almond Drain areas).

Reclamation should consider including compliance with water quality objectives in the Grasslands wetland channels as a performance criteria. Reclamation should also develop and implement a plan on how to meet selenium objectives in the Grassland wetland supply channels. Compliance with these water quality objectives will likely benefit giant garter snake which forage in these waters.

Monitor and assess the effects of SJRECWA 10-year Transfer Program on water quality and giant garter snake populations in Mud and Salt Sloughs: Reclamation should monitor and assess the effect of reduced flow in Mud and Salt Slough from the SJRECWA 10-Year Transfer program on waterborne selenium concentrations and giant garter snake populations. This is an issue of emerging significance in the environmental baseline for Reclamation actions in this part of the San Joaquin Valley.

Determine effects of selenium and mercury on giant garter snake: Reclamation, together with the Service and other appropriate agencies, should implement a study on the effects of contaminants (specifically selenium and mercury) on giant garter snake surrogate species within the Grassland wetlands, Grassland wetlands supply channels, and Mud Slough (North).

Develop a selenium budget for the Sun Joaquin River, Delta: Reclamation, together with the Service and other appropriate agencies, should complete the studies necessary to develop a selenium budget and to determine the sources, fate and impact of all selenium discharges in the San Joaquin River. This budget would include all presently impaired downstream water bodies used by listed species (e.g., giant garter snake, delta smelt, California clapper rail) including Mud Slough (North), the San Joaquin River, and the North Bay (e.g., Suisun Bay) and Sacramento-San Joaquin Delta.

REINITIATION –CLOSING STATEMENT

This concludes formal consultation on the Extension of the GBP. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Reclamation 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 GBP that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the GBP 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 GBP. In instances where the amount or extent of incidental take is exceeded, any activities causing such take must cease, pending reinitiation.

Literature Cited

Alterio, N. (1996). *Secondary poisoning of stoats (Mustela erminea), feral ferrets (Mustela furo), and feral cats (Felis catus) by the anticoagulant poison, brodifacoum.* New Zealand Journal of Zoology 23:331-338.

Alterio, N., and H. Moller. (2000). *Secondary poisoning of stoats (Mustela erminea) in a South Island podocarp forest, New Zealand: implications for conservation.* Wildlife Research 27:501-508.

American Farmland Trust. (2007). *Paving Paradise: Anew Perspective in Farmland Conversion*. Also available with supporting spreadsheets at www.farmland.org/california. 15pp.

Archon, M. (1992). *Ecology of the San Joaquin kit fox in western Merced County, California.* Master's Thesis. School of Natural Sciences, California State University, Fresno, CA.

Balestreri, A.N. (1981). *Status of the San Joaquin kit fox at Camp Roberts, California, 1981.* U.S. Department of the Army, Engineering, Environmental, and Natural Resources Office. California Polytechnic State University, San Luis Obispo, CA, 30 pp.

Barrett, L. (1990). *Annual review of animal rabies in California. 1989*. California Veterinarian 44:52-54.

Barton, C. and K. Kinkead. (2005). *Do Erosion Control and Snakes Mesh*? J. Soil & Water Conserv. 60(2):33A-35A.

Beam, J. A., & Menges, T. M. (1997). *Evaluation of Management Practices on State-owned Wildlife Areas and Private Duck Clubs in the Grassland Basin of the San Joaquin Valley Relative to the Giant Garter Snake (Thamnophis gigas).* Unpublished Report, California Department of Fish and Game, Los Banos, CA.

Beam, J. A., Cripe, K., & Fien, C. (1999). *San Joaquin Valley Giant Garter Snake Project.* Unpublished Report, California Department of Fish and Game, Los Banos, CA.

Bean, E. and P.J. White. (2000). *Estimation of the abundance of San Joaquin kit foxes on the Carrizo Plain National Monument using distance sampling*. Report submitted to U. S. Fish and Wildlife Service, Sacramento, CA, 12 pp.

Beckon, W. N., Eacock, M. C., & Gordus, A. G. (2008). *Biological Effects of the Grassland Bypass Project, January 1, 2004 - December 31, 2005.* Pages 93-167 *in* Grassland Bypass Project 2004-2005. Prepared by the San Francisco Estuary Institute, Oakland, CA.

Area Manager, U.S. Bureau of Reclamation

Beckon, W. N., Gordus, A., & Eacock, M. C. (2003). *Biological Effects of the Grassland Bypass Project. Chapter 7. 2000-2001*. San Francisco Estuary Institute, Oakland, CA.

Beckon, W. N., Maurer, T. C., & Detwiler, S. J. (2007). *Selenium in the Ecosystem of the Grassland Area of the San Joaquin Valley: Has the Problem been Fixed?* U.S. Fish and Wildlife Service, California/Nevada Operations Office, Sacramento, CA.

Bell, H.M., J.A. Alvarez, L.L. Eberhardt, and K. Ralls. (1994). *Distribution and abundance of San Joaquin kit fox, Distribution and abundance of San Joaquin kit fox.* California Department of Fish and Game, Nongame Bird and Mammal Section. Report 94-00.

Berry, W.H., J.H. Scrivner, T.P. O'Farrell, C.E. Harris, T.T. Kato, and P.M. McCue. (1987). Sources and rates of mortality of the San Joaquin kit fox, Naval Petroleum Reserve #1, Kern County, California, 1980-1986. U.S. Department of Energy Topical Report No. EGG 10282-2154 , Santa Barbara, CA, 34 pp.

Berry, W.H., WG. Standley, T.P. O'Farrell, and T.T. Kato. (1992). *Effects of military-authorized activities on the San Joaquin kit fox (Vulpes velox macrotis) at Camp Roberts Army National Guard Training Site, California*. U. S. Department of Energy Topical Report No. EGG 10617-2159, EG&G/EM Santa Barbara Operations, National Technical Information Service, Springfield, VA.

Besser, J. M., Canfield, T. J., & LaPoint, T. W. (1993). *Bioaccumulation of organic and inorganic selenium in a laboratory food chain*. Environ. Toxicol. and Chem. , 12:57-72.

Bidlack, A. (2007). *Mesocarnivore responses to changes in habitat and resource availability in California.* Ph.D. Dissertation. University of California, Berkeley, CA.

Bjurlin, C.D., and B.L. Cypher. (2003). *Effects of roads on San Joaquin kit foxes: a review and synthesis of existing data.* Pages 397-406 *In:* Proceedings of the 2003 International Conference on Ecology and Transportation, Eds. C.L. Irwin, P. Garrett, and K.P. Mc Dermott. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC.

Bjurlin, C.D., B.L. Cypher, C.M. Wingert, and C.L. Van Horn Job. (2005). *Urban roads and the endangered San Joaquin kit fox.* California State University-Stanislaus, Endangered Species Recovery Program, Fresno, CA.

Branco, S. (2007). *Den at mall reoccupied.* The Bakersfield Californian. Available on the internet at: http://gsearch.bakersfield.com/search?q=cache:Jm7OGU4KH60J:www.bakersfield.com/619/story/126271.html. Accessed April 23, 2007 and March 31, 2009.

Briden, L.E., M. Archron, and D.L. Chesemore. (1987). *Ecology of the San Joaquin kit fox in western Merced County*. California State university, Fresno, CA, 16 pp.

Briden, L.E., M. Archon, D.L. Chesemore. (1992). *Ecology of the San Joaquin Kit Fox in Western Merced County, California.* Pages 81-87 *In*: D. F. Williams, S. Byrne, T. A. Rado (editors), Endangered and Sensitive Species of the San Joaquin Valley, California: their Biology, Management and Conservation. California Energy Commission, Sacramento, CA.

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*. Unpublished report for the California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, CA, 24 pp. and Appendix.

Bunn, D., A. Mummert, M. Hoshovsky, K. Gilardi, and S. Shanks. (2007). *California Wildlife: Conservation Challenges; California's Wildlife Action Plan.* Prepared by the UC Davis Wildlife Health Center for the California Department of Fish and Game. Available on the internet at http://www.dfg.ca.gov/wildlife/WAP/docs/report/full-report.pdf. Accessed November 12, 2008.

Bury, R. B., and J.A. Wheelan. (1984). *Ecology and management of the bullfrog*. Resource Publication 155:1-23.

California Department of Conservation. (1994,1996,1998). Division of Land Resource Protection Farmland Mapping and Monitoring Program, Sacramento, CA.

California Department of Conservation. (2006, 2008). Farmland Mapping and Monitoring Program: 2004 - 2008 Field Reports and Historic Land Use Conversion tables. Available on the internet at: http://redirect.conservation.ca.gov/DLRP/fmmp/product_page.asp. Accessed November 10, 2008 and April 16, 2009.

California High Speed Rail Authority and U.S. Federal Railroad Administration. (2005). *Final program environmental impact report/environmental impact statement (EIR/EIS) for the proposed California high-speed train system, Volume I:Report*. Available on the internet at http://www.cahighspeedrail.ca.gov/library/Default.aspx?ItemID=7226. Accessed April 8, 2009.

[CANG] California Air National Guard. (2008). *Biological assessment of the effects of multiple activities conducted at Camp Roberts, San Luis Obispo and Monterey Counties, California, on Federal endangered and threatened species*. Office of Adjutant General, CANG, Camp Roberts, California. Prepared for the U.S.D.I. Fish and Wildlife Service, Ventura Field Office, Ventura, CA. April 2008.

[CAST] Council for Agricultural Science and Technology. (1994). *Risk and benefits of selenium in agriculture.* Council for Agricultural Science and Technology, Ames, IA.

Caughley G., and A. Gunn. (1996). *Conservation Biology in Theory and Practice*. Blackwell Science, Cambridge, MA, 459 pp.

Cayan, D., M. Dettinger, I. Stewart, and N. Knowles. (2005). Recent changes towards earlier springs: early signs of climate warming in western North America? U.S. Geological Survey, Scripps Institution of Oceanography, La Jolla, CA.

Cayan, D., A.L. Luers, M. Hanemann, G. Franco, and B. Croes. (2006). Scenarios of Climate Change in California: An Overview. California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2005-186-SF. Available at: http://www.energy.ca.gov/2005publications/CEC-500-2005-186/CEC-500-2005-186-SF.PDF.

[CDFA] California Department of Food and Agriculture. (2008a). *Environmental Assessment 2007 – 2011 of the California Department of Food and Agriculture Curly Top Virus program for the Bureau of Land Management*. April 2007.

[CDFA] California Department of Food and Agriculture. (2008b). *Curly top virus control program: introduction, general program, program specifics, and biological control webpages*. Available on the internet at http://www.cdfa.ca.gov/PHPPS/IPC/curlytopvirus/ctv_hp.htm. Accessed December 9, 2008.

[CDFG] California Department of Fish and Game. (1980). *At the crossroads, a report on California's endangered and rare fish and wildlife*. California Department of Fish and Game, Sacramento, CA, 147 pp.

[CDFG] California Department of Fish and Game. (1985). *Blunt-nosed leopard lizard essential habitat update, July 1, 1984 – September 30, 1985*. California Department of Fish and Game, Sacramento, CA, Job EF84 II-1.

[CDFG] California Department of Fish and Game. (1999). *Exposure of Non-target Wildlife to Anticoagulant Rodenticides in California.* Robert C. Hosea. California Department of Fish and Game Pesticide Investigations Unit. Rancho Cordova, CA.

[CDFG] California Department of Fish and Game. (2006a). *San Joaquin Valley Giant Garter Snake Trapping Effort 2006.* Los Banos Wildlife Area Publication #23, California Department of Fish and Game, Los Banos, CA.

Area Manager, U.S. Bureau of Reclamation

[CDFG] California Department of Fish and Game (2006b). *Agroforestry Biomonitoring Data, San Joaquin Valley Collection Years 1991 and 1997-1998*. CDFG Central Valley Bay Delta Branch, Stockton, CA.

[CDFG] California Department of Fish and Game. (2008). Chimineas Unit Regulations and Access Permit Chimineas Unit – Carrizo Plains Ecological Reserve 2008/2009.

[CDPR] California Department of Pesticide Regulation. (2007). *Endangered Species Project. Sacramento, California*. Available on the internet at http://www.cdpr.ca.gov/docs/es/intro.htm. Accessed December 9, 2008.

[CDWR] California Department of Water Resources. (2008). *Managing An Uncertain Future, Climate Change Adaptation Strategies for California's Water.* California Department of Water Resources, Sacramento, CA, 30 pp. Available at: http://www.water.ca.gov/climatechange/docs/ClimateChangeWhitePaper.pdf.

[CFGC] California Fish and Game Commission. (2008). *California 08-09 Mammal Hunting Regulations Booklet.* Available on the internet at http://www.dfg.ca.gov/regulations/08-09-mammal-regs.pdf. Accessed October 21, 2008.

