United States Department of the Interior

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

In reply refer to:
1-1-07-F-0044

APR 27 2007

Memorandum

To: Regional Planning Officer, Mid-Pacific Regional Office, Bureau of Reclamation, Sacramento, California (Attn.: Alan Candlish)

From: Acting Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, California Cay C. Goude

Subject: Formal Consultation on the Contra Costa Water District Alternative Intake Project, Contra Costa County, California

This memorandum is in response to your August 14, 2006, request for formal section 7 consultation on the proposed Contra Costa Water District (CCWD) Alternative Intake Project, located on Victoria Canal in San Joaquin and Contra Costa Counties, California. Your letter was received in our office on August 16, 2006. This document represents the U.S. Fish and Wildlife Service's (Service) draft biological opinion on the effects of the action on the threatened delta smelt (*Hypomesus transpacificus*) and giant garter snake (*Thamnophis gigas*). This response is in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act).

The Service has determined that the project is not likely to adversely affect the San Joaquin kit fox (*Vulpes macrotis mutica*) due to the minimal construction activity along the eastern edge of Byron Tract that lacks suitable habitat.

The following sources of information were used to develop this biological opinion: (1) the July 2005 *Draft Appendix E-1 Alternative Intake Project Action Specific Implementation Plan for the Contra Costa Water District Alternative Intake Project*; (2) the November 15, 2005 *Alternative Intake Project Administrative Draft Environmental Impact Report/ Environmental Impact Statement*; (3) the March 20, 2006 *Alternative Intake Project Action Specific Implementation Plan Appendix E-1 to the Draft Environmental Impact Report/ Environmental Impact Statement*; (4) the May 2006 *Alternative Intake Project Action Specific Implementation Plan Appendix E-1 to the Draft Environmental Impact Report/ Environmental Impact Statement*; (5) the May 2006 *Draft Environmental Impact Report/ Environmental Impact Statement*; (6) the October 2006 *Final Environmental Impact Report/ Environmental Impact Statement*; (7) various meetings and correspondence between the U.S. Bureau of Reclamation (Reclamation), the National Marine Fisheries Service (NMFS), the California Department of Fish and Game (DFG), CCWD, EDAW Inc., Hanson Environmental Inc., and the Service; and (8) other information available to the Service.

Consultation History

January-May 2005:	The Service participated in various delta fisheries meetings where the proposed project was discussed.
May 31, 2005:	The Service participated in the Alternative Intake Project Fisheries Coordination Meeting.
June 2, 2005:	The Service participated in an inter-agency pre-application meeting for the proposed project.
June 29, 2005:	The Service received a request for informal consultation and the July 2005 Administrative Draft Appendix E-1 Alternative Intake Project Action Specific Implementation Plan (ASIP) for the Contra Costa Water District Alternative Intake Project. Reclamation designated EDAW Inc. as the non-federal representative to conduct informal consultation, prepare the section 7 analysis, and provide information for the consultation.
September 19, 2005:	The Service participated in the Alternative Intake Project Fisheries Coordination Meeting.
September 2005-November 2006:	Reclamation, CCWD, NMFS, DFG, EDAW, Hanson Environmental Inc., and the Service engaged in various email and telephone correspondences.
November 15, 2005:	The Service participated in the Alternative Intake Project Fisheries Coordination Meeting.
December 7, 2005:	The Service received comments on the Alternative Intake Project Administrative Draft ASIP and Environmental Impact Report Environmental Impact Statement (EIR/EIS) from DFG.
December 16, 2005:	The Service participated in the Alternative Intake Project Fisheries Coordination Meeting.
January 12, 2006:	The Service received the Administrative Draft EIR/EIS components from EDAW, Inc.
January 26, 2006:	The Service participated in the Alternative Intake Project Fisheries Coordination Meeting.

February 2, 2006:	The Service received the City of Sacramento Fish Screen Replacement Project Fish Rescue/Salvage Plan that was discussed in prior meetings.
March 21, 2006:	The Service received the March 20, 2006 ASIP.
March 24, 2006:	The Service participated in the Alternative Intake Project Fisheries Coordination Meeting.
May 4, 2006:	The Service received the May 2006 Draft EIR/EIS, EIR/EIS Executive Summary, ASIP, and a request for comments on these documents.
August 16, 2006:	The Service received a request for formal consultation, a draft of the biological opinion, and the May 2006 ASIP.
October 5, 2006:	The Service participated in the Alternative Intake Project Fisheries Coordination Meeting.
October 27, 2006:	The Service received the Final EIR/EIS.
November 16, 2006:	CCWD called the Service stating that the CCWD Board of Directors certified the EIR/EIS and chose the agency preferred Alternative 3, Modified Operations Alternative.
December 14, 2006:	The Service transmitted a draft biological opinion to Reclamation.
February 8, 2007:	The Service received comments on the draft biological opinion from Reclamation.
March 8, 2007:	The Service received new design information for the intake and fish screen from CCWD.
April 12, 2007:	DFG emailed new compensation language to the Service, NMFS, and CCWD.

BIOLOGICAL OPINION

Description of the Proposed Action

Project Summary

The proposed action would be implemented in the Sacramento-San Joaquin Delta, in San Joaquin and Contra Costa Counties. Its main features would be a new, screened water intake and pump station located along the lower third of Victoria Canal on Victoria Island in the central Delta, and a pipeline that would extend from the new intake directly across Victoria Island and

Old River and tie into CCWD's existing Old River conveyance system on Byron Tract. The project's construction footprint is approximately 470 acres.

The proposed action would include a new intake at a location with better quality water, but would not increase CCWD's total diversion capacity (rate or average annual quantity). The new intake would have a capacity of up to 250 cubic feet per second (cfs) and would be a part of the Old River conveyance system. The existing Old River intake and pump station, with a current capacity of 250 cfs, would remain in use. The combined permitted capacity of the Old River conveyance system would remain 320 cfs. Rock Slough would continue to provide a portion of CCWD's water supply, but would be used less frequently under the proposed action because of the operational flexibility a new intake with better water quality would provide. The Mallard Slough intake would continue to provide a portion of CCWD's water supply in a manner similar to its current operations.

Implementation of the proposed action would provide CCWD with the operational flexibility to divert water from either the new intake on Victoria Canal or the existing Old River intake, or to blend waters from Victoria Canal and Old River, to provide the highest water quality for CCWD customers. The proposed action would involve adding a new point of diversion to certain existing water rights held by CCWD and by Reclamation. CCWD would not seek to increase its water rights, Central Valley Project (CVP) contract amounts, or permitted Los Vaqueros Reservoir filling rates through this action.

Proposed Facilities

Intake and Fish Screen

The new intake structure would consist of a reinforced concrete structure with side retaining walls; and a fish screen, open to Victoria Canal, supported on concrete columns. The intake structure would be approximately 100 feet to 200 feet long, depending on the depth of the screen, which is anticipated to be 10 feet to 15 feet. The final sizing will be based on confirmation of fish screen design details with fishery agencies, levee geotechnical design considerations, channel bathymetry, and costs (e.g., it may be preferable to construct a narrower, deeper screen than a shallow, wide screen).

The state-of-the-art fish screen would provide a positive barrier against entrainment of fish and debris into the wet well/pump bays. The fish screen would be regularly cleaned with a mechanical cleaning system. The facility would be designed for a maximum perpendicular flow-through design velocity for the fish screens of 0.2 foot per second for any flow in Victoria Canal, which is consistent with the most stringent fish screening requirements in the Delta (i.e., Service screening criteria for delta smelt).

One or two existing agricultural siphons in Victoria Canal and/or agricultural drainage pipes on Victoria Island may need to be temporarily removed or relocated during construction. At the completion of construction, any siphons that have been removed would be replaced and restored to their original operational condition or permanently relocated.

Pump Station and Ancillary Structures

A pump station would lift water from the new intake and convey it through the pipeline system and to the existing Old River pump station system on Byron Tract. The pump station and associated mechanical piping would occupy a footprint area approximately 140 feet long by 60 feet wide. Normal water surface elevations at the intake would vary with tide; however, the intake pumps would be designed to operate at high and low water levels. The pumps would discharge into a common pipeline.

The intake/pump station facilities would also include a smaller motor control center/maintenance building and an electrical substation. The substation would be an open area measuring approximately 120 feet by 80 feet surrounded by chain-link fencing.

Construction for the Intake, Fish Screen, Pump Station, and Ancillary Structures

Soil densification may be required beneath the intake and levee to reduce the liquefaction potential of the soil and to improve its lateral strength during seismic events. Preloading of the soils beneath the levee may also be required to reduce long-term settlement of the levee.

In-water construction activities for installation of the intake and fish screen would be conducted either from a barge or from the top of the levee road. Most of the construction activities would be conducted in a dewatered cofferdam and would be isolated from Victoria Canal. As part of the construction of the new intake structure, a sheet pile cofferdam would be installed in Victoria Canal to isolate the work area from the canal water and provide a means to conduct construction work in a dewatered environment. Following installation of the cofferdam, the water in the cofferdam enclosure would be treated (as necessary) and discharged back to Victoria Canal, and the remaining intake construction work would be conducted in a dewatered environment.

If material needs to be removed for bed preparation at the cofferdam site, this excavated material would be contained within a designated containment area or areas on the land side of the levee. An earthen dike or siltation fences would enclose the containment area(s). Retention of the excavated materials would promote settling of the suspended sediments. Any excess water (desilted supernatant) would be returned back into Victoria Canal or Old River.

To provide additional depth for the fish screen, excavation may be required in Victoria Canal in the immediate vicinity of the intake in an area up to 50,000 square feet to depths within 1 to 2 feet of existing channel bottom. The need for excavation would be determined during final design based on the results of field data. Excavated materials would be transferred to the designated containment or disposal areas on the land side of the levee.

Utilities

There are no utilities present at the proposed intake site. Electricity, non-potable water, a sanitary holding tank, and a telecommunications system would be provided as part of the proposed action.

A new power substation would be constructed on-site. Power transmission lines would be installed from either the Pacific Gas and Electric Company (PG&E) or the Western Area Power Administration (WAPA) distribution system to the substation. Power supply to the facility would be transmitted through the distribution system from a combination of available sources, which may include PG&E and/or Reclamation's CVP. Potential corridors for power lines are the same as for the pipeline, although the pipeline and power lines may not be on the same alignment.

Water from Victoria Canal would be pumped through a screening filter to provide non-potable service water for the pump seals and washrooms.

Sanitary services for CCWD personnel on site for maintenance activities would be provided through the use of a below-ground holding tank that would be regularly maintained.

Antennas would be installed at the site to allow the station programmable logic controller and security system to communicate with CCWD's supervisory control and data acquisition system.

Access and Security

Site access would be via the existing levee roads or an existing north-south dirt road located off of State Route 4. The levee access roads may be surfaced with aggregate base rock to improve access during all weather conditions, but otherwise would not be modified. The north-south dirt road may be improved to accommodate two-way traffic and to meet anticipated vehicular traffic loadings.

Site security would include chain-link fencing surrounding the pump station and intake, switchyard and ancillary buildings.

Levee Improvements

The existing levee would be reinforced and reconfigured to serve as the engineered soil platform for the proposed intake/pump station facilities and to allow installation of the new intake structure. The approximate footprint area of the levee improvements (i.e., measured at the base of the side slopes) would be 250–300 feet wide by 1,000–1,200 feet long. Approximately 6–8 acres at the intake site would be removed from agricultural use by the proposed levee modification.

The levee construction would require approximately 140,000 to 170,000 cubic yards of fill material. The top of the reconfigured levee would be surfaced with aggregate base to maintain vehicular traffic during rain events. A ramp would be provided to allow access to the pump station and ancillary buildings. Slope protection (i.e., riprap) would be installed on the water side of the levee for up to 400–500 feet on each side of the intake structure.

Construction of levee improvements would occur in two phases. First, an earthen setback levee would be constructed on the landward side of the existing levee. The setback levee would be integrated with the existing levee to provide continuity of the land/water barrier. Construction activities for the new intake would be initiated along the existing levee edge after the setback levee is completed. All new construction for the setback levee would incorporate modern techniques for soil compaction.

The new levee configuration would consist of additional earthen fill placed approximately 1,000–1,200 feet longitudinally and 250–300 feet laterally on the land side of the existing levee. Sheet piles would also be longitudinally placed approximately 320 feet upstream and downstream of the new intake, and would be integrated into the new setback levee to serve as a seepage barrier. A 36-inch layer of riprap would be installed on the water side of the existing levee for a distance of approximately 400–500 feet both upstream and downstream of the new intake, resulting in approximately 2,250 cubic yards of replaced riprap and 1,700 cubic yards of new riprap. The new fill behind the existing levee would be constructed to maintain continuity of the existing road system along the existing levee crest. The installation of the new intake and construction of the new levee would also result in permanent fill of approximately 900 linear feet of a drainage ditch at the toe of the levee. A new, 1,050-foot drainage ditch would be constructed at the toe of the levee. The elevation along the top of the new embankment fill would match the existing levee top elevation. Erosion control measures such as hydroseeding would be used on the landward side of the new setback levee.

Conveyance Pipeline

The new conveyance pipeline would cross Victoria Island and Old River to tie into CCWD's existing Old River distribution system.

Pipeline Across Victoria Island

The new conveyance pipeline would traverse Victoria Island buried within a trench from the new intake and pump facility on Victoria Canal to the Old River levee. The pipeline would transect Victoria Island diagonally and would be approximately 11,500 feet long. The pipeline would be sized to accommodate a flow rate of up to 250 cfs. The pipe diameter would be approximately 6 feet. Pipeline features such as air release, control valves, cathodic protection test stations, and access hatches would be installed in vaults or on pads above ground along the pipeline route.

The proposed pipeline routing may affect existing irrigation and drainage ditches that are used to irrigate existing fields and divert irrigation/storm water drainage from the fields (for discharge to Old River or Victoria Canal). Any ditches that potentially could be affected by the pipeline routing would be siphoned under, rerouted, crossed over, or replaced. The selected method for ditch crossings would be developed based on discussions with the landowner and considerations of both farming operations and construction costs. Nearly all effects on drainages would be temporary, as the ditches would be recontoured to their pre-project dimensions where possible.

The conveyance pipeline would be constructed across Victoria Island using a conventional trench design. Because the conveyance pipeline would likely be installed below the groundwater table, the trench is designed to provide enough earthen cover over the pipe to counter any buoyant forces that may occur. The pipeline would be buried in a trench that would be excavated to maintain a minimum cover of 5 feet over the pipeline. The as-built surface elevation would generally match the original ground surface elevation.

Dewatering would likely be required for construction of the pipeline across Victoria Island. Discharge of dewatering water could be to land or to Old River.