CH2MHILL. (1999). *Kesterson Reservoir 1998 Biological Monitoring. Kesterson Program.* U. S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, CA.

Chen, T.W., and J.F. Deng. (1986). *A brodifacoum intoxication case of mouthful amount.* Veterinary and Human Toxicology 28:488.

Chesemore, D.L., T.D. Kelly, and A.R. Dyer. (1990). *Wildlife use of agroforestry plantations in the San Joaquin Valley of California 1987-1989*. San Joaquin Valley Drainage Program, Sacramento, CA.

Chilcott, J. and R. Schnagl. (April 1, 2008). *Central Valley Selenium Control Program. Presentation to the North Bay Selenium Advisory Committee Meeting*. Central Valley Regional Water Quality Control Board, Central Valley Region, Sacramento, CA. 69 pp. Available at: http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/seleniumtmdl.shtml

Chilcott, J. (2000). *Review of Selenium Concentrations in Wetland Water Supply Channels in the Grassland Watershed.* Staff Report, CalEPA, California Regional Water Quality Control Board, Central Valley Region, Sacramento, CA.

Christensen, J. H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R. K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C. G. Menéndez, J. Räisänen, A. Rinke, A. Sarr, and P. Whetton (2007). *Regional Climate Projections, in Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change edited by S. Solomon, et al., Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Clark, D.R., Jr. (1987). *Selenium accumulation in mammals exposed to contaminated California irrigation drainwater*. The Science of the Total Environment 66:147-168.

Clark, Jr., H.O., and B.L. Cypher, and P.A. Kelly. (2002). *Aerial Surveys for kit fox natal dens in the Northern Range, California*. California State University-Stanislaus, Endangered Species Recovery Program. Fresno, CA, 10 pp.

Clark, H.O., Jr., D.A. Smith, B.L. Cypher, and P.A. Kelly. (2003a). *Detection dog surveys for the San Joaquin kit fox along the Delta-Mendota Canal, Contra Costa, San Joaquin, Alameda, Stanislaus, and Merced Counties, California.* California State University, Stanislaus, Endangered Species Recovery Program. Prepared for the Bureau of Reclamation, South-Central California Area Office, Fresno, CA.

Clark, H.O., D.A. Smith, B.L. Cypher, and P.A. Kelly. (2003b). *Detection Dog Surveys for San Joaquin Kit Foxes in their Northern Range*. Prepared for Endangered Species Recovery Program, Fresno, CA, Contract #4600013447.

Clark, H.O., R.R. Duke, M.C. Orland, R.T. Golightly, and S.I. Hagen. (2007a). *The San Joaquin kit fox in North-Central California: a review*. Transactions of the Western Section of the Wildlife Society 43:27-36.

Clark, H.O., D.P. Newman, S.I. Hagen. (2007b). *Analysis of San Joaquin kit fox element data with the California Diversity Database: a case for data reliability*. Transactions of the Western Section of the Wildlife Society 43:37-42.

Clark, Jr., H.O., G.D. Warrick, B.L. Cypher, P.A. Kelly, D.F. Williams, and D.E. Grubbs. (2005). *Competitive interactions between endangered kit foxes and non-native red foxes*. Western North American Naturalist 65:153-163.

Cleveland, L., E.E. Little, D.R. Buckler, and R.H. Weidmeyer. (1993). *Toxicity and Bioaccumulation of Waterborne and Dietary Selenium in Juvenile Bluegill (Lepomis macrochirus)*. Aquatic Toxicol. 27:265-280.

[CNDDB] California Department of Fish and Game, Natural Diversity Data Base. (2008). Element occurrence reports for *Vulpes macrotis mutica*. Unpublished cumulative data current to December 1, 2008. California Department of Fish and Game, Biogeographic Data Branch. RareFind Version 3.1.0. Government Version - December 1, 2008.

Cox, P. and R.H. Smith. (1992). *Rodenticide ecotoxicology: pre-lethal effects of anticoagulants on rat behaviour*. Proceedings of the fifteenth vertebrate pest conference 1992. University of Nebraska, Lincoln. Available on the internet at http://digitalcommons.unl.edu/vpc15/86. Accessed February 3, 2009.

Coyle, J. J., D.R. Buckler, C.G. Ingersoll, J.F. Fairchild, and T.W. May. (1993). *Effect of Dietary Selenium on the Reproductive Success of Bluegills (Lepomis macrochirus).* Environ. Toxicol. & Chem. 12:551-565.

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, CA.

[CVRWQCB] Central Valley Regional Water Quality Control Board. (1998). *Amendments to the water quality control plan for the Sacramento River and San Joaquin River Basins for the control of agricultural subsurface drainage discharges. Fourth edition.* CalEPA, California Regional Water Quality Control Board, Central Valley Region. Sacramento, CA. Available at: http://www.epa.gov/waterscience/standards/wqslibrary/ca/ca_9_central_valley.pdf

Cypher, B.L. (2000). Effects of roads on San Joaquin kit foxes: a review and synthesis of existing data. Endangered Species Recovery Program, Fresno, CA, 59 pp.

Cypher, B.L . (2003). Foxes. Pages 511-546 In: G.A. Feldhamer, B.C. Thompson, and J.A. Chapman (editors), *Wild Mammals of North America: Biology, Management, and Conservation*. Second edition. The Johns Hopkins University Press, Baltimore, MD.

Cypher, B.L. (2006). *Kit fox conservation in the San Luis Drainage Study Unit*. Unpublished report to the U.S. Bureau of Reclamation South-Central California Area Office. California State University, Stanislaus, Endangered Species Recovery Program. Fresno, CA.

Cypher, B.L., and A.D. Brown. (2006). *Demography and ecology of endangered San Joaquin kit foxes at the Bena Landfill, Kern County, California*. California State University-Stanislaus, Endangered Species Recovery Program, Turlock, CA, 17 pp.

Area Manager, U.S. Bureau of Reclamation

Cypher, B.L., and J.H. Scrivner. (1992). *Coyote control to protect endangered San Joaquin kit foxes at the Naval Petroleum Reserves, California*. Proceedings of the Vertebrate Pest Conference, 15:42-47.

Cypher, B.L., and K.A. Spencer. (1998). *Competitive interactions between coyotes and San Joaquin kit foxes*. Journal of Mammalogy 79:204-214.

Cypher, B.L., and G.D. Warrick. (1993). *Use of human-derived food items by urban kit foxes.* 1993 Transactions of the Western Section of The Wildlife Society 29:34-37.

Cypher, B.L., G.D. Warrick, M.R.M. Otten, T. P. O'Farrell, W.H. Berry, E.C. Harris, T.T. Kato, P M. McCue, J.H. Scrivner, and B.W. Zoellick. (2000). *Population dynamics of San Joaquin kit foxes at the Naval Petroleum Reserve in California*. Journal of Wildlife Management 64, Wildlife Monographs No. 145.

Cypher, B.L., H.O. Clark, Jr., P.A. Kelly, C. Van Horn Job, G.D. Warrick, and D.F. Williams. (2001). *Interspecific interactions among wild canids: implications for the conservation of endangered San Joaquin kit foxes*. Endangered Species Update 18:171-174.

Cypher, B.L., P.A. Kelly, and D.F. Williams. (2003). *Factors influencing populations of endangered San Joaquin kit foxes: implications for conservation and recovery.* Pages 125-137 *In:* M.A. Sovada and L. Carbyn (editors), The Swift Fox: Ecology and Conservation in a Changing World. Canadian Plains Research Center, Regina, Saskatchewan.

Cypher, B.L., C.D. Bjurlin, and J.L. Nelson. (2005a). *Effects of two-lane roads on endangered San Joaquin kit foxe*s. California State University-Stanislaus, Endangered Species Recovery Program, Fresno, CA.

Cypher, B. L., P.A. Kelly, D.F. Williams, H. O. Clark Jr., A. D. Brown, and S. E. Phillips. (2005b). *Foxes in farmland: recovery of the endangered San Joaquin kit fox on private lands in California*. CSU, Stanislaus, Endangered Species Recovery Program, Fresno, CA. Prepared for the National Fish and Wildlife Foundation. June 27, 2005.

Cypher, B. L., S. E. Phillips, and P. A. Kelly. (2007). *Habitat suitability and potential corridors for San Joaquin kit fox in the San Luis Unit, Fresno, Kings, and Merced Counties. California*. Prepared for the U.S. Bureau of Reclamation, South-Central California Area Office, and the U.S. Fish and Wildlife Service, Endangered Species Program, Fresno, CA.

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, 52 pp. Available at: http://www.sfei.org/staffpubs_pages/pubs_davis.htm

DeBare, I. (2008). *PG&E plans big investment in solar power*. San Francisco Chronicle. Available at http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/08/15/BUP412B774.DTL. Accessed August 18, 2008.

DeForest , D.K., K.V. Brix, and W.J. Adams. (1999). *Critical review of proposed residue-based selenium toxicity thresholds for freshwater fish*. Human and Ecological Risk Assessment 5:1187-1228.

Dennis, B. and M.R.M. Otten. (2000). *Joint effects of density dependence and rainfall on abundance of San Joaquin kit fox*. Journal of Wildlife Management 64: 388-400.

Dickert, C. (2002). *San Joaquin Valley giant garter snake project 2001*. California Department of Fish and Game, Los Banos, CA, 14 pp.

Dickert, C. (2003). *Progress report for the San Joaquin Valley giant garter snake conservation project-2003*. California Department of Fish and Game, Los Banos, CA, 37 pp.

Dickert, C. (2005). *Giant Garter Snake Surveys at Some Areas of Historic Occupation in the Grassland Ecological Area, Merced Co. and Mendota Wildlife Area, Fresno, Co., California.* California Fish and Game 91(4): 255-269.

Eason, C.T., L. Milne, M. Potts, G. Morriss, G.R.G. Wright, and O.R.W. Sutherland. (1999). *Secondary and tertiary poisoning risks associated with brodifacoum*. New Zealand Journal of Ecology 23:219-224.

Eason, C.T., G.R.G. Wright, L.M. Milne, and G.A. Morriss. (2001). *Laboratory and field studies of brodifacoum residues in relation to risk of exposure to wildlife and people*. Science of Conservation 177B:11-23.

Eason, C.T., E.C. Murphy, G.R.G. Wright, and E.B. Spurr. (2002). *Assessment of risks of brodifacoum to non-target birds and mammals in New Zealand*. Ecotoxicology 11:35-48.

EG&G. (1981). *Inventory of San Joaquin kit fox on BLM lands in the western San Joaquin Valley*. Final Report. February 1981. Prepared for the Bureau of Land Management through interagency agreement CA-910-IA0-7 with the Department of Energy, Nevada Operations Office, under Contract No. DE-AC08-76NVO1183.

Egoscue, H.J. (1962). *Ecology and life history of the kit fox in Tooele County, Utah*. Ecology. 43:481-497.

Engberg , A., D.W. Westcot, 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, Jr. and R.A. Engberg, eds. Marcel Dekker, Inc., NY.

Eppinger and Chilcott. (2002). *Review of Selenium Concentrations in Wetlands Water Supply Channels in the Grassland Watershed (Water Years 1999 and 2000)*. Staff Report of the California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region, Sacramento, CA, 31 pp. Available at: http://www.swrcb.ca.gov/rwqcb5/water_issues/water_quality_studies/SJR9900.pdf

Field, C.B., G.C. Daily, F.W. Davis, S. Gaines, P.A. Matson, J. Melack, and N.L. Miller. (1999). *Confronting climate change in California. Ecological impacts on the Golden State.* A report of the Union of Concerned Scientists, Cambridge, Massachusetts, and the Ecological Society of America, Washington, DC.

Field, C.B., M. Brklacich, D.L. Forbes, P. Kovacs, J.A. Patz, S.W. Running, and M.J. Scott. (2007). North America. Pages 617-652 *in* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, C.E. Hanson eds., *Climate change 2007: impacts, adaptation, and vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge, United Kingdom.

Fitch, H. S. (1940). *A biogeographical study of the ordinoides Artenkreis of garter snakes (genus Thamnophis). University of California Publications in Zoology* 44:1-150.

Fitch, H. S. (1941). *The feeding habits of California garter snakes.* Department of Fish & Game 27(2):2-32.

Foe, C. (November 14, 2005). *Methyl Mercury Concentration in Mud Slough, San Luis Drain, and Refuge Wetlands*. Letter from Central Valley Regional Water Quality Control Board, Rancho Cordova, CA, to T. C. Maurer, U.S. Fish and Wildlife Service, Sacramento, CA. 2 pp.

Fox, W. (1948). *The relationships of the garter snakes of the garter snake Thamnophis ordinoides.* Copeia 1948:113-120.

Frankham, R., and K. Rails. (1998). *Inbreeding leads to extinction*. Nature 241:441-442.