Old River Pipeline Crossing

The conveyance pipeline would be tunneled under Old River at an elevation determined to avoid unconsolidated soils and provide for sufficient protection of the pipeline, estimated to be at least 50 feet below ground surface elevation.

The pipeline would be installed under Old River using standard tunneling techniques. A large pit would be excavated on Byron Tract, west of the existing levee. A similar pit would be excavated on Victoria Island. One pit would operate as a launching pit while the other acts as a receiving pit, functioning as a drop shaft for the completed pipeline. The pit dimensions would be approximately 30 feet long by 15 feet wide by 80 feet deep. Once the new pipe is in place, concrete access vaults would be constructed within both the launching and receiving pits, prior to backfilling of the pits.

Pipeline Connection to the Old River Distribution System

A new pipeline, approximately 50–100 feet long, would connect the pipeline from the Old River crossing to CCWD's existing Old River delivery pipeline within the existing setback levee. Pipe would be installed on Byron Tract using the method described above for Victoria Island.

Easements

CCWD would acquire land and/or easements as needed for construction and long-term access to the project sites. On Victoria Island, CCWD would purchase or obtain a permanent easement up to 70 feet wide for the pipeline alignment. For the duration of project construction, a total construction easement (including the width of the permanent easement) of approximately 200 feet would also be required. Land and/or easements may also be required for the intake site, the levee crossings, and the river crossing (for in-river crossing alternative only).

Additional temporary construction easements of approximately 10 acres would also be required for construction staging areas. Additional temporary construction easements of approximately 25–40 acres for site access would be required on Victoria Island (range includes on-island road access and potential levee road access.

<u>Borrow Areas</u>

Borrow areas are sites where native materials are obtained for required construction activities. Borrow material would be required for both the construction of the setback levee and backfill for the pipeline trench. Approximately 140,000–170,000 cubic yards of borrow material would be required to construct the new setback levee. The amount of material needed for pipeline backfill depends on pipeline length, material, and depth of burial. An estimated 120,000–170,000 cubic yards of high-quality material would be required for the pipeline backfill. Depending on local soil conditions, this material may be available from the excavation of the pipeline trench itself, or may need to be borrowed from another location to backfill the pipeline. The excavation and backfill of the pipeline trench would result in a net excess of 20,000–60,000 cubic yards.

Preliminary soils data confirms that on-site soils are suitable for levee and pipeline backfill. Accordingly, an option for new embankment and trench fill would be to select native material obtained from Victoria Island. Based on preliminary field work, it is expected that select soils for the setback levee could be obtained by on-site shallow excavation (e.g., "land leveling") to depths of approximately 1 to 1.5 feet in an area of up to 135 acres.

If on-site borrow activity is not used, the contractor would obtain borrow material from an off-site borrow location. The contractor typically would select a source of off-site borrow. Potential borrow areas have been identified within 20 miles of the project site.

Construction Access and Staging

Construction staging areas would be located on both Victoria Island and Byron Tract. Staging areas for construction parking and the temporary stockpiling of excavated soils and storage of construction equipment and materials are expected to occupy approximately 10 acres on Victoria Island. Pipeline materials (e.g., piping, backfill material, and geogrids) would be stored along the pipeline route within the temporary easement. A smaller staging area would be located on Byron Tract.

Construction Workforce, Equipment, and Schedule

The total construction duration is estimated at 36 months. There would be overlap in the timing of construction of some of the components.

Anticipated Duration of Major Construction Components for the Proposed Action	
Construction Phase	**Anticipated Duration**
Existing Victoria Canal Levee Improvements	6–8 months
New Victoria Canal Intake Structure/Fish Screen and Pump Station Installation	24 months
New Pipeline Installation	6–18 months
Old River Pipeline Crossing	7–9 months
New Pipeline Connection at the Existing Old River Pump	1 month

Anticipated Duration of Major Construction Components for the Proposed Action	
Construction Phase	**Anticipated Duration**
Station	
Total Construction Duration	36 months

At the construction sites, typical heavy construction equipment that may be used includes excavators, backhoes, bulldozers, scrapers, graders, sheepsfoot or tamping foot rollers, water trucks, a front-end loader, several dump trucks, a drill rig, a pump truck, truck-mounted cranes, pile drivers, pickup trucks, and miscellaneous equipment.

It is anticipated that approximately 50 to 75 truck round trips would be required to transport the contractor's equipment to the site. A similar number of round trips would be needed to remove the equipment from the site as the work is completed. About 200–300 highway truck trips would be needed to bring the riprap to the site from the quarry of origin. An additional 1,000–1,500 trips would be needed to bring aggregate surfacing to the site from the quarry of origin. About 300–400 concrete loads, transported by transit mixer truck, are also likely. About 150 trailer truck loads would be required to bring other permanent materials, such as geogrid, fish screens, sheet piles, masonry, piping, structural steel, utility poles, and ancillary equipment, to the site. In addition, about 50 highway truckloads may be needed to carry construction debris and waste dump materials to a suitable landfill. If off-site borrow material is used to provide fill for the setback levee construction, up to an additional 11,500 trips may be needed. This would total about 14,000 total round trips during the construction period of approximately 30–36 months, or an average of about 15 round trips per day. The actual round trips per day during construction may range between 8 and 100 to meet specific construction sequencing needs. The construction labor force is estimated to average about 75 to 100 people over the total construction period. Peak staffing could be close to 125 people if major construction components are conducted simultaneously (e.g., if the intake and the conveyance pipeline are constructed at the same time).

Typical construction would occur during daylight hours Monday through Friday. However, the construction contractor may extend the hours and may schedule construction work on weekends if necessary to complete aspects of the work within a given timeframe. An exception to the typical construction timing would be tunneling to install the pipeline under Old River, which would not depend on daylight and may be conducted around the clock.

Operations and Maintenance

CCWD currently delivers water using the three Delta intakes based on a goal of delivering water with chloride concentrations of 65 mg/l or better to its untreated- and treated-water customers, as described in the background section of this document. The May 2006, Draft EIR/EIS contains a complete background of CCWD facilities and operations. With implementation of the proposed action, CCWD would have the flexibility to relocate some of its pumping from the existing Old

River intake to the new location during certain periods of the year to obtain better water quality. In general, Old River water quality is best in late spring and early summer. Victoria Canal water quality is better than Old River water quality in late summer and fall.

The addition of the proposed intake on Victoria Canal would provide CCWD with the flexibility to divert water for conveyance to the Los Vaqueros Reservoir and the Contra Costa Canal using the existing Old River intake, the new Victoria Canal intake, or a combination of the two intakes. The preferred alternative (Alternative 3, Modified Operations), would relocate a portion of the current Rock Slough pumping as well as some of the Old River pumping to the new intake on Victoria Canal. CCWD will immediately apply to change its permits to allow diversion of up to 320 cfs through the Old River conveyance system. Combined diversions from the 250-cfs Old River pump station and the proposed 250-cfs alternative intake would be limited to 320 cfs by the capacity of the pipeline connecting the Old River pump station to CCWD's transfer station that routes water either to the Los Vaqueros Reservoir or the Contra Costa Canal. CCWD would not increase the total annual quantity diverted from the Delta. This change would enable CCWD to relocate up to half of the current unscreened Rock Slough diversions to the screened Old River conveyance system in the near term. Rock Slough would continue to provide a portion of CCWD supply, but would be used less frequently. Mallard Slough intake would continue to provide a portion of CCWD's water supply in a manner similar to its current operations.