Germano, D.J., and D.F. Williams. (2005). *Population ecology of blunt-nosed leopard lizards in high elevation foothill habitat.* Journal of Herpetology 39:1-18.

Germano, D.J., G. B. Rathbun, and L. R. Saslaw. (2001). *Managing exotic grasses and conserving declining species.* Wildlife Society Bulletin 29:551-559.

Gerrard, R.P., Stine, R. Church, and M. Gilpin. (2001). *Habitat evaluation using GIS - A case study applied to the San Joaquin kit fox*. Landscape and Urban Planning 52:239-255.

Gillespie, R.B., and P.C. Baumann. (1986). *Effects of high tissue concentrations of selenium on reproduction by bluegills*. Trans. Am. Fish. Soc. 115:208–213.

Graham, R.V., B.G. Blaylock, F.O. Hoffman and M.L. Frank. (1992). *Comparison of selenomethionine and selenite cycling in freshwater experimental ponds*. Water Air Soil Pollut. 62:25-42.

Goldingay, R.L., P.A. Kelly, and D.F. Williams. (1997). *The kangaroo rats of California: endemism and conservation of keystone species*. Pacific Conservation Biology 3:47-60.

Golightly, R.T., and R.D. Ohmart. (1983). *Metabolism and body temperature of two desert canids: coyotes and kit foxes*. Journal of Mammalogy 64:624-635.

Grassland Area Farmers. (2005). *Grassland Bypass Project Floodwaters Report*. Report submitted by the Grassland Area Farmers, Los Banos, California, to USBR and the Central Valley Regional Water Quality Control Board, May 31, 2005. Eight page report and two page transmittal memo. Available as Attachment B starting on page 98 in the following document on web: http://www.usbr.gov/mp/grassland/documents/GBPTPRT2005report_mar02.pdf

Grinnell, J., J.S. Dixon, and J.M. Linsdale. (1937). *Fur-bearing mammals of California*. Bull. California State Comm. Hort. 7:597-708.

Haight R.G., and B. Cypher, P.A. Kelly, S. Phillips, H.P. Possingham, K. Ralls, A.M. Starfield, P.J. White, and D. Williams. (2002). *Optimizing habitat protection using demographic models of population viability*. Conservation Biology 16:1386-1397.

Hall, E.R. (1946). *Mammals of Nevada*. University of California Press, Berkeley, CA.

Hamilton S.J. (2003.) *Commentary: review of residue-based selenium toxicity thresholds for freshwater fish*. Ecotoxicol. Environ. Safety 56:201–210.

Hamilton, S.J. (2004). *Review of selenium toxicity in the aquatic food chain*. Science of the Total Environment 326:1–31.

Hammitt, W.E. and D. N. Cole. (1998). *Wildland recreation, ecology and management.* John Wiley and Sons, Inc. New York, NY.

Hansen, E.C. (2002). *Year 2001 Investigations of the Giant Garter Snake (Thamnophis gigas) in the Greater American Basin: Sutter County*. Prepared for Sacramento Area Flood Control Agency, Sacramento, CA, 18 pp. and appendices.

Hansen, E.C. (2004). *Year 2003 investigations of the giant garter snake (Thamnophis gigas) in the Middle American Basin: Sutter County, California.* Unpublished report prepared for Sacramento Area Flood Control Agency, Sacramento, CA, 40 pp.

Hansen, E.C. (2005). *Mortality of Giant Garter Snake (Thamnophis gigas) resulting from activities conducted pursuant to Permit TE-018177-2: Eric C. Hansen, permittee*. Letter to Linda Belluomini and Larry Host, USFWS Regional Office and USFWS Sacramento Fish and Wildlife Office, respectively, July 5, 2005. Consulting Environmental Biologist, Sacramento, CA, 1pp.

Hansen, E.C. (2006). *Year 2005 investigations of the giant garter snake (Thamnophis gigas) in the Middle American Basin: Sutter County, California*. Annual report prepared for Sacramento Area Flood Control Agency, Sacramento, CA, Contract No. 381, 40 pp.

Hansen, E.C. (2007). *Implementation of Priority 1 Recovery Tasks for the Giant Garter Snake (Thamnophis gigas) in Merced County, California*. Report prepared for the U.S. Fish and Wildlife Service pursuant to FWS Agreement No. 802706G120, Sacramento, CA.

Hansen, E.C. (2008a). *Implementation of Priority 1, Priority 2, and Priority 3 Recovery Tasks for Giant Garter Snake (Thamnophis gigas) – continuing Surveys in Merced County, California, with an Expansion to Northern Fresno County*. Prepared for the U.S. Fish and Wildlife Service pursuant to FWS Agreement No. 802707G112, Sacramento, CA, 108 pp.

Hansen, E.C. (2008b). *Report of Progress to Date for the project entitled Implementation of Priority 1, Priority 2, and Priority 3 Recovery Tasks for Giant Garter Snake (Thamnophis gigas) – Comparative pathology, health, and contaminant exposure within San Joaquin Valley and Sacramento Valley giant garter snake populations*. Prepared for the U.S. Bureau of Reclamation pursuant to BOR Agreement No. 08FG200042, Sacramento, CA, 13 pp.

Hansen, G. E. (1986). *Status of the giant garter snake Thamnophis couchi gigas (Fitch) in the Southern San Joaquin Valley During 1986*. Unpublished (final) report for California Department of Fish and Game, Standard Agreement No. C-1433. 31 pp.

Hansen, G.E. (1988). *Review of the status of the giant garter snake (Thamnophis couchi gigas) and its supporting habitat during 1986-1987*. Final report for California Department of Fish & Game Contract C-2060. Unpublished Report. 31 pp.

Hansen, G.E. (1995). *Recovery of the giant garter snake (Thamnophis gigas) and mitigation habitat within the Strawberry Creek enlargement and realignment project: Progress report #4 of 5.* Unpublished report prepared for LSA Associates, Inc., Point Richmond, CA, 4 pp.

Hansen, G.E. (1996). *Status of the giant garter snake (Thamnophis gigas) in the San Joaquin Valley in 1995.* Final report for the California Department of Fish and Game, Standard Agreement No. FG4052IF. Unpublished Report, 31 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 Report. 80-5:1-14.

Hansen, G.E. and J.M. Brode. (1993). *Results of relocating canal habitat of the giant garter snake (Thamnophis gigas) during widening of State Route 99/70 in Sacramento and Sutter counties, California*. Unpublished (final) report for Caltrans Interagency Agreement 03E325 (FG7550) (FY 87/88-91-92). Rancho Cordova, CA. March 3, 1993. 36 pp.

Hansen, R.B. (1988). *Porterville urban area boundary biotic survey*. Unpublished report, Hansen's Biological Consulting, Visalia, CA, 219 pp.

Hansen, R.W. (1980). *Western aquatic garter snakes in central California: an ecological and evolutionary perspective*. Masters thesis, Depart. Biology, Calif. State Univ., Fresno, CA, 78 pp.

Hansen, R.W. and G. E. Hansen. (1990). *Thamnophis gigas: Reproduction.* Herpetol. Rev. 21(4):93-94.

Hansen, S.R., and Morehardt, J.E. (1987). *Identification of potential substances of concern in agricultural drainage water from the San Joaquin Valley: a screening level analysis*. Prepared for the San Joaquin Valley Drainage Program, Sacramento, CA under EA Prop BAC 72A by E.A. Engineering Science, and Technology, Inc., Lafayette, CA.

Hansen, W., and P. Whiteley. (1990). *Mallard ducklings show decreased natural resistance to duck hepatitis virus following selenium exposure*. U.S. Department of Interior, Fish and Wildlife Service, National Wildlife Health Research Center, Research Information Bulletin No. 90-79, Madison, WI. 2 pp.

Harris, J. H. (2000). *Preliminary Assessment of Biological Resources Portions of Mercy Springs Water District.* Environmental Consulting, Oakland, CA, 11 pp.

Hawbecker, A.C. (1943). *Food of the San Joaquin kit fox*. Journal of Mammalogy 24:499.

Hedgal, P.L., and B.A. Colvin. (1988). *Potential hazard to eastern screech-owls and other raptors of brodifacoum bait used for vole control in orchards*. Environmental Toxicology and Chemistry 7:245-260.

Heinz, G.H. (1979). *Methylmercury: reproductive and behavioral effects on three generations of mallard ducks*. J. Wildl. Manage. 43:394-401.

Heinz, G.H. (1996). *Selenium in birds*. Pages 453-464 *in*: W.N. Beyer, G.H. Heinz, and A.W. Redmon, eds., Interpreting Environmental Contaminants in Animal Tissues. CRC Press, Lewis Publishers, Boca Raton, FL.

Heinz, G.H., D.J. Hoffman, A.J. Krynitsky, and D.M.G. Weller. (1987). *Reproduction in mallards fed selenium*. Environ. Toxicol. Chem. 6:423-433.

Heinz, G.H., D.J. Hoffman, and L.G. Gold. (1989). *Impaired reproduction of mallards fed an organic form of selenium*. J. Wildl. Manage. 53:418-428.

Herbel, M.J., T.J. Johnson, K.K. Tanji, S. Gao, and T.D. Bullen. (2002). *Selenium isotope ratios in California drainage water management systems.* Journal of Environmental Quality 31:1146-1156.

Hersteinsson, P. and D.W. Macdonald. (1982). *Interspecific competition and the geographical distribution of red and arctic foxes (Vulpes vulpes and Alopex lagopus).* Oikos 64:505-515.

Hieb, K., T. Greiner, and S. Slater. (2002). *San Francisco Bay species 2002 status and trends report*. IEP Newsletter 16:14-22.

Hinds, N.E.A. (1952). *Evolution of the California landscape*. California Division of Mines Bulletin No. 158. 240 pp.

Hopkins W.A., C.L. Rowe, and J.D. Congdon. (1999). *Increased maintenance costs and trace element concentrations in banded water snakes, Nerodia fasciata, exposed to coal combustion wastes*. Environ. Toxicol. Chem. 18:1258–1263.

Hopkins, W.A., J.H. Roe, J.W. Snodgrass, B.P. Staub, B.P. Jackson, and J.D. Congdon. (2002). *Effects of chronic dietary exposure to trace elements on banded water snakes (Nerodia fasciata).* Environ. Toxicol. & Chem. 21(5):906-913.

Hopkins, W.A., B.P. Staub, J.A. Baionno, B.P. Jackson, J.H. Roe, and N.B. Ford. (2004). *Trophic and maternal transfer of selenium in brown house snakes (Lamprophis fuliginosus).* Ecotoxicol. and Environ. Safety 58:285–293.

Hosea, R.C. (2000). *Exposure of non-target wildlife to anticoagulant rodenticides in California*. California Department of Fish and Game Pesticide Investigations Unit, Rancho Cordova, CA.

Howald, G.R., P. Mineau, J. E. Elliott, and K. M. Cheng. (1999). *Brodifacoum poisoning of avian scavengers during rat control on a seabird colony*. Ecotoxicology 8:431-447.

HT Harvey and Associates. (2004). *Habitat Conservation Plan for the San Joaquin kit fox at the Arnaudo Brothers, Wathern-Castanos, and River East Holdings sites within, and adjacent to, the Santa Nella Community Specific Plan area*. Prepared for Wathern-Castanos, Arnaudo Brothers, and River East Holdings June 14, 2004.

HT Harvey and Associates. (2007). Letter to Dennis Falaschi, Panoche Drainage District from Brian B. Boroski, HT Harvey and Associates, regarding response to questions raised by the U.S. Fish and Wildlife Service and the California Department of Fish and Game regarding the In-Valley Treatment / Drainage Reuse facility expansion. HT Harvey and Associates, Fresno, CA, 14 pp. July 10, 2007.

HT Harvey and Associates. (2009). *San Joaquin River Water Quality Improvement Project, Phase I Wildlife Monitoring Report 2008*. Prepared by HT Harvey and Associates, Fresno, CA for Panoche Drainage District, Firebaugh, CA, 73 pp.

Huffman, L., and T.D. Murphy. (1992). *The effects of rodenticide and off-road vehicle use on San Joaquin kit fox activity in Bakersfield, California*. Page 378 *In:* D. F., Williams, S. Byrne, and T. A. Rado (editors) Endangered and Sensitive Species of the San Joaquin Valley, California. California Energy Commission, Sacramento, CA.

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.

(IPCC) Intergovernmental Panel on Climate Change. (2007). *Climate change 2007: the physical science basis. Summary for policymakers*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC Secretariat, World Meteorological Organization and United Nations Environment Programme, Geneva, Switzerland.

Jackson, V.L., and J.R. Choate. (2000). Dens and den sites of the swift fox, Vulpes velox. The Southwestern Naturalist 45:212-220.

Jackson, W.B., and D.E. Kaukeinen. (1972). *The problem of anticoagulant rodenticide resistance in the United States*. Proceedings of the Fifth Vertebrate Pest Conference (1972):142-148.

Jensen, C.C. (1972). *San Joaquin kit fox distribution*. Unpublished Data. Report, U.S. Fish and Wildlife Service, Sacramento, CA, 18 pp.

Johnson, C.D., G.M. Santolo, D.R. Keegan. (1994). *San Joaquin kit fox crossing study Santa Nella, California: California aqueduct, Delta-Mendota Canal, San Luis Wasteway, and San Luis Dam* (Draft). Prepared for U. S. Bureau of Reclamation, Sacramento, CA, 14 pp.

Kato, T.T. (1986). *Survey of potential habitat for the endangered San Joaquin kit fox (Vulpes macrotis mutica) in the Carrizo Plain, San Luis Obispo County, CA.* Rep. No. EGG 10282-2124, EG&G Energy Measurements, Goleta, CA, 24 pp.

Kelly, A.E. and M.L. Goulden. (2008). *Rapid shifts in plant distribution with recent climate change.* Proceedings of the National Academy of Sciences 105:11823-11826.

Kelly, D. L. (2007). *Conservation Management of Two Populations of Western Pond Turtles (Emys marmorata) in Butte County, California*. MS Thesis, CSU Chico, CA, 98 pp.

Kelly, P.A., S.E. Phillips, and D.F. Williams. (2005). *Documenting ecological change in time and space: the San Joaquin Valley of California.* Pages 57-79 *In:* E.A. Lacy and P. Myers (editors), Mammalian diversification: from chromosomes to phylogeography (A celebration of the career of James L. Patton). University of California Press. Available on the internet at http://repositories.cdlib.org/ucpress/. Accessed October 24, 2008.

Knapp, D.K. (1978). *Effects of agricultural development in Kern County, California, on the San Joaquin kit fox in 1977.* California Department of Fish and Game, Nongame Wildlife Investigations Final Report, Project E-1-1,Jov V-1.21. 48pp. + app.

Koopman, M.E., B.L. Cypher, and J. H. Scrivner. (2000). *Dispersal patterns of San Joaquin kit foxes (Vulpes macrotis mutica).* Journal of Mammalogy 81:213-222.

Koopman, M.E., B.L. Cypher, and D.R. McCullough. (2001). *Factors influencing space and prey use by San Joaquin kit foxes*. Transactions of the Western Section of the Wildlife Society 37:77-83.

Lande, R. (1988). *Genetics and demography in biological conservation*. Science 241:1455-1460.

Laughrin, L. (1970). *San Joaquin kit fox: its distribution and abundance*. Wildlife Management Branch, Admin. Rep. No. 70-2, California Department of Fish and Game, Sacramento, CA, 20 pp.

Lemly, A.D. (1993). *Guidelines for evaluating selenium data from aquatic monitoring and assessment studies*. Environ. Monitor. Assess. 28:83-100.

Lemly. (1996a). *Selenium in aquatic organisms*. Pages 427-445 *in:* W.N. Beyer, G.H. Heinz, and A.W. Redmon eds., Environmental contaminants in wildlife: Interpreting tissue concentrations. CRC Press, Lewis Publishers, Boca Raton, FL.

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

Lemly, A.D. (1997). *Ecosystem recovery following selenium contamination in a freshwater reservoir*. Ecotoxicol. Environ. Safety 36:275-281.

Lemly, A.D. (2002). *Selenium Assessment in Aquatic Ecosystems: A Guide for Hazard Evaluation and Water Quality Criteria*. Springer Series on Environmental Management, D.E. Alexander, series editor. Springer-Verlag, New York, NY, 161 pp.

Lewis, J.C., K.L. Sallee, and R.T. Golightly, Jr. (1993). *Introduced red fox in California.* California Department of Fish and Game, Sacramento. Non-game bird and mammal section, Report 93-1:1-70.

Loarie, S.R., B.E. Carter, K. Hayhoe, S. McMahon, R. Moe, C.A. Knight, D.D. Ackerly. (2008). *Climate change and the future of California's endemic flora*. PLoS ONE 3: e2502. Available on the internet at http://www.plosone.org. Accessed on June 25, 2008.

Luoma, S.N., and T.S. Presser. (2009). *Emerging Opportunities in Management of Selenium Contamination*. Environ. Sci. & Technol. 43 (22): 8483–8487.

Macdonald, D.W., and D.R. Voigt. (1985). *The biological basis of rabies models.* Pages 71-108 *In* P.J. Bacon (editor), Population dynamics of rabies in wildlife. Academic Press, London, Great Britain.

Maier, K.J., C.R. Nelson, F.C. Bailey, S.J. Klaine, and A.W. Knight. (1998). *Accumulation of Selenium by the Aquatic Biota of a Watershed Treated with Seleniferous Fertilizer*. Bull. of Env. Contam. and Tox., Vol. 60(3):409-416.

Martin, P.F. (1988). *The toxic and teratogenic effects of selenium and boron on avian reproduction*. M.S. thesis, University of California, Davis, CA.

Matlack, R. S., P. S. Gipson, and D. W. Kaufman. (2000). *The swift fox in rangeland and cropland in western Kansas: relative abundance, mortality, and body size*. The Southwestern Naturalist 45(2):221-225.

McCue, P.M., and T.P. O'Farrell. (1988). *Serological survey for selected diseases in the endangered San Joaquin kit fox* (*Vulpes macrotis mutica*). Journal of Wildlife Diseases 24:274-281.

McCue, P.M., T. Kato, M.L. Sauls, T.P. O-Farrell. (1981). *Inventory of San Joaquin kit fox on land proposed as Phase II. Kesterson Reservoir, Merced County, California.* Topical Report EGG 1183-2426, EG&G, Santa Barbara Operations, U.S. Department of Energy, Goleta, CA.

McGrew, J.C. (1979). *San Joaquin Kit Fox Vulpes macrotis*. Mammalian species 123:1-6.

McHugh, P. (2004). *Lake enlargement bid enrages some*. San Francisco Chronicle. March 18, 2004. San Francisco, CA.

McLaughlin, J.F., J.J. Hellmann, C.L. Boggs, P.R. Ehrlich. (2002). *Climate change hastens populations extinctions*. Proceedings of the National Academy of Sciences 99: 6070-6074.

McLaughlin, T. (2006). *Sediment Monitoring in the San Luis Drain, Mud and Salt Sloughs, January 1, 2004 - December 31, 2005.* Pages 209-226 *in* Grassland Bypass Project 2004-2005. Prepared by the San Francisco Estuary Institute, Oakland, CA.

McMillin, S.C., R.C. Hosea, B.F. Finlayson, B.L. Cypher, and A. Mekebri. (In review). *Anticoagulant rodenticide exposure in an urban population of the San Joaquin kit fox.*

Moonjian, J. (2007). *A current distribution and a dietary analysis of San Joaquin kit fox in San Luis Obispo County.* Master's Thesis. California Polytechnic State University. San Luis Obispo, CA.

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: Sections 1-3. Prepared by the San Joaquin Valley Drainage Program, Sacramento, CA.

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

Morrell, S.H. (1975). *San Joaquin kit fox distribution and abundance in 1975*. California Department of Fish and Game, Wildlife Management Branch Administrative Report No.

75-3, in fulfillment of contracts W-54-R-7-1 with the Service and Contract 3904 with the California Department of Food and Agriculture.

Moser, S., G. Franco, S. Pittiglio, W. Chou, D. Cayan. (2009). *The future is now: an update on climate change science impacts and response options for California.* California Energy Commission, PIER Energy-Related Environmental Research Program. CEC-500-2008-071. Available on the internet at http://www.energy.ca.gov/2008publications/CEC-500-2008-071/CEC-500-2008-071.PDF. Accessed June 4, 2009.

Mount, M.E., and B.F. Feldman. (1983). *Mechanism of diphacinone rodenticide toxicosis in the dog and its therapeutic implications*. American Journal of Veterinary Research 44:2009-2017.

Munday, J.S., and L.J. Thompson. (2003). *Brodifacoum toxicosis in two neonatal puppies*. Veterinary Pathology 40:216-219.

Nassos, P.A., J.R. Coats, R.L. Metcalf, D.D. Brown and L.G. Hansen. (1980). *Model ecosystem, toxicity, and uptake evaluation of 75Se-selenium*. Bull. Environ. Contam. Toxicol. 24:752-758.

Nelson, J.L., B.L. Cypher, C.D. Bjurlin, and S. Creel. (2007). *Effects of habitat on competition between kit foxes and coyotes*. Journal of Wildlife Management 71:1467-1475.

O'Farrell, T.P. (1984). *Conservation of the endangered San Joaquin kit fox (Vulpes macrotis mutica) on the Naval Petroleum Reserves, California*. Acta Zool. Fennica 172:207-208.

O'Farrell, T.P. and L. Gilbertson. (1979). *Ecological life history of the desert kit fox in the Mojave desert of southern California*. Final Report. U.S. BLM, Desert Plan Staff, Riverside, CA.

O'Farrell, T.P., and P. McCue. (1981). *Inventory of San Joaquin kit fox on Bureau of Land Management lands in the western San Joaquin Valley.* Final report. EG&G. U.S. Department of Energy, Goleta, CA, EGG-1183-2416.

O'Farrell, T.P., T. Kato, P. McCue, and M.L. Sauls. (1980). *Inventory of the San Joaquin kit fox on BLM lands in southern and southwestern San Joaquin Valley*. Final Report, EGG 1183-2400, EG&G, Santa Barbara Operations, U.S. Department of Energy, Goleta, CA.

Ohlendorf, H. M. and R. L. Hothem. (1995). *Agricultural drainwater effects on wildlife in Central California*. Pages 577-595 *In:* Hoffman, D. J., B. A. Rattner, G. A. Burton, Jr., and J. Cairns, Jr. (eds.), *Handbook of Ecotoxicology*. Lewis Publishers, Inc., Boca Raton, FL.

Ohlendorf, H.M., D.J. Hoffman, M.K. Saiki, and T.W. Aldrich. (1986). *Embryonic mortality and abnormalities of aquatic birds: Apparent impacts of selenium from irrigation drainwater*. Sci. Total Environ., 52: 49-63.

O'Neill, S. (2004). *Toxic prey: Poison targeting the rodent population is turning up in their predators.* Los Angeles Times. April 13, 2004.

Orloff, S.G. (2002). Chapter 9: Medium to Large Mammals. Pages 337 – 383 *In* J. E. Vollmar (editor), *Wildlife and rare plant ecology of Eastern Merced County's vernal pool grasslands*. Vollmar Consulting, Berkeley, CA.

Orloff, S.G., F. Hall, and L. Spiegel. (1986). *Distribution and habitat requirements of the San Joaquin kit fox in the northern extreme of their range*. Transcripts from the Western Section of the Wildlife Society 22:60-70.

O'Toole, D. and M.F. Raisbeck. (1998). *Magic numbers, elusive lesions: Comparative pathology and toxicology of selenosis in watefowl and mammalian species*. Pages 355-395 *In:* W.T. Frankenberger, Jr., and R.A. Enberg (editors), Environmental chemistry of selenium. Marcel Dekker Inc., New York, NY.

Padgett, S.L., J.E. Stokes, R.L. Tucker, and L.G. Wheaton (1998). *Hematometra secondary to anticoagulant rodenticide toxicity.* Journal of the American Animal Hospital Association 34:437-439.

Paquin, M.M., G.D. Wylie, and E.J. Routman. (2006). *Population Structure of the Giant Garter Snake, Thamnophis gigas*. Conservation Genetics, 7(1): 25-36.

Paveglio, F.L. and S.D. Clifton. (1988). *Selenium accumulation by San Joaquin kit foxes and coyotes in the Kesterson National Wildlife Refuge area*. Unpublished report prepared for the U.S. Bureau of Reclamation, Mid-Pacific Region. 2800 Cottage Way, Sacramento, California by the U.S. Fish and Wildlife Service, Los Banos, CA, 62 pp.

Paveglio, F.L., and K.M. Kilbride. (2007). *Selenium in Aquatic Birds from Central California*. J. Wildl. Manage. 71(8): 2550-2555.

Pierson, F.W., R.R. Thomasson, and J.E. Chilcott. (1987). *Investigation of Check Drains Discharging into the Delta-Mendota Canal*. Central Valley Regional Water Quality Control Board, Agricultural Unit, Sacramento, CA, 26pp.

Presser, T.S. and S. N. Luoma. (2006). *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, 196 pp. Available at: http://pubs.usgs.gov/pp/p1646/

Ralls, K., and P.J. White. (1995). *Predation on San Joaquin kit foxes by larger canids.* Journal of Mammalogy 76:723-729.

Ralls, K., P.J. White, J. Cochram, and D.B. Siniff. (1990). *Kit fox – coyotes relationships in the Carrizo Plain Natural Area.* Annual report to the U.S. Fish and Wildlife Service. Department of Zoological Research, Smithsonian Institution, Washington, D.C.