The proposed intake would tie into CCWD's existing water supply and would not divert additional water out of the Delta; it would simply allow CCWD to shift the location and timing of pumping between the existing Old River intake and a new location based on water quality. CCWD would not seek to increase its water rights, contract amounts, or permitted Los Vaqueros Reservoir filling rates through this project.

The pump station for the new intake on Victoria Canal would be operated similarly to the existing Old River pump station. The Old River pump station is normally operated remotely from the Bollman Water Treatment Plant but can be locally operated at the pump station itself. CCWD personnel sequentially start the Old River pumps to initiate diversion from Old River. The number of pumps operating at any given time depends on CCWD's flow requirements and diversion strategy. When the pump station is taken off line, the pumps are turned off and the wet well remains flooded.

Maintenance activities at the proposed new intake and pump station would be similar to maintenance activities currently conducted at the Old River pump station, including pump and equipment inspections and maintenance, water quality monitoring, and fish monitoring activities. Periodic maintenance dredging may also be required at the new intake facility. The existing Old River facility has not required any maintenance dredging to date, but an intake on Victoria Canal could experience different sedimentation conditions. Because the proposed new pump station would be unstaffed, CCWD personnel would monitor the station via telemetry as well as through regular inspections.

Operation and maintenance activities will be necessary to maintain function of the fish screen and the pumping plant for the life of the facility. The fish screen structure will be constructed to permit vehicle access for screen panel removal and maintenance. The fish screen will be operated and maintained to reduce debris and sediment accumulation that will adversely affect the magnitude and uniformity of approach velocities by creating turbulence in front of the screen.

The fish screen will be mechanically cleaned using a traveling rake. The cleaning system will operate continuously to reduce and avoid accumulation of debris so that the screen operates in accordance with the approach velocity design criteria. Each screen panel will be removable to allow for annual pressure washing, cleaning and maintenance, as well as inspections of screen integrity. A portable, high pressure wash water system will be used for the panel cleaning. Screen panels will be removed annually (at a minimum) for inspection, repair, and high pressure washing. Back-up panels would be available on-site to replace screen panels that require maintenance or repair. A floating log-boom will be provided in Victoria Canal to deflect floating debris that may otherwise impinge on the screen, damage screen panels, or damage the traveling rake cleaning system.

The intake structure top elevation would be two feet higher than the 100 year floodwater surface elevation in Victoria Canal. The facility is designed to withstand flood events, and to drain naturally into the canal as flows recede.

Conservation Measures

1. To reduce turbidity in Victoria Canal during project-related construction activities (primarily excavation and cofferdam installation), CCWD shall:

    a. obtain and comply with Regional Water Quality Control Board (RWQCB) Section 401 Water Quality Certification and DFG Streambed Alteration Agreement, as needed;

    b. monitor periods of construction activity and coordinate with the contractor to identify periods when localized increases in turbidity may occur;

    c. install a silt curtain to reduce the dissipation of suspended sediments during dredging and cofferdam installation; and

    d. conduct cofferdam installation and removal, to the extent possible, during summer to avoid the potential risk of adverse impacts to Chinook salmon, steelhead, and delta smelt, which are all more abundant in the area during fall, winter, and spring. Installation of the cofferdam will occur during the designated in-water work window between August 1 and November 30, unless modified by written agreement with NMFS, Service, and DFG.

2. In addition, successful project-related turbidity control shall be accomplished by installation and subsequent removal of the temporary cofferdam, while maintaining suspended sediment and turbidity levels to the extent possible within the water quality criteria established by

RWQCB. CCWD would be required to comply with water quality criteria established by applicable State and Federal permits and approvals for the proposed action. In addition, CCWD shall implement the following measures during project-related dredging and soil disposal that comply with the Fisheries Management Plan for Essential Fish Habitat (EFH) for Pacific Salmon:

a. monitor project construction-related dredging activities especially any contaminated sediments, regularly report effects on EFH, and re-evaluate activities based on monitoring results;

b. employ best engineering and management practices for all project construction-related dredging projects to minimize water-column discharges; and

c. consider upland disposal options as an alternative to open water disposal during project construction activities. Dredged sediments removed during intake construction will be used beneficially on-site or disposed of at an upland site.

3. Avoidance and minimization measures would be implemented in accordance with standard RWQCB requirements that have been used in other similar fish screen construction projects. CCWD shall be responsible for implementing the following measures to the extent practicable during project construction activities:

a. The discharge of petroleum products or other excavated materials to surface waters is prohibited;

b. Project construction activities shall minimize substrate disturbance;

c. Project construction activities shall not cause turbidity increases in surface waters as follows:

(1) where natural turbidity is between 0 and 5 Nephelometric Turbidity Units (NTUs), increases shall not exceed 1 NTU; (2) where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20%; (3) where natural turbidity is between 50 and 100 NTUs, increase shall not exceed 10 NTUs; and (4)where natural turbidity is greater than 100 NTUs, increases shall not exceed 10%.

These limits would be eased during in-water working periods to allow a turbidity increase of 15 NTU over background turbidity as measured in surface waters 300 feet downstream from the working area. In determining compliance with the above limits, appropriate averaging periods may be applied provided that beneficial uses would be fully protected;

d. Project construction activities shall not cause settleable matter to exceed 0.1 ml/l in surface waters as measured in surface waters 300 feet downstream from the project;

e. Project construction activities shall not cause visible oil, grease, or foam in the work area or downstream;

f. All areas disturbed by project construction activities shall be protected from washout or erosion;

g. In the event that project construction activities create a visible plume in surface waters, CCWD will initiate monitoring of turbidity levels at the discharge site and 300 feet downstream, taking grab samples for analysis of NTU levels twice per day during the work period while the visible plume persists;

h. CCWD shall notify RWQCB, DFG, Service, and NMFS immediately if the above criteria for turbidity, oil/grease, or foam are exceeded; and

i. CCWD shall notify RWQCB, DFG, Service, and NMFS immediately of any spill of petroleum products or other organic or earthen materials.

4. CCWD shall prepare a soil erosion control plan and stormwater pollution prevention plan (SWPPP) prior to project grading and excavation activities to minimize potential project construction-related silt from entering waterways and increasing turbidity. The plans would include, but would not be limited to, the following measures to minimize project-related erosion and sedimentation:

    a. use sedimentation basins and straw bales or other measures to trap sediment and prevent sediment and silt loads to waterways during project construction;

    b. cover graded areas adjacent to levees and in other areas that may be subject to erosion (as appropriate) with protective material, such as mulch, and re-seed with adapted native plant species after project construction is complete;

    c. incorporate bank stabilization (riprap) into the project design on both the east and west sides of the intake to minimize channel margin erosion of soils into Victoria Canal. To the extent practicable, the aerial extend of riprap will be minimized and small (<8 inch diameter) riprap will be used for levee protection;

    d. minimize project construction-related surface disturbance of soil and vegetation and restore terrestrial habitats immediately after construction to the extent feasible;

    e. place any project construction-related stockpiled soil where it would not be subject to accelerated erosion; and

    f. commence re-vegetation with grasses native to the Delta and placement of erosion control devices, such as crushed rock, as soon as a graded area has attained finish grade.

    g. CCWD shall ensure that a certified erosion control specialist or California-registered civil engineer prepare the plan. A project field manager would be responsible for monitoring in accordance with established protocols/procedures. If needed, RWQCB staff would review the plan prior to project construction to verify that physical best management practices (BMPs) have been incorporated to reduce project construction-related erosion and sedimentation to the maximum extent possible and ensure compliance with this measure.

5. Implement measures to reduce and/or avoid underwater sound pressure impacts. Potential risk of adverse impacts and incidental take of steelhead (*Onchorynchus mykiss)*, Chinook salmon (*Onchorynchus tshawytscha*), delta smelt, and other fish species shall be avoided by installing the sheet pile cofferdam using a vibration hammer that minimizes underwater sound pressure levels to the greatest extent feasible to minimize effects to sensitive fish species. If it is determined that a higher intensity percussion hammer would be required for installing the cofferdam, avoidance of potential adverse effects would be achieved by consulting with Service, NMFS, and DFG to determine the appropriate actions, which may include surveying Victoria Canal at the intake site to determine fish presence prior to installation, and possibly modifying the work window accordingly. Installation of the cofferdam, however, is expected to occur during the designated in-water work-window in summer and early fall when water temperatures within the central and south Delta are seasonally elevated and aquatic habitat in these areas is considered to be generally unsuitable for both salmonids and delta smelt. Chinook salmon and delta smelt avoid habitats, including Victoria Canal, when seasonal water temperatures increase during late spring and early summer reaching levels above 77°F. Installation of the cofferdam using percussion hammers during summer would reduce and avoid potential adverse effects to these species.

6. CCWD shall prepare and implement a hazardous materials control and spill prevention and response plan prior to construction. Measures that would be included in the plan to minimize project construction-related effects will include the following:

   a. establish a spill prevention and countermeasure plan before the commencement of project construction that includes strict on-site handling rules to keep construction and maintenance materials out of drainages and waterways;

   b. prevent project-related raw cement, concrete, or concrete washings; asphalt, paint, or other coating material; oil or other petroleum products; or any other substances that could be hazardous to aquatic life from contaminating the soil or entering watercourses, including Victoria Canal;

   c. clean up all project-related spills immediately according to the spill prevention and countermeasure plan, and notify RWQCB immediately of spills and cleanup procedures;

   d. provide staging and storage areas for project-related equipment, materials, fuels, lubricants, solvents, and other possible contaminants away from watercourses and their watersheds; and

e. conduct periodic inspection during construction.

f. The Service, NMFS, DFG, and RWQCB shall review the plan prior to construction to verify that hazardous material control and spill response measures have been incorporated to control the use of hazardous materials and reduce the chance of spills to the maximum extent practicable. The Service, NMFS, and DFG shall have access to inspect construction activities to ensure compliance.

7. CCWD shall develop and implement a Fish Rescue Plan acceptable to DFG, Service, and NMFS. Installation of the cofferdam and dewatering a portion of the proposed intake structure site during fish screen construction may result in fish stranding. CCWD shall ensure that a qualified fishery biologist with a current DFG collections permit designs and conducts the fish rescue and relocation effort to collect fish from the area behind the cofferdam. The fish rescue effort would be implemented during the dewatering of the area behind the cofferdam and would involve capture and return of those fish to suitable habitat within Victoria Canal. To ensure compliance, a fisheries biologist shall be present on-site during initial pumping (dewatering) activities.

CCWD shall monitor progress of installation of the cofferdam and the schedule for dewatering. CCWD shall coordinate the dewatering schedule with the construction contractor and fishery biologist to allow for the fish rescue to occur prior to completely closing the cofferdam and again when water depths are approximately two feet. The Service, NMFS, and CDFG shall be notified at least 48 hours prior to the fish rescue. Information on the species and sizes of fish collected in the rescue and estimates of survival immediately before release would be recorded during the time of the fish rescue and provided in a letter report to be submitted within 30 days after the fish rescue to the Service, NMFS, and DFG.

8. To compensate for the loss of 0.7 acre of shallow water habitat, applicant shall acquire, conserve, fund and manage at least 2.1 acres (3:1 ratio) of shallow water habitat at a mitigation bank or other location approved by the Service, DFG, and NMFS. If 2.1 acres cannot be acquired prior to project impacts, CCWD shall provide DFG, prior to project impacts, the following:

a. an Irrevocable Letter of Credit or other form of Security approved by the Service, DFG, and NMFS in the amount of $73,500 ($35,000/acre), to cover the costs of land acquisition, land conservation, and land management planning. The Security shall allow DFG to draw on the principal sum if DFG, at its sole discretion, determines that CCWD has failed to acquire the required 2.1 acres of shallow water habitat within 1 year of project impacts;

b. payment in the form of a check in the amount of $10,500 ($5000/acre) for use as principal for a permanent capital endowment. Interest from this amount shall be available for the operation, management and protection of the mitigation lands, including reasonable administrative overhead, biological monitoring, improvements to carrying capacity, law enforcement measures, and any other action designed to protect or improve the habitat values of the mitigation lands. The endowment principal shall not be drawn upon unless such withdrawal is deemed necessary by DFG to ensure the continued viability of the species on the mitigation lands.

The 2.1 acres shall be conserved through fee title transfer or a conservation easement acceptable to the Service, DFG, and NMFS. A management plan acceptable to the Service, DFG, and NMFS is required for the mitigation site. The management plan shall be developed prior to acquisition of mitigation land and shall include, but not be limited to; description of the habitat, habitat enhancements to site, monitoring and management of invasive aquatic plant species, maintaining shallow water habitat depth criteria, success criteria and adaptive management if not met.

9. CCWD will install a state-of-the-art positive barrier fish screen that would minimize fish entrainment and impingement at the new Victoria Canal intake. To ensure that the fish screen operates as intended and the risk of incidental take associated with diversions at this facility are in conformance with the Act and the California Endangered Species Act, long-term monitoring of operation and maintenance of the positive barrier screen shall be conducted. Monitoring at the onset of diversions through the Victoria Canal intake would include approach velocity measurements immediately after initiation of the positive barrier screen operations, with fine-tuning of velocity control baffles or other modifications as necessary, to achieve uniformity of velocities in conformance with the screen criteria ($\leq$0.2 feet/second) established by DFG and NMFS, and mandated by the Service in a number of biological opinions. Long-term velocity tests have been scheduled at 5-year intervals for the Old River Fish Screen Facility, and a similar schedule to test for effectiveness will be implemented for ensuring proper functionality of the proposed action's positive barrier fish screen.

CCWD shall also monitor the condition of the positive barrier screen on an annual basis for as long as diversions are occurring at Victoria Canal. CCWD shall conduct periodic visual inspections at least monthly, during periods of the year when the intake is in operation, to remove accumulated debris and repair screen panels as necessary. NMFS, Service, and DFG shall have access to the positive barrier screen for underwater inspections following completion of intake screen construction. The standards for success would be long-term reliable operation of the fish screen, and conformance with intake screen design criteria.

CCWD will also operate the new Victoria Canal intake consistent with the existing Los Vaqueros Project biological opinion operational restrictions on filling Los Vaqueros Reservoir and diverting Delta water, and consistent with any future changes to that biological opinion. CCWD will also operate the new Victoria Canal intake consistent with any section 7 biological opinion issued for the proposed action.