Ralls, K., B. Cypher, and L.K. Speigel. (2007). *Social monogamy in kit foxes: formation, association, duration, and dissolution of mated pairs.* Journal of Mammology 88:1439-1446.

Ramey, C.A., G.H. Matschke, and R.E. Engeman. (2007). *Chlorophacinone baiting for Belding's ground squirrels*. Pages 526-537 *In*: D.L. Nolte, W.M. Arjo, and D.H. Stalman, Eds. Proceedings of the 12th Wildlife Damage Management Conference. 2007. Available online at http://digitalcommons.unl.edu/icwdm_usdanwrc/772. Accessed December 4, 2008.

Rathbun, G.B., E. Cypher, S. Fitton, D.J. Germano, and L.R. Saslaw. (1998). *Effects of livestock grazing on a community of species at risk of extinction in the San Joaquin Valley, California.* 1998 Annual Report. The Lokern Grazing Study Project. Bureau of Land Management, Bakersfield, CA, http://www.csub.edu/~dgermano/GrazingWebSite.htm

Reilly, K., and D. Mangiamele. (1992). *California rabies surveillance. 1991.* California Veterinarian 46:47-51.

Rhian, M., and A.L. Moxon. (1943). *Chronic selenium poisoning in dogs and its prevention by arsenic.* Journal of Pharmacology and Experimental Therapeutics. 78:249-264.

Roe, J.H., W.A. Hopkins, J.A. Baionno, B.P. Staub, C.L. Rowe, and B.P Jackson. (2004). *Maternal transfer of selenium in Alligator Mississippiensis nesting downstream from a coal-burning power plant*. Environ. Toxicol. & Chem., 23(8)1969–1972.

Root, R.P. and J.J. Eliason. (2001). *Results of radio telemetry study of San Joaquin kit foxes at Camp Roberts National Guard Training Site, California*. Program and Abstracts, National Military Fish and Wildlife Association Conference, Washington D.C. March 19 – 24, 2001.

Rossman, D.A., N.B. Ford, and R.A. Seigel. (1996). *The Garter Snakes: Evolution and Ecology*. University of Oklahoma Press, Norman, OK, 331 pp.

Rossman, D.A. and G.R. Stewart. (1987). *Taxonomic reevaluation of Thamnophis couchii (Serpentes: Colubridae).* Occasional Papers of the Museum of Zoology, Louisiana State University 63:1-25.

Rubial, R. (1959). *The Ecology of a Brackish Water Population of Rana pipiens*. Copeia, (4):315-322, 1959.

Rubial, R. (1962). *The Ecology and Genetics of a Desert Population of Rana pipiens*. Copeia, (1): 189-195, 1962.

Saccheri, I., M. Kuussaari, M. Kankare, P. Vikman, W. Fortelius, and I. Hanski. (1998). *Inbreeding and extinction in a butterfly population*. Nature 392:491-494.

Saiki, M. K. (1998). *An ecological assessment of the Grassland Bypass Project on fishes inhabiting the Grassland Water District, California*. Unpublished report by the U.S. Fish and Wildlife Service, Sacramento, CA.

Saiki, M.K., M.R. Jennings, and R.H. Wiedmeyer. (1992). *Toxicity of agricultural subsurface drainwater from the San Joaquin Valley, California, to juvenile chinook salmon and striped bass*. Trans. Amer. Fish. Soc., 121: 78-93.

Salmon, T.P., D.A. Whisson, R. Berentsen, W.P. Gorenzel. (2007). Comparison of 0.005% and 0.01% diphacinone and chlorophacinone baits for controlling California ground squirrels (*Spermophilus beecheyi*). Wildlife Research 34:14-18.

Schultz, L.J., and L.R. Bairett. (1991). *Controlling rabies in California 1990*. California Veterinarian 45:36-40.

Schwartz, M.K., K. Ralls, D.F. Williams, B.L. Cypher, K.L. Pilgrim, and R.C. Fleisher. (2005). *Gene flow among San Joaquin kit fox populations in a severely changed ecosystem.* Conservation Genetics 6:25-37.

Scrivner, J.H., T.P. O'Farrell, T.T. Kato, and M.K. Johnson. (1987a). *Diet of the San Joaquin kit fox, Vulpes macrotis mutica, on Naval Petroleum Reserve #1, Kern County, California, 1980-1984*. Report Number. EGG 10282-2168, EG&G Energy Measurements, Goleta, CA, 26 pp.

Scrivner, J.H., T.P. O'Farrell, and T. Kato. (1987b). *Dispersal of San Joaquin kit foxes, Vulpes macrotis mutica, on Naval Petroleum Reserve #1, Kern County, California.* EG&G, Goleta, CA. EGG 10282-2190.

Scrivner, J.H., T.P. O'Farrell, and K.L. Hammer. (1993). Summary and evaluation of the kit fox relocation program, Naval Petroleum Reserve #1, Kern County, California. U.S. Department of Energy Topical Report, EG&F/EM Santa Barbara Operations Report No. EGG 10282-2168, Goleta, CA, 26 pp.

Seiler, R.L., Skorupa, J.P., Naftz, D.L. and Nolan, B.T. (2003). *Irrigation-induced contamination of water, sediment, and biota in the western United States—synthesis of data from the National Irrigation Water Quality Program*. U. S. Geological Survey Professional Paper 1655, Carson City, NV, 123 pp. Available at: http://pubs.usgs.gov/pp/pp1655/

Shepard, S. (2007). *Shrinking space, more vehicles squeeze off-road recreation*. The Bakersfield Californian. Available online at http://www.bakersfield.com/102/story/155886.html. Accessed May 29, 2008.

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 and R.A. Engberg (eds.), Environmental Chemistry of Selenium. Marcel Dekker, New York, NY. Available at: http://wwwrcamnl.wr.usgs.gov/Selenium/Library.htm

Skorupa, J.P. and H.M. Ohlendorf. (1991). *Contaminants in drainage water and avian risk thresholds*. Chapter 18 *in* the Economics and Management of Water and Drainage in Agriculture. A. Dinar and D. Zilberman eds. Kluwer Academic Publishers.

[SLDMWA] San Luis and Delta-Mendota Water Authority. (1997). *Report on waste discharge: Grasslands Bypass Channel Project, Merced and Fresno counties.* Report submitted to the California Regional Water Quality Control Board, Central Valley Region.

Sloan, J. (2005). *Progress report for the San Joaquin Valley giant garter snake conservation project – 2004*. Unpublished Report. California Department of Fish and Game, Los Banos, CA, 29pp.

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.

Smith, D.A., K. Rawls, B.L. Cypher, and J.E. Maldonado. (2005). *Assessment of scat-detection dog surveys to determine kit fox distribution.* Wildlife Society Bulletin 33:897-904.

Smith, D.A., K. Ralls, B.L. Cypher, H.O. Clark, P.A. Kelly, D.F. Williams, and J.E. Maldonado. (2006). *Relative abundance of endangered San Joaquin kit foxes (Vulpes macrotis mutica) based on scat-detection dog surveys*. The Southwestern Naturalist 51: 210-219.

Sparks, J. (2000). *San Joaquin Valley Giant Garter Snake Project 2000.* Unpublished Report, California Department of Fish and Game, Los Banos, CA.

Spencer, K.A., W.H. Berry, W.G. Standley, and T.P. O'Farrell. (1992). *Reproduction of the San Joaquin kit fox on Camp Roberts Army National Guard Training site, California.* U.S. Department of Energy Topical Report EGG 10617-2154.

Spiegel, L.K. (1996). *Studies of San Joaquin kit fox in undeveloped and oil-developed areas: an overview*. Pages 1- 14 *In* L.K. Spiegel (editor), Studies of the San Joaquin kit fox in undeveloped and oil-developed areas. California Energy Commission, Sacramento, CA.

Spiegel, L.K., and M. Disney. (1996). *Mortality sources and survival rates of San Joaquin kit foxes in oil-developed and undeveloped lands of southwestern Kern County, California.* Pages 71-92 *In* L.K. Spiegel (editor), Studies of the San Joaquin kit fox in undeveloped and oil-developed areas. California Energy Commission, Sacramento, CA.

Spiegel, L.K., and M. Small. (1996). *Estimation of relative abundance of San Joaquin kit foxes between an undeveloped site and an oil-developed site in Kern County, California.* Pages 115-123 *In* L.K. Spiegel (editor), Studies of the San Joaquin kit fox in undeveloped and oil-developed areas. California Energy Commission, Sacramento, CA..

Spiegel, L.K., and J. Tom. (1996). *Reproduction of San Joaquin kit fox undeveloped and oil-developed habitats of Kern County, California.* Pages 53-69 *In* L.K. Spiegel (editor), Studies of the San Joaquin kit fox in undeveloped and oil-developed areas. California Energy Commission, Sacramento, CA.

Spiegel, L.K., B.L. Cypher, and T. Dao. (1996). *Diet of the San Joaquin kit fox at three sites in western Kern County*. Pages 39-50 *In* L.K. Spiegel (editor), Studies of the San Joaquin kit fox in undeveloped and oil-developed areas. California Energy Commission, Sacramento, CA.

Standley, W.G., and P.M. McCue. (1992). *Blood characteristics of San Joaquin kit fox (Vulpes velox macrotis) at Camp Roberts Army National Guard Training Site, California.* U. S. Department of Energy Topical Report, EG&G/EM Santa Barbara Operations Report No. EGG 10617-2160.

Standley, W.G., W.H. Berry, T.P. O'Farrell, and T.T. Kato. (1992). *Mortality of San Joaquin kit fox (Vulpes macrotis mutica) at Camp Roberts Army National Guard Training Site, California.* U. S. Department of Energy Topical Report, EG&G/EM Santa Barbara Operations Report No. EGG 10617-2157.

Stanley, T.R., Jr., G.J. Smith, D.J. Hoffman, F.H. Heinz, and R. Rosscoe. (1996). *Effects of boron and selenium on mallard reproduction and duckling growth and survivial*. Environ. Toxicol. Chem. 16:1124-1132.

Area Manager, U.S. Bureau of Reclamation

Stephenson, M., C. Foe, G.A. Gill, and K.H. Coale. (2005). *Transport, Cycling, and Fate of Mercury and Monomethyl Mercury in the San Francisco Delta and Tributaries: An Integrated Mass Balance Assessment Approach*. Project Highlight Report, Submitted to: C. Kelly, and D. Podger, California Bay Delta Authority, Sacramento, CA, 12 pp. Available at: http://www.delta.dfg.ca.gov/erp/docs/wq_mercuryissues/Transport_Cycling.pdf

Stitt, E., P. Balfour, T. Luckau, and T.E. Edwards. (2005). *The Southern Watersnake (Nerodia fasciata) in Folsom, California: History, Population Attributes, and Relation to Other Introduced Watersnakes in North America*. Final Report to U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, 2800 Cottage Way, Sacramento, California under Cooperative Agreement #11420-1933-CM02 by ECORP Consulting, Inc. April 11, 2005. 72 pp. and Appendices.

Stone, W.B., J.C. Okoniewski, and J.R. Stedelin. (1999). *Poisoning of wildlife with anticoagulant rodenticides in New York*. Journal of Wildlife Diseases 35:187-193.

Stuart, J.N., M.L. Watson, T.L. Brown, and C. Eustice. (2001). *Plastic netting: An entanglement hazard to snakes and other wildlife.* Herpetological Review 32(3): 162-164.

Swick, C.D. (1973). *Determination of San Joaquin kit fox range in Contra Costa, Alameda, San Joaquin, and Tulare Counties, 1973*. Special Wildlife Investigations Project W-54-R-4. California Department of Fish and Game. Sacramento, CA, 15 pp.

[SWRCB] California State Water Resources Control Board. (2000). *Revised Water Right Decision 1641*. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, CA. March 15, 2000. Available on the internet at: http://www.waterrights.ca.gov/hearings/Decisions/WRD1641.PDF. Accessed March 31, 2009.

[SWRCB] California State Water Resources Control Board. (2007). *EPA Approved 2006 Revision of the Clean Water Act Section 303(d) List of Water Quality Limited Segments.* SWRCB Division of Water Quality, Sacramento, CA. Available at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/303d_lists2006_epa.shtml

Teitz, M.B., C. Dielzel, W. Fulton. (2005). *Urban development futures in the San Joaquin Valley*. Public Policy Institute of California, San Francisco, CA.

Timm, R.M., D.L. Schnabel, T.P. Salmon, W.P. Gorenzel, N. Dechoretz, and M. Meyers. (2004). *California's rodenticide surcharge program: history and accomplishments.* Proceedings of the 21st Vertebrate Pest Conference, University of California, Davis, 2004:350-356.