In addition, CCWD will incorporate entrainment monitoring for fish eggs, larvae, and juveniles at the new Victoria Canal intake consistent with the on-going fishery monitoring being conducted at the Old River Fish Facility. Informal consultation with NMFS, Service, and CDFG has indicated that a monitoring program as frequent and long-term as that at the Old River Fish Screen Facility is likely not necessary due to the similarities in screen design and the proven effectiveness of the Old River screen. Consequently, entrainment monitoring will be conducted at the Victoria Canal intake for the first year of operation. Following one year of entrainment monitoring, CCWD will issue a performance report within 60 days to NMFS, Service, and DFG as a cumulative record of monitoring and communications with the regulatory agencies. Using the 1-year monitoring results, CCWD will recommend continuation, modification, or discontinuation of the biological monitoring program for approval by NMFS, Service, and DFG, and then an assessment will be made whether further sampling is necessary, or should be integrated with Old River intake sampling.

Previous monitoring conducted for the Old River Fish Screen Facility to evaluate the effectiveness of the screen to reduce and avoid entraining fish eggs and larvae has provided a technical basis for evaluating the effectiveness of the new Victoria Canal positive barrier fish screen. Juvenile Chinook salmon nor other species are being substantially entrained into the state-of-the-art positive barrier fish screen that was installed and fully operable at the Old River intake by 1998. This determination has been made by Morinaka (2000) following fishery sampling behind the screen with a large sieve net that caught few fish, and among them was only one delta smelt and no Chinook salmon. Morinaka concluded, "the results demonstrate that a properly designed and operated fish screen can reduce entrainment losses." The low approach velocities of these screens (e.g., at Victoria Canal and Old River intakes) designed to meet agency criteria is such that juvenile fish can usually escape entrainment.

Implementation of this multi-faceted measure will minimize adverse effects and the risk of incidental take related to increased fish losses through entrainment and impingement by ensuring that the positive barrier fish screen is operating effectively and efficiently.

10. CCWD shall implement measures to minimize effects on the giant garter snake. Work that may affect giant garter snake habitat includes constructing the new intake station and levee improvements on Victoria Canal, installing the conveyance pipeline across irrigation ditches, and connecting the conveyance pipeline to the existing facilities at the Old River intake and pump station (either by tunneling or crossing the levee). Minimization and avoidance measures may include the following:

    a. All project-related construction activity within giant garter snake habitat (aquatic habitat and adjacent suitable upland habitat within 200 feet) shall be conducted between May 1 and October 1 to the extent feasible. For any project-related construction outside of the May 1–October 1 period, CCWD shall contact the Service's Sacramento Fish and Wildlife Office to determine if additional measures are necessary to minimize and avoid take.

    b. Dewatering of aquatic habitat for project-related construction purposes shall not occur between October 1 and April 15, with the exception of the area within the cofferdam, unless authorized by the Service. Any dewatered habitat must remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat. If complete dewatering is not possible, potential snake prey (i.e., fish and tadpoles) will be removed so that snakes and other wildlife are not attracted to the project construction area.

c. Within 24 hours prior to commencement of project-related construction activities, the site shall be inspected by a qualified biologist who is approved by the Service's Sacramento Fish and Wildlife Office. The construction area shall be re-inspected whenever a lapse in project-related construction activity of two weeks or greater has occurred. If a giant garter snake is encountered during project-related construction, all project-related construction activities shall cease in the immediate area until appropriate corrective measures have been completed or it has been determined by the biologist that the snake will not be harmed and the Service shall be contacted by telephone immediately.

d. Movement of heavy equipment to and from the project site during project-related construction activities shall be restricted to established roadways and haul routes to minimize habitat disturbance, and project construction equipment shall be stored in established staging areas.

e. Before ground disturbance, all on-site project-related construction personnel shall be given instruction regarding the presence of the giant garter snake and the importance of avoiding impacts to this species and its habitat.

f. After completion of project-related construction activities, any temporary fill and construction debris shall be removed, and wherever feasible, disturbed areas shall be restored to pre-project conditions.

g. No plastic, monofilament, jute, or similar erosion control matting that could entangle snakes will be placed on the project site when working within 200 feet of potential snake habitat.

11. To minimize project effects to giant garter snakes during filling of the 900 foot drainage ditch, CCWD shall have a biological monitor, approved by DFG and the Service, onsite during all ditch filling activities. The biological monitor shall ensure that take of giant garter snakes is minimized during filling of the ditch by monitoring the ditch for giant garter snakes in advance of and during ditch filling. The biological monitor shall have full authority to stop project work if needed to ensure giant garter snakes are not taken. If CCWD does not have a biological monitor on-site during said activities, DFG and/or the Service shall have full authority to stop activities to fill the 900 foot ditch until an approved biological monitor is on-site.

12. To compensate for project effects to giant garter snake habitat by filling of 900 foot drainage ditch, CCWD shall create giant garter snake habitat at a ratio of at least 1.1:1 (compensation: effect). The created ditch shall be constructed prior to ditch filling OR the created ditch shall be completed within 6 months of initiation of ditch filling activities and prior to October 1 of

the year impacts to ditch occur. The created ditch shall be on-site and shall reconnect on-site drainage ditch adjacent to where 900 foot ditch previously existed. If the created ditch is not completed by October 1, then CCWD shall provide financial security to DFG, in the form of an Irrevocable Letter of Credit or other form acceptable to DFG and the Service, in the amount of $165,000 to cover the costs of ditch creation. The financial security shall be provided prior to November 1 of the year impacts to 900 foot ditch occurred and shall be in place until all ditch creation activities are completed.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the proposed action, the action area includes: (1) Victoria Island, Victoria Canal, and Byron Tract; (2) the Sacramento-San Joaquin Delta; and (3) the Los Vaqueros Reservoir and the CCWD water conveyance system

Status of the Species

Delta Smelt

Delta smelt was federally listed as a threatened species on March 5, 1993 (Service 1993a). Critical habitat for delta smelt was designated on December 19, 1994 (Service 1994). The Sacramento-San Joaquin Delta Native Fishes Recovery Plan was completed in 1996 (Service 1996). The Five Year Status Review for the delta smelt was completed on March 31, 2004 (Service 2004).

Description. Delta smelt are slender-bodied fish that typically reach 60-70 mm standard length (measured from tip of the snout to origin of the caudal fin), although a few may reach 120 mm standard length. The mouth is small, with a maxilla that does not extend past the midpoint of the eye. The eyes are relatively large; with the orbit width contained approximately 3.5-4 times in the head length. Small, pointed teeth are present on the upper and lower jaws. The first gill arch has 27-33 gill rakers and there are 7 branchiostegal rays (paired structures on either side and below the jaw that protect the gills). Counts of branchiostegal rays are used by taxonomists to identify fish. The pectoral fins reach less than two-thirds of the way to the bases of the pelvic fins. There are 9-10 dorsal fin rays, 8 pelvic fin rays, 10-12 pectoral fin rays, and 15-17 anal fin rays. The lateral line is incomplete and has 53-60 scales along it. There are 4-5 pyloric caeca. Live fish are nearly translucent and have a steely-blue sheen to their sides. Occasionally there may be one chromatophore (cellular organelle containing pigment) between the mandibles, but usually there is none. Delta smelt belong to the family Osmeridae, a more ancestral member of the order Salmoniformes which also includes the family Salmonidae (salmon, trout, whitefish, and graylings) (Moyle and Cech 1988).