University of California. (2009). *Ground Squirrel BMP: Best Management Practices for California Ground Squirrel Control*. University of California Agricultural and Natural Resources. The Regents of the University of California. Available on the internet at http://groups.ucanr.org/GSBMP. Accessed January 12, 2009.

Unrine, J.M., W.A. Hopkins, C. S. Romanek, and B.P. Jackson. (2007). *Bioaccumulation of trace elements in omnivorous amphibian larvae: Implications for amphibian health and contaminant transport*. Environ. Pollut. 149:182-192.

Unrine, J.M., B.P. Jackson, W.A. Hopkins, and C. Romanek. (2006). *Isolation and partial characterization of proteins involved in maternal transfer of selenium in western fence lizard (Sceloporus occidentalis)*. Environ. Toxicol. & Chem. 25(7): 1864–1867.

URS Corporation. (2007). *Mitigated Negative Declaration and Initial Study for San Joaquin River Water Quality Improvement Project Phase I, Part 2*. Prepared for Panoche Drainage District.

[USBLM] U.S. Bureau of Land Management. (1984). Hollister Resource Management Plan. U.S. Bureau of Land Management, Hollister Field Office, CA.

[USBLM] U.S. Bureau of Land Management. (1997). Caliente Resource Management Plan. Bureau of Land Management, Bakersfield Field Office, CA.

[USBLM] Bureau of Land Management. (2002). Decision record for the control of curly top virus on public lands in California 2002 – 2006. March 11, 2002.

[USBLM] Bureau of Land Management. (2008a). News Release: BLM plans oil and gas competitive lease auction. 10-27-08. Available on the internet at http://www.blm.gov/ca/st/en/info/newsroom/2008/october/CC0905_December_lease_auction.html. Accessed November 10, 2008.

[USBLM] Bureau of Land Management. (2008b). Notice of Competitive Lease Sale, oil and gas. April 25, 2008. California State Office, Sacramento, CA. Available on the internet at: http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/pa/energy/minerals.Par.69568.File.dat/6-11-08%20SALE_NOTICE.pdf. Accessed November 10, 2008.

[USBLM] Bureau of Land Management. (2008c). Notice: Amendment to the oil and gas lease sale notice dated April/25/2008; for the June 11, 2008 competitive oil and gas sale. May 8, 2008. Available on the internet at: http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/pa/energy/minerals.Par.73470.File.dat/June%2011,%202008_amendednotice.pdf. Accessed November 10, 2008.

Area Manager, U.S. Bureau of Reclamation 182

[USBLM] Bureau of Land Management. (2008d). Notice: Amendment to the oil and gas lease sale notice dated April/25/2008; for the June 11, 2008 competitive oil and gas sale. June 6, 2008. Available on the internet at: http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/pa/energy/minerals.Par.18494.File.dat/June%2011,%202008_amendednotice4.pdf. Accessed November 10, 2008.

[USBLM] Bureau of Land Management. (2008e). Notice of competitive lease sale, oil and gas. July 25, 2008. California State Office, Sacramento, CA. Available on the internet at http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/pa/energy/minerals.Par.63602.File.dat/Sept-08_Salenotice.pdf. Accessed November 10, 2008.

[USBLM] Bureau of Land Management. (2008f). Notice of competitive lease sale, oil and gas. October 24, 2008. California State Office, Sacramento, CA. Available on the internet at http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/pa/energy/minerals.Par.93714.File.dat/Salenotice_Dec.08.pdf. Accessed November 10, 2008.

[USBLM] Bureau of Land Management. (2008g). Caliente Resource Management Plan Revision. Available on the internet at: http://www.blm.gov/ca/st/en/fo/bakersfield/Programs/planning/caliente_rmp_revision.html. Accessed November 10, 2008.

[USBLM] Bureau of Land Management. (2008h). Letter from BLM to Vintage Production California LLC, re: oil exploration activity in the Carrizo Plains National Monument. BLM File 3150 (P) CA-160.85. March 11, 2008.

[USBLM] Bureau of Land Management. (2008i). Oil and Gas, Bureau of Land Management California webpage. Updated on November 24, 2008. Available on the internet at http://www.blm.gov/ca/st/en/prog/energy/og.htmal. Accessed November 29, 2008.

[USBLM] Bureau of Land Management. (2008j). Environmental Assessment (EA) for oil and gas competitive leasing certain parcels within the Bakersfield Field Office, March 12, 2008. EA No. CA-160-07-143. U.S. BLM. Available on the internet at http://www.blm.gov/pgdata/etc/medialis/blm/ca/pdf/bakersfield/minerals.Par.88054.fiel.dat/EA-CA-160-07-143_draft.pdf. Accessed November 10, 2008.

[USBR] U.S. Bureau of Reclamation. (2002). *Selenium in the Delta-Mendota Canal 1987 – 2001*. U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, CA, 8 pp. and 3 appendices.

[USBR] U.S. Bureau of Reclamation. (2004a). *Water Transfer Program for the San Joaquin River Exchange Contractors Water Authority 2005-2014 Final Environmental Impact Statement/Environmental Impact Report*. Prepared for USBR Mid-Pacific Region, Sacramento and Fresno, and the San Joaquin River Exchange Contractors Water Authority by URS Corporation, Oakland, CA. 17 sections and 5 appendices.

[USBR] U.S. Bureau of Reclamation. (2004b). *Consolidated Place Use Habitat Management Plan and Mitigation Reporting Program.* Submitted to the State Water Resources Control Board for Review and Approval, October 2004. U.S. Bureau of Reclamation. Mid-Pacific Region. Sacramento, CA.

[USBR] U.S. Bureau of Reclamation. September (2005a). *Draft Environmental Impact Statement, San Luis Unit Long Term Contract Renewal.* U.S. Bureau of Reclamation, South Central California Office, Fresno, CA. 5 chapters and 6 Appendices. Available at: http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=63

[USBR] U.S. Bureau of Reclamation (2005b). *Final Environmental Assessment and Finding of No Significant Impact on the Meyers Farm Water Banking Project*. FONSI-05-09. U.S. Bureau of Reclamation, Soutch Central California Office, Fresno, CA, 50pp.

[USBR] U.S. Bureau of Reclamation. February 15, (2008). *Delta-Mendota Canal Water Quality Monitoring Program Monthly Report of Flows, Concentrations, and Loads, December 2007*. Reports distributed monthly via e-mail by Chris Eacock, USBR, Mid-Pacific Region, South Central California Office, Fresno, CA, 22 pp.

[USBR] U.S. Bureau of Reclamation. (2009). *Biological Assessment Grassland Bypass Project, 2010 – 2019, Merced and Fresno Counties, California.* U.S. Bureau of Reclamation, South Central California Office, Fresno, CA, 248 pp. and appendices.

[USBR and SJRECWA] U.S. Bureau of Reclamation and the San Joaquin River Exchange Contractors Water Authority. (2007). *Final Environmental Assessment/Initial Study, Groundwater Pumping/Water Transfer Project for 25 Consecutive Years.* U.S. Bureau of Reclamation, Sacramento and Fresno, CA and the San Joaquin River Exchange Contractors Water Authority, Los Banos, CA. 7 sections. Available at: http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=2771

[USBR *et al.*] United States Bureau of Reclamation, Central Valley Regional Water Quality Control Board, U.S. Fish and Wildlife Service, California Department of Fish and Game, San Luis & Delta-Mendota Water Authority, U.S. Environmental Protection Agency, and U.S. Geological Survey. (September 2001 to June 2006). *Grassland Bypass Project Monthly Reports*. U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, CA. Compiled and distributed by San Francisco Estuary Institute and available at: http://www.sfei.org/grassland/reports/gbppdfs.htm

[USBR *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*. San Francisco Estuary Institute, Oakland, CA.

[USBR *et al.*] U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, California Department of Fish and Game, and the Grassland Water District. (2001). Final Environmental Assessment and CEQA Initial Studies for Refuge Water Supply Long-Term Water Supply Agreements, San Joaquin River Basin. U.S. Bureau of Reclamation, Sacramento, CA.

U. S. Census Bureau. 2008. State & County QuickFacts: Los Banos, CA. Available on the internet at: http://quickfacts.census.gov/gfd/states/06/0644028.html. Accessed November 7, 2008.

[USDA] U.S. Department of Agriculture. (2007). *Biological Assessment USDA Animal and Plant Health Inspection Service, California Wildlife Services Program, Part II Integrated wildlife damage management to protect livestock, property, human health and safety, and natural resources in the State of California*. USDA APHIS-WS, Sacramento, CA. July 8, 2004, amended February 7, 2007.

[USDOI] U.S. Department of the Interior. (1994). *The Impact of Federal Programs on Wetlands, Vol. II.* A Report to Congress by the Secretary of the Interior. Washington, D.C.

[USDOI] 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 pp. Available at: http://www.usbr.gov/niwqp/guidelines/index.html

[USDOD] U.S. Department of Defense. (2008). *Fort Hunter Liggett Hunting and Fishing Program, training area availability*. Environmental Division. Available on the internet at http://www.liggett.army.mil/sites/fishhunt/. Accessed October 28, 2008.

[USEPA] U. S. Environmental Protection Agency. (2005). Federal Register 70: 75481-75482. December 20, 2005.

[USEPA] U. S. Environmental Protection Agency. (2008). *Risk mitigation decision for ten rodenticides May 28, 2008 (revised June 24, 2008)*. Office of Prevention, Pesticides, and Toxic Substances, U. S. EPA, Washington D.C.

[USFWS] U.S. Fish and Wildlife Service. (1967). *Native fish and wildlife. Endangered species.* Federal Register 32:4001. [Includes blunt-nosed leopard lizard and San Joaquin kit fox].

[USFWS] U.S. Fish and Wildlife Service. (1980). *Blunt-nosed leopard lizard recovery plan.* Portland, OR, 62 pp.

[USFWS] U.S. Fish and Wildlife Service. (1983). *The San Joaquin Kit Fox Recovery Plan.* Prepared by Dr. Thomas O'Farrell under interagency contract DE-ACOB-76NV01183 with the U.S. Department of Energy for U.S. Fish and Wildlife Service, Portland, OR 90 pp.

[USFWS] U.S. Fish and Wildlife Service. (1991). *Endangered and threatened wildlife and plants; proposed endangered status for the giant garter snake, proposed rule.* Federal Register 56:67046-67053.

[USFWS] U.S. Fish and Wildlife Service. (1992). *Re-initiation of the February 28, 1979, formal consultation with the United States Department of Agriculture (USDA) on its Animal Damage Control (ADC) Program as required under section 7 of the Endangered Species Act of 1973*. U. S. Fish and Wildlife Service, Director of the Fish and Wildlife Service, Washington D.C. July 28, 1992. Provided by the USDA APHIS-WS, Sacramento, California, based on its inclusion in USDA 2007.

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

[USFWS] U.S. Fish and Wildlife Service. (1993b). *Effects of 16 vertebrate control agents on threatened and endangered species*. U.S. Fish and Wildlife Service, Endangered Species Program, Arlington, VA. March 1993. 177 pp.

[USFWS] U.S. Fish and Wildlife Service. (1995). *Biological opinion for the reinitiation of formal consultation concerning oil production at the maximum efficient rate on Elk Hills Naval Petroleum Reserve, Kern County, California*. Service File # 1-1-95-F-102. Sacramento, CA.

[USFWS] U.S. Fish and Wildlife Service. (1997). *Intra-Service biological and conference opinion on issuance of an incidental take permit to Kern Water Bank Authority, for the development, operation, and maintenance of the Kern Water Bank and the Kern Water Conservation Bank, Kern County, California.* Service File # 1-1-97-F-108. U.S. Fish and Wildlife Service, Sacramento, CA.

[USFWS] (1998) U.S. Fish and Wildlife Service. (1998). *Recovery plan for upland species of the San Joaquin Valley, California.* U.S. Fish and Wildlife Service, Region 1, Portland, OR. 319 pp.

[USFWS] U.S. Fish and Wildlife Service. (1999). *Draft recovery plan for the giant garter snake (Thamnophis gigas).* U.S. Fish and Wildlife Service, Portland, OR. 192 pp.

[USFWS] U.S. Fish and Wildlife Service. (2000a). *Biological Opinion for the Interim Water Contract Renewal, Ref. No. 1-1-00-F-0056*. February 29, 2000. U.S. Fish and Wildlife Service, Sacramento, CA.

[USFWS] U.S. Fish and Wildlife Service. (2000b). *Impacts of Riprapping to Ecosystem Functioning, Lower Sacramento River, Californa*. Prepared for the U.S. Corps of Engineers, Sacramento District by the U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, to address impacts of the Sacramento River Bank Protection Project, Contracts 42E and 42F, Sacramento, CA, 40 pp.

[USFWS] U.S. Fish and Wildlife Service. (2001). *Biological opinion on the Bureau of Land Management Oil and Gas Programmatic for Kings and Kern Counties, California.* Service File # 1-1-01-F-0063. Sacramento, CA.

[USFWS] U.S. Fish and Wildlife Service. (2003). *Amendment to the section 7 biological opinion on the Bureau of Land Management Programmatic (1-1-01-F-0063) to include NPR-2, Kern County, California*. USFWS File # 1-1-03-F-0295. Sacramento, CA.

[USFWS] U.S. Fish and Wildlife Service. (2005). Comments on *Potential Risks of Nine Rodenticides to Birds and Nontarget Mammals: A Comparative Approach.* Letter to K. White, Office of Pesticide Programs, U.S. EPA, Washington DC, from E. Wilson, Chief Division of Environmental Quality, USFWS, Arlington VA, 6 pp.

[USFWS] U.S. Fish and Wildlife Service. (2006a). *Giant Garter Snake (Thamnophis gigas) 5-Year Review: Summary and Evaluation.* U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, CA, 46 pp.

[USFWS] U.S. Fish and Wildlife Service. (2006b). Service memorandum providing concurrence with the determination that the San Joaquin River Exchange Contractors Water Authority Water Transfer Program may affect but is not likely to adversely affect the threatened giant garter snake (*Thamnophis gigas*) for the 2006 water year. Service File No. 06-I-1131. Memorandum to U.S. Bureau of Reclamation, South-Central California Area Office, Fresno, from Ken Sanchez, Assistant Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, CA, 3 pp.

[USFWS] U.S. Fish and Wildlife Service. (2006c). *San Luis Drainage Feature Re-evaluation Fish and Wildlife Coordination Act Report.* U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, CA, 73 pp.

Area Manager, U.S. Bureau of Reclamation

[USFWS] U.S. Fish and Wildlife Service. (2007a). *Programmatic biological opinion for activities conducted at Fort Hunter Liggett, Monterey County, California (1-8-07-F-11R).* Service File # PAS 2041.4788.6686. March 26, 2007. U.S. Fish and Wildlife Service, Ventura, CA.

[USFWS] U.S. Fish and Wildlife Service. (2007b). Re: Amended Biological Assessment for APHIS-WS activities to protect livestock, property, human health and safety, and natural resources in the State of California. May 8, 2007.

[USFWS] U.S. Fish and Wildlife Service. (2007c). Comments on Draft EA/IS for 25-Year Groundwater Pumping/Water Transfer Project for the San Joaquin River Exchange Contractors Water Authority. Memorandum to Robert Eckart, U.S. Bureau of Reclamation, Sacramento, from Mike Hoover, Assistant Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, CA, 18 pp. and attachments.

[USFWS] U.S. Fish and Wildlife Service. (2008). Proposed Sand and Gravel Mining Projects in the Salinas River Watershed, San Luis Obispo County, California. Service File # 81440-2008-TA-0587. September 16, 2008. U.S. Fish and Wildlife Service, Ventura, CA.

[USFWS] U.S. Fish and Wildlife Service. (2009). Letter to the U.S. Environmental Protection Agency providing *comments and recommendations on the proposed numeric water quality selenium standard for the Great Salt Lake*. Letter from N.E. Walsh, Acting Regional Director, U.S. Fish and Wildlife Service, Region 6, Denver CO, to C. Rushin, Acting Administrator, U.S. Environmental Protection Agency, Denver, CO, 5 pp.

[USGS] U.S. Geological Survey. (2004). *National Assessment of oil and gas fact sheet: Assessment of undiscovered oil and gas resources of the San Joaquin Basin Province of California, 2003*. Available on the internet at http://pubs.usgs.gov/fs/2004/3043/FS-2004-3043-508.pdf. Accessed on April 8, 2009.

Vollmar, J.E. (2002). Chapter 1, Introduction. *In*: J.E. Vollmar (editor), *Wildlife and rare plant ecology of Eastern Merced County's vernal pool grasslands*. Vollmar Consulting, Berkeley, CA, 445 pp.

Waithman, J.D. (1974). *San Joaquin kit fox distribution in the California counties of Santa Barbara, Kings, Tulare, and Kern*. Special Report, U.S. Fish and Wildlife Service. June 28, 1974.

Warrick, G.D., and B.L. Cypher. (1998). *Factors affecting the spatial distribution of San Joaquin kit foxes.* Journal of Wildlife Management 62:707-717.

Warrick, G.D., and B.L. Cypher. (1999). *Variation in body mass of San Joaquin kit foxes. Journal of Mammalogy* 80:972-979.

Warrick, G.D., T.T. Kato, M.V. Phillips, and H.J. Hill. (1997). *Assessment of impacts and evaluation of restoration methods on areas affected by a well blowout, Naval Petroleum Reserve No. 1, California.* Fifth International Conference Effects of Oil on Wildlife. Monterey, CA. Nov. 3-6, 1997:53-66.

Warrick, G.D., H.O. Clark, Jr., P.A. Kelly, and D.F. Williams, and B.L. Cypher. (2007). *Use of agricultural lands by San Joaquin kit foxes*. Western North American Naturalist 67:270-277.

Westlands Water District. (2004). *Irrigator*. Newsletter of Westlands Water District. Fresno, CA. Mailed to/rec'd by Fresno BOR, 7/14/2004.

White, P.J., and R.A. Garrott. (1997). *Factors regulating kit fox populations*. Canadian Journal of Zoology 75:1982-1988.

White, P.J., and R.A. Garrott. (1999). *Population Dynamics of Kit Foxes.* Canadian Journal of Zoology 77:486-493.

White, P.J., and K. Ralls. (1993). *Reproduction and spacing patterns of kit foxes relative to changing prey availability*. Journal of Wildlife Management 57:861-867.

White, P.J., K. Ralls, and C.A. Vanderbilt. (1995). *Overlap in habitat and food use between coyotes and San Joaquin kit foxes.* Southwestern Naturalist 40:342-349.

White, P.J., C.A. Vanderbilt-White, and K. Ralls. (1996). *Functional and numerical responses of kit foxes to a short-term decline in mammalian prey*. Journal of Mammalogy 77:370-376.

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

Whiteley, P.L. and T.M. Yuill. (1991). *Interactions of environmental contaminants and infectious disease in avian species*. Pages 2338 – 2342 *in*: Acta XX Congressus Internationalis Ornithologici. C.S.I.R.O. Australian Animal Health Laboratory, Australia.

Whitney, D. (2008a). *Oil exploration firm looks at nature preserve*. The Sacramento Bee. March 2, 2008. Available on the internet at http://www.sacbee.com/capitoland california/v-print/story/753076.html. Accessed November 10, 2008.

Whitney, D. (2008b). *Carrizo oil explorer considers dynamite*. San Luis Obispo Tribunes and wire service sources. Available on the internet at http://www.sanluisobispo.com/news/local/v-print/story/331162.html. Accessed September 12, 2008.

Wilber, C.G. (1980). *Toxicology of selenium: A review*. Clin. Toxicol. 17:171-230.

Williams, D.F. (1985). *A review of the population status of the Tipton kangaroo rat, Dipodomys nitratoides nitratiodes*. Final report 10181-4861(ts) '84 SE-0020-4 prepared for the U.S. Fish and Wildlife Service, Endangered Species Office. Sacramento, CA, 48 pp.

Williams, D.F. (1990). *Assessment of potential habitat for the blunt-nosed leopard lizard and San Joaquin kit fox in western Madera County, California*. U.S. Fish and Wildlife Service, Endangered Species Office, Sacramento, CA, 31 pp.

Williams, D.F. and D.J. Germano. (1992). *Recovery of endangered kangaroo rats in the San Joaquin Valley, California.* Transactions of the Western Section of the Wildlife Society 28:93-106.

Williams, D.F., D.J. Germano, and W. Tordoff. (1993). *Population studies of endangered kangaroo rats and blunt-nosed leopard lizards in the Carrizo Plain Natural Area, California.* State of California, Department of Fish and Game, Wildlife Management Division, Nongame Bird and Mammal Sec. Rep. 93-01. 114 pp.

Williams, T.W., Spies, J., and M. Olds. (2004). *San Joaquin Valley Giant Garter Snake Conservation Project. 2004 Field Season Report* – San Luis National Wildlife Refuge. Los Banos, CA.

Williams, T. and V. Wunderlich. (2003). *Progress report: 2003 San Joaquin Valley giant garter snake conservation project*. Unpublished report. U.S. Fish and Wildlife Service, San Luis National Wildlife Refuge Complex, Los Banos, CA, 12 pp.

Woock, S.E., W.R. Garrett, W.E. Partin, and W.T. Bryson. (1987). *Decreased survival and teratogenesis during laboratory selenium exposures to bluegill, Lepomis macrochirus*. Bull. Environ. Contam. Toxicol. 39:998-1005.

Woodbridge, B. (1998). *Swainson's hawk (Buteo swainsoni*). In "The Riparian Bird ConservationPlan: a Strategy for Reversing the Decline of riparian-associated Birds in California." California Partners in Flight. http://www.prbo.org/calpif/htmldocs/riparian_v-2.html

Wylie, G. D. (1998a). *Giant garter snake project: 1998 progress report*. Unpublished (preliminary) report. U. S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, CA, 4 pp. & Figures.

Wylie, G. D. (1998b). *Results of the 1998 survey for giant garter snakes in and around the Grasslands Area of the San Joaquin Valley*. U. S. Geological Survey, Biological Resources Division, Dixon Field Station, Biological Resources Division, U.S. Geological Survey, Dixon, CA.

Wylie, G. and M. Amarello. (2008). *Surveys for the current distribution and abundance of giant garter snakes (Thamnophis gigas) in the southern San Joaquin Valley*. Prepared for the U.S. Bureau of Reclamation, Mid-Pacific Region, South-Central California Area Office, Fresno, CA, 14 pp.

Wylie, G.D. and M.L. Casazza. (2001). *Investigations of giant garter snakes in the Natomas Basin: 2001 field season.* Unpublished report. U.S. Geological Survey, Biological Resources Division, Dixon, CA, 9 pp.

Wylie, G. D., M.L. Casazza, and N.M. Carpenter. (2000). *Monitoring giant garter snakes at Colusa National Wildlife Refuge: 2000 report*. U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, CA.

Wylie, G.D., M.L. Casazza, and N. M. Carpenter. (2002a). *Monitoring giant garter snakes at Colusa National Wildlife Refuge: 2001 progress report*. Unpublished report. U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, CA, 10 pp.

Wylie, G.D., M. L. Casazza, and J. K. Daugherty. (1997) *1996 progress report for the giant garter snake study*. Unpublished (preliminary) report. U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, CA, 6 pp. & Figures.

Wylie, G.D., M.L. Casazza, and L.L. Martin. (2002b). *The distribution of giant garter snakes and their habitat in the Natomas Basin: A report for the U.S. Fish and Wildlife Service*. Unpublished report. U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, CA, 25 pp.

Wylie, G.D., M. L. Casazza, L.L. Martin, and N. M. Carpenter. (2003a). *Monitoring giant garter snakes at Colusa National Wildlife Refuge: 2002 progress report*. Unpublished report. U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, CA, 16 pp.

Area Manager, U.S. Bureau of Reclamation

Wylie, G.D., M.L. Casazza, and L.L. Martin. (2003b). *Giant garter snake surveys in the Natomas Basin: 2000-2002. Unpublished report.* U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, CA, 20 pp.

Wylie, G. D., Casazza, M.L., and M. Carpenter. (2003c). *Diet of bullfrogs in relation to predation on giant garter snakes at Colusa National Wildlife Refuge*. California Fish and Game 89(3):139-145.

Wylie, G.D., M.L. Casazza, L.L. Martin, and N.M. Carpenter. (2004a). *Monitoring giant garter snakes at Colusa National Wildlife Refuge: 2003 progress report.* Unpublished report. U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, CA, 17 pp.

Wylie, G. D., M. L. Casazza, and L. L. Martin. (2004b). *Giant garter snake surveys in the Natomas Basin: 2003 Results.* Unpublished report. U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, CA, 75 pp.

Wylie, G.D., M.L. Casazza, L.L. Martin, and M. Carpenter. (2005). *Identification of key giant garter snake habitats and use areas on the Sacramento National Wildlife Refuge Complex.* Unpublished report. U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, CA, 31 pp.

Wylie, G.D., T. Graham, M.L. Casazza, M.M. Paquin, and J. Daugherty. (1996). *National Biological Service giant garter snake study progress report for the 1995 field season*. Unpublished (preliminary) report. U. S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, CA, 6 pp. & Figures.

Wylie, G.D. and L.L. Martin. (2004). *Results of 2004 monitoring for giant garter snakes (Thamnophis gigas) for the bank protection project on the left bank of the Colusa Basin Drainage Canal in Reclamation District 108, Sacramento River bank river protection project, phase II*. Unpublished report prepared for U.S. Army Corps of Engineers, Environmental Planning Section, Sacramento, CA, 18 pp.