Distribution. Delta smelt are endemic to the upper Sacramento-San Joaquin estuary. They occur in the Delta primarily below Isleton on the Sacramento River, below Mossdale on the San Joaquin River, and in Suisun Bay. They move into freshwater when spawning (ranging from

January to July) and can occur in: (1) the Sacramento River as high as Sacramento, (2) the Mokelumne River system, (3) the Cache Slough region, (4) the Delta, and, (5) Montezuma Slough, (6) Suisun Bay, (7) Suisun Marsh, (8) Carquinez Strait, (9) Napa River, and (10) San Pablo Bay. It is not known if delta smelt in San Pablo Bay are a permanent population or if they are washed into the Bay during high outflow periods. Since 1982, the center of delta smelt abundance has been the northwestern Delta in the channel of the Sacramento River. In any month, two or more life stages (adult, larvae, and juveniles) of delta smelt have the potential to be present in Suisun Bay (Department of Water Resources (DWR) and Reclamation 1994; Molye 1976; Wang 1991). Delta smelt are also captured seasonally in Suisun Marsh.

Habitat Requirements. Delta smelt are euryhaline (a species that tolerates a wide range of salinities) fish that generally occur in water with less than 10-12 parts per thousand (ppt) salinity. However, delta smelt have been collected in the Carquinez Strait at 13.8 ppt and in San Pablo Bay at 18.5 ppt (DFG 2000). In recent history, they have been most abundant in shallow areas where early spring salinities are around 2 ppt. However, prior to the 1800's before the construction of levees that created the Delta Islands, a vast fluvial marsh existed in the Delta and the delta smelt probably reared in these upstream areas. During the recent drought (1987-92), delta smelt were concentrated in deep areas in the lower Sacramento River near Emmaton, where average salinity ranged from 0.36 to 3.6 ppt for much of the year (DWR and Reclamation 1994). During years with wet springs (such as 1993), delta smelt may continue to be abundant in Suisun Bay during summer even after the 2 ppt isohaline (an artificial line denoting changes in salinity in a body of water) has retreated upstream (Sweetnam and Stevens 1993). Fall abundance of delta smelt is generally highest in years when salinities of 2 ppt are in the shallows of Suisun Bay during the preceding spring ($p < 0.05$, $r = 0.50$) (Herbold 1994) (p is a statistical abbreviation for the probability of an analysis showing differences between variables, r is a statistical abbreviation for the correlation coefficient, a measure of the linear relationship of two variables). Herbold (1994) found a significant relationship between number of days when 2 parts per thousand was in Suisun Bay during April with subsequent delta smelt abundance ($p < 0.05$, $r = 0.49$), but noted that autocorrelations (interactions among measurements that make relationships between measurements difficult to understand) in time and space reduce the reliability of any analysis that compares parts of years or small geographical areas. It should also be noted that the point in the estuary where the 2 ppt isohaline is located (X2) does not necessarily regulate delta smelt distribution in all years. In wet years, when abundance levels are high, their distribution is normally very broad. In late 1993 and early 1994, delta smelt were found in Suisun Bay region despite the fact that X2 was located far upstream. In this case, food availability may have influenced delta smelt distribution, as evidenced by the *Eurytemora* found in this area by DFG. In Suisun Marsh, delta smelt larvae occur in both large sloughs and small dead end sloughs. New studies are under way to test the hypothesis that adult fall abundance is dependent upon geographic distribution of juvenile delta smelt. The core juvenile distribution, regardless of water year type, is usually centered upstream of X2 in eastern Suisun Bay and the lower Sacramento River to about Three-Mile Slough (Sweetnam 1999; Dege and Brown 2004).

Critical thermal maxima for delta smelt was reached at 25.4 degrees Celsius in the laboratory (Swanson et al., 2000); and at water temperatures above 25 degrees Celsius delta smelt are no longer found in the delta (DFG, pers. comm.).

Life History. Wang (1986) reported spawning taking place in fresh water at temperatures of about 7°-15° Celsius (C). However, ripe delta smelt and recently hatched larvae have been collected in recent years at temperatures of 15°-22°C, so it is likely that spawning can take place over the entire 7°-22° C range. Temperatures that are optimal for survival of embryos and larvae have not yet been determined, although R. Mager, University of California at Davis (UCD), (unpublished data) found low hatching success and embryo survival from spawns of captive fish collected at higher temperatures. Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the waters are well oxygenated and temperatures relatively cool, usually less than 20°-22°C in summer. When not spawning, they tend to be concentrated near the zone where incoming salt water and out flowing freshwater mix (mixing zone). This area has the highest primary productivity and is where zooplankton populations (on which delta smelt feed) are usually most dense (Knutson and Orsi 1983; Orsi and Mecum 1986). At all life stages delta smelt are found in greatest abundance in the top 2 m of the water column and usually not in close association with the shoreline.

Delta smelt inhabit open, surface waters of the Delta and Suisun Bay, where they presumably school. In most years, spawning occurs in shallow water habitats in the Delta. Shortly before spawning, adult smelt migrate upstream from the brackish-water habitat associated with the mixing zone to disperse widely into river channels and tidally-influenced backwater sloughs (Radtke 1966; Moyle 1976, 2002; Wang 1991). Migrating adults with nearly mature eggs were taken at the Central Valley Projects's (CVP) Tracy Pumping Plant, located in the south Delta, from late December 1990 to April 1991 (Wang 1991). In February 2000, gravid adults were found at both CVP and the State Water Projects' (SWP) fish facilities in the south Delta. Spawning locations appear to vary widely from year to year (DWR and Reclamation 1993). Sampling of larval smelt in the Delta suggests spawning has occurred in the Sacramento River, Barker, Lindsey, Cache, Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs, in the San Joaquin River off Bradford Island including Fisherman's Cut, False River along the shore zone between Frank's and Webb tracts, and possibly other areas (Wang 1991). In years of moderate to high Delta outflow, smelt larvae are often most abundant in Suisun Bay and sloughs of Suisun Marsh, but it is not clear the degree to which these larvae are produced by locally spawning fish and the degree to which they originate upstream and are transported by river currents to the bay and marsh. Some spawning probably occurs in shallow water habitats in Suisun Bay and Suisun Marsh during wetter years (Sweetnam 1999 and Wang 1991). Spawning has also been recorded in Montezuma Slough near Suisun Bay (Wang 1986) and also may occur in Suisun Slough in Suisun Marsh (P. Moyle, UCD, unpublished data).

The spawning season varies from year to year, and may occur from late winter (December) to early summer (July). Pre-spawning adults are found in Suisun Bay and the western delta as early as September (DWR and Reclamation 1994). Moyle (1976, 2002) collected gravid adults from December to April, although ripe delta smelt were common in February and March. In 1989 and 1990, Wang (1991) estimated that spawning had taken place from mid-February to late June or early July, with peak spawning occurring in late April and early May. A recent study of delta smelt eggs and larvae (Wang and Brown 1993 as cited in DWR and Reclamation 1994) confirmed that spawning may occur from February through June, with a peak in April and May.

Spawning has been reported to occur at water temperatures of about 7° to 15° C. Results from a UCD study (Swanson and Cech 1995) indicate that although delta smelt tolerate a wide range of temperatures (<8° C to >25° C), warmer water temperatures restrict their distribution more than colder water temperatures.

Delta smelt spawn in shallow, fresh, or slightly brackish water upstream of the mixing zone (Wang 1991). Most spawning occurs in tidally-influenced backwater sloughs and channel edgewaters (Moyle 1976, 2002; Wang 1986, 1991; Moyle *et al.* 1992). Although delta smelt spawning behavior has not been observed in the wild (Moyle *et al.* 1992), some researchers believe the adhesive, demersal eggs attach to substrates such as cattails, tules, tree roots, and submerged branches in shallow waters (Moyle 1976, 2002; Wang 1991).