Young, B. (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, CA.

Young, B. (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, CA.

Young, B. (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, CA.

Young, L.S. (1989). *Effects of agriculture on raptors in the western United States: an overview.* Proceedings of the Western Raptor Management Symposium and Workshop; Natural Science and Technology Series 12.

Zawislanski, P.T., S.M. Benson, R. TerBerg, and S.E. Borglin. (2002). *Land Disposal of San Luis Drain Sediments, Panoche Water District, South Dos Palos, California*. University of California, Lawrence Berkeley Lab, Paper LBNL-51025, Berkeley, CA, 107 pp. Available at: http://repositories.cdlib.org/lbnl/LBNL-51025

Zoellick, B.W., T.P. O'Farrell, P.M. McCue, C.E. Harris, and T.T. Kato. (1987). *Reproduction of the San Joaquin kit fox on Naval Petroleum Reserve #1, Elk Hills, California, 1980-1985*. Rep. No. EGG 10282-2144, EG&G Energy Measurements, Goleta, CA, 42 pp.

<u>*In Litteris*</u>

Briden, L. (2006). California Department of Fish and Game.

Broderick, L.R. (2007). Comment letter on the January 7, 2007, Federal Register announcement of "Rodenticides; proposed risk mitigation decision," Docket Number OPP-2002-0049 from Director, California Department of Fish and Game. April 4, 2007.

Cypher, B. (2007). Electronic mail from Biologist, Endangered Species Recovery Program, California State University-Stanislaus, Bakersfield, California, to Joseph Terry, Fish and Wildlife Biologist, San Joaquin Valley Branch, Endangered Species Division, SFWO, USFWS, Sacramento, CA.

Cypher, B. (2008, 2009). Electronic mail from Biologist, Endangered Species Recovery Program, California State University-Stanislaus, Bakersfield, California, to Karen Leyse, Fish and Wildlife Biologist, Recovery Branch, Endangered Species Division, SFWO, USFWS, Sacramento, CA. Emails provided information on status of core and satellite population status for the San Joaquin kit fox, providing information on disease prevalence, and providing information on current available habitat.

Cypher, B. (2009). Transmittal of analysis on Potential Use of the San Joaquin River Water Quality Improvement Project Area by San Joaquin kit foxes. December 15, 2009.

Cypher, B. and J. Constable. (2006). California State University, Stanislaus, Endangered Species Recovery Program. San Joaquin kit foxes in the Santa Nella Region and northern range: observations and recommendations. January 19, 2006.

Eacock, C. (2009). Electronic mail providing information on funding for drainage-related projects in the Grassland Drainage Area and transmitting information from Chris Linneman of Panoche Drainage District on how many miles of opens drains will be converted to closed pipe or buried using federal funds. Environmental Specialist, U.S. Bureau of Reclamation, South Central California Area Office, Fresno, CA. September 28, 2009

Erickson, B. (2006). Rodenticides Incidents Update: memorandum from B. Erickson, Biologist, to Susan Lewis, Chief, SRRD, EPA, Washington D.C. November 15, 2006.

Garrison, D. (2009). Electronic mails from USFWS Region 8 Refuge Water Acquisition Specialist on status of Level 4 refuge water deliveries in the Grasslands Area and expected habitat improvements with provision of full Incremental Level 4 refuge water deliveries. June 30, and December 3, 2009.

Hansen, E. (2009). Electronic mail providing data on giant garter snake trapping efforts in American Basin, Natomas Basin and Badger Creek. Consulting Environmental Biologist, Sacramento, CA. November 5, 2009.

Hosea, R. (1999). Letter from Principal Investigator, Pesticide Investigations Unit, California Department of Fish and Game, Rancho Cordova, California, to Christine Van Horn Job, Wildlife Biologist, Endangered Species Recovery Program, California State University-Stanislaus, Bakersfield, CA. October 14, 1999

Krise, P. (2006). Electronic mail regarding illegal disking from a local landowner, Bakersfield, California, to Annette Tenneboe, Biologist, California Dept. Fish and Game, Fresno, CA.

Kleinsmith, D. (2009). Electronic message from U.S. Bureau of Reclamation, with attachment, providing the acres of Consolidated Place of Use mitigation to K. Leyse, SFWO, USFWS, Sacramento, CA. May 18, 2009.

Lemly, D. (2009). Electronic message transmitting review comments on draft Environmental Baseline section on the selenium effects to giant garter snakes. Research Biologist, USDA Forest Service, Southern Research Unit Headquarters, Wake Forest University, Winston-Salem, NC. November 17, 2009.

Littrell, E. (1987). Pesticide Laboratory Report, Pesticide Investigations Laboratory, CDFG. August 21, 1987.

Lowe, J. (2006). Electronic mail from Wildlife Biologist, U.S. Bureau of Land Management, Hollister, California to J. Terry, Biologist, SFWO, USFWS, Sacramento, CA.

Lowe, J. (2007). Electronic mail from Wildlife Biologist, U.S. Bureau of Land Management, Hollister, CA, to J. Terry, Biologist, SFWO, USFWS, Sacramento, CA.

McMillin, S. (2008). Electronic message from Environmental Scientist, Pesticide Investigations Unit, California Department of Fish and Game, to K. Leyse of the Service. September 3, 2008.

Moore, M. L. (2008). Electronic messages (with attachment) from Associate Wildlife Biologist, California National Guard, Camp Roberts Headquarters, to K. Leyse, SFWO, USFWS, Sacramento, CA. June 27 and June 30, 2008.

Mueller, M. (2008). Electronic message to J. Gann, Biologist, CDFG, forwarded to S. Larsen, SFWO, USFWS, Sacramento, CA. September 8, 2008.

Parris, R. (2007). Electronic mail from Refuge Biologist, San Luis National Wildlife Refuge Complex, Los Banos, CA to M. Owens, Wildlife Biologist, San Joaquin Valley Branch, Endangered Species Division, SFWO, USFWS, Sacramento, CA.

Parris, B. (2008). Electronic mail from Refuge Biologist, San Luis National Wildlife Refuge Complex, Los Banos, California to Karen Leyse, Fish and Wildlife Biologist, SFWO, USFWS, Sacramento, CA. Message includes a table with kit fox spotlighting, scat, and camera survey results from 2006-2008.

Pau, N. (2002). Memorandum from N. Pau, USFWS, to C. Goude, M. Fris, V. Campbell, and J. Knight: New information affecting the San Joaquin kit fox conservation strategy in the San Joaquin Multi-species and Open Space Plan. February 12, 2002. File: RI E-1 KF PACT.

Phillips, S. (2009). Electronic mail from ESRP GIS Manager to K. Leyse, Fish and Wildlife Biologist, Recovery Branch, SFWO, USFWS, Sacramento, CA.

Saslaw, L. (2007). Electronic mail from Field Manager, Bureau of Land Management, Bakersfield, California to K. Leyse, Recovery Branch, Endangered Species Division, SFWO, USFWS, Sacramento, CA.

Skorupa, J. (2009). Electronic mail summarizing Tulare Lake Drainage District egg selenium data for June 1995 and June 1996. U.S. Fish and Wildlife Service, Division of Environmental Quality, Arlington, VA. January 7, 2009.

Skorupa, J. (2009). Electronic mail transmitting a recommendation to use a fish dietary toxicity threshold for selenium as a model for giant garter snakes. Clean Water Act Biologist, USFWS, Division of Environmental Quality, Arlington, VA. September 29, 2009.

Skourpa, J. (2009). Electronic mail transmitting comments on factors that likely influenced shorebird nest abandonment at the SJRIP drainage reuse area. Clean Water Act Biologist, USFWS, Division of Environmental Quality, Arlington, VA. October 27, 2009.

Skorupa, J. (2009). Electronic mail transmitting comments on draft Environmental Baseline section on the selenium effects to giant garter snake. Clean Water Act Biologist, USFWS, Division of Environmental Quality, Arlington, VA. November 6, 2009.

Vance, J. (2006). Electronic mail regarding native habitat being disked in Kings County from Environmental Scientist, Permitting and Regionwide Conservation Planning, California Dept. Fish and Game, Fresno, California, to S. Jones, Chief, San Joaquin Valley Branch, Endangered Species Division, USFWS, Sacramento, CA.

Vance, J. (2009). Electronic mail from Environmental Scientist, California Department of Fish and Game, Fresno, California to S. Jones, USFWS, Sacramento, California, providing information on proposed large-scale solar farms in the Panoche and Little Panoche Valleys.

Williams, D.F. (1989). Letter to R. Schlorff, CDFG, Sacramento, CA.

Williams, P. (2007). Electronic mail from Refuge Biologist, Kern National Wildlife Refuge Complex, Delano, California to J. Terry, Biologist, San Joaquin Valley Branch, Endangered Species Division, SFWO, USFWS, Sacramento, CA.

<u>Personal Communications</u>

Beam, J. (as cited in Hansen 2008a). Manager Los Banos Wildlife Area Complex, California Department of Fish and Game, Los Banos, CA.

Bennet, J.R. (1998). U.S. Department of Agriculture, Animal Damage Control, as cited in as cited in Warrick and Cypher 1998.

Brode, J. (1992). California Department of Fish and Game, as cited in USFWS 1993.

Clark, L. (2008). Fort Hunter Liggett Military Reservation, California. Provided information on the status of the kit fox at the facility. December 8, 2008.

Coolahan, C. (2009). USDA APHIS State Director, Wildlife Services, Sacramento, CA. Provided information on predator and rodent control materials currently authorized for use by APHIS within the range of the San Joaquin kit fox. January 22, 2009.

Cypher, B. (2006, 2008). Researcher/Wildlife Biologist, Endangered Species Recovery Program. California State University-Stanislaus, Bakersfield, CA. Provided information on the recovery strategy for the kit fox, on the fox's status in core and satellite areas, and on research activities to Karen Leyse, Fish and Wildlife Biologist, USFWS, Sacramento, CA. August 19, 2008.

Dixon, B. (2009). Environmental Engineer, Occidental of Elk Hills, Inc., Bakersfield, CA. Provided information on management of Occidental oilfield and conservation holdings, and measures to prevent OHV damage to holdings. January 13, 2009.

Forrest, K. (2007). Refuge Manager, San Luis National Wildlife Refuge Complex, Los Banos, CA. Provided information on notification of availability of Incremental Level 4 refuge water supplies to the Grasslands Area wetlands to Joy Winckel, Fish and Wildlife Biologist, USFWS, Sacramento, CA. June 13, 2007.

Golden, N. (2008). USFWS, Division of Environmental Quality, Arlington, VA. Provided information on status of Informal Consultation with the USEPA on Second Generation Anticoagulant Rodenticides.

Hansen, E. (2006, 2008). Consulting Environmental Biologist, Sacramento, CA. Provided information on population trends, threats, and recommendations for future actions.

Hansen, G. (1991). Consulting Herpetologist, Sacramento, CA.

Hansen, G. (1992). Consulting Herpetologist, Sacramento, CA.

Hansen, G. (1998). Consulting Herpetologist, Sacramento, CA.

Hansen, R. (1992). Biological Consultant, Visalia, CA.

Hau, K. (2003). California Department of Transportation.

Jennings, M. (1993). Herpetologist, USFWS, Sacramento, CA.

Kelly, P. (2000). Endangered Species Recovery Program, Fresno, pers. comm. to P. White, Fish and Wildlife Service, Sacramento, April 6, 2000.

Leach, S. (2006). Senior Biologist, URS Corporation, Oakland, CA.

Littlefield, M. (2007). Fish and Wildlife Biologist, USFWS, formerly Lead Fish and Wildlife Biologist for Fort Hunter Liggett and Camp Roberts Military Reserves, Department of Defense.

Moore, M. L. 2008. Provided information on kit fox at Camp Roberts to Karen Leyse, Fish and Wildlife Biologist, SFWO, USFWS, Sacramento, California. June, 2008.

Roberts, J. 2006, 2008. Director, The Natomas Basin Conservancy.

Saslaw, L. (2008, 2009). Field Manager, U.S. Bureau of Land Management. Bakersfield, CA. Provided information on issues pertaining to the kit fox on BLM lands, including Carrizo Plains National Monument. 2007, October 7 and 16, 2008, January 5, 2009, February 4, 2009.

Seay, J. (2006). Biologist, HT Harvey and Associates, Fresno, CA.

Stockton, M. 2006. Refuge Manager, Bitter Creek National Wildlife Refuge. Kern County, California.

Area Manager, U.S. Bureau of Reclamation

Vance, J. Wildlife Biologist. California Department of Fish and Game. Fresno, California. 2007.

Wylie, G. (2005, 2006). U.S. Geological Survey, Biological Resources Division, Dixon.