Laboratory observations have indicated that delta smelt are broadcast spawners (DWR and Reclamation 1994) and eggs are demersal (sinks to the bottom) and adhesive, sticking to hard substrates such as: rock, gravel, tree roots or submerged branches, and submerged vegetation (Moyle 1976, 2002; Wang 1986). At 14°-16° C, embryonic development to hatching takes 9 -14 days and feeding begins 4-5 days later (R. Mager, UCD, unpublished data). Newly hatched delta smelt have a large oil globule that makes them semi-buoyant, allowing them to maintain themselves just off the bottom (R. Mager, UCD, unpublished data), where they feed on rotifers (microscopic crustaceans used by fish for food) and other microscopic prey. Once the swimbladder (a gas-filled organ that allows fish to maintain neutral buoyancy) develops, larvae become more buoyant and rise up higher into the water column. At this stage, 16-18 mm total length, most are presumably washed downstream until they reach the mixing zone or the area immediately upstream of it. Growth is rapid and juvenile fish are 40-50 mm long by early August (Erkkila *et al.* 1950; Ganssle 1966; Radtke 1966). By this time, young-of-year fish dominate trawl catches of delta smelt, and adults become rare. Delta smelt reach 55-70 mm standard length in 7-9 months (Moyle 1976, 2002). Growth during the next 3 months slows down considerably (only 3-9 mm total), presumably because most of the energy ingested is being directed towards gonadal development (Erkkila *et al.* 1950; Radtke 1966). There is no correlation between size and fecundity, and females between 59-70 mm standard lengths lay 1,200 to 2,600 eggs (Moyle *et al.* 1992). The abrupt change from a single-age, adult cohort during spawning in spring to a population dominated by juveniles in summer suggests strongly that most adults die after they spawn (Radtke 1966 and Moyle 1976, 2002). However, in El Nino years when temperatures rise above 18° C before all adults have spawned, some fraction of the unspawned population may also hold over as two-year-old fish and spawn in the subsequent year. These two-year-old adults may enhance reproductive success in years following El Nino events.

In a near-annual fish like delta smelt, a strong relationship would be expected between number of spawners present in one year and number of recruits to the population the following year. Instead, the stock-recruit relationship for delta smelt is weak, accounting for about a quarter of the variability in recruitment (Sweetnam and Stevens 1993). This relationship does indicate, however, that factors affecting numbers of spawning adults (e.g., entrainment, toxics, and predation) can have an effect on delta smelt numbers the following year.

Delta smelt feed primarily on (1) planktonic copepods (small crustaceans used by fish for food),

(2) cladocerans (small crustaceans used by fish for food), (3) amphipods (small crustaceans used by fish for food) and, to a lesser extent, (4) on insect larvae. Larger fish may also feed on the opossum shrimp (*Neomysis mercedis*). The most important food organism for all sizes seems to be the euryhaline copepod (*Eurytemora affinis*), although in recent years the exotic species, *Pseudodiaptomus forbesi*, has become a major part of the diet (Moyle *et al.* 1992). Delta smelt are a minor prey item of juvenile and subadult striped bass (*Morone saxatilis*) in the Sacramento-San Joaquin Delta (Stevens 1966). They also have been reported from the stomach contents of white catfish (*Ameiurus catus*) (Turner 1966 *in* Turner and Kelley (eds) 1966) and black crappie (*Pomoxis nigromaculatus*) (Turner 1966 *in* Turner and Kelley 1966) in the Delta.

Abundance. The smelt is endemic to Suisun Bay upstream of San Francisco Bay and throughout the Delta, in Contra Costa, Sacramento, San Joaquin, Solano and Yolo counties, California. Historically, the smelt is thought to have occurred from Suisun Bay and Montezuma Slough, upstream to at least Verona on the Sacramento River, and Mossdale on the San Joaquin River (Moyle *et al.* 1992, Sweetnam and Stevens 1993).

Since the 1850s, however, the amount and extent of suitable habitat for the delta smelt has declined dramatically. The advent in 1853 of hydraulic mining in the Sacramento and San Joaquin rivers led to an increase in siltation and the alteration of the circulation patterns of the Estuary (Nichols *et al.* 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94% of the Estuary's tidal marshes (Nichols *et al.* 1986, Monroe and Kelly 1992). The extensive levee system in the Delta has led to a loss of seasonally flooded habitat and significantly changed the hydrology of the Delta ecosystem, restricting the ability of suitable habitat substrates to re-vegetate.

Delta smelt were once one of the most common pelagic (living in open water away from the bottom) fish in the upper Sacramento-San Joaquin estuary, as indicated by its abundance in DFG trawl catches (Erkkila *et al.* 1950; Radtke 1966; Stevens and Miller 1983). Delta smelt abundance from year to year has fluctuated greatly in the past, but between 1982 and 1992 their population was consistently low. The decline became precipitous in 1982 and 1983 due to extremely high outflows and continued through the drought years 1987-1992 (Moyle *et al.* 1992). In 1993, numbers increased considerably, apparently in response to a wet winter and spring. During the period 1982-1992, most of the population was confined to the Sacramento River channel between Collinsville and Rio Vista (D. Sweetnam, DFG unpublished data). This was still an area of high abundance in 1993, but delta smelt were also abundant in Suisun Bay. The actual size of the delta smelt population is not known. However, the pelagic life style of delta smelt, short life span, spawning habits, and relatively low fecundity indicate that a fairly substantial population probably is necessary to keep the species from becoming extinct. Recreation in the Delta has resulted in the presence and propagation of predatory non-native fish such as striped bass. Additionally, recreational boat traffic has led to a loss of habitat from the building of docks and an increase in the rate of erosion resulting from boat wakes. In addition to the loss of habitat, erosion reduces the water quality and retards the production of phytoplankton in the Delta.

In addition to the degradation and loss of estuarine habitat, delta smelt have been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta (Moyle *et al.* 1992). These adverse conditions are primarily a result of the steadily increasing proportion of river flow being diverted from the Delta by the Projects, and occasional droughts (Monroe and Kelly 1992).

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

According to seven abundance indices which provide information on the status of the delta smelt, this species was consistently at low population levels through the 1980's (Stevens *et al.* 1990). These same indices also showed a pronounced decline from historical levels of abundance (Stevens *et al.* 1990). For a large part of its annual life span, this species is associated with the freshwater edge of the mixing zone, where the salinity is approximately 2 ppt. (also described as X2) (Ganssle 1966, Moyle *et al.* 1992, Sweetnam and Stevens 1993). The relationship between the portion of the smelt population west of the Delta as sampled in the summer townet survey and the natural logarithm of Delta outflow from 1959 to 1988, indicates the summer townet index increased dramatically when outflow was between 34,000 and 48,000 cubic feet per second, placing X2 between Chipps and Roe islands (DWR and Reclamation 1994).

Specifically, the summer townet abundance index constitutes one of the more representative indices because the data have been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959) (DFG 2001). The summer townet abundance index measures the abundance and distribution of juvenile delta smelt and provides data on the recruitment potential of the species (DFG 2001). Since 1983, (except for 1986, 1993, and 1994), this index has remained at consistently lower levels than previously found (DFG 2001). These consistently lower levels correlate with the 1983 to 1992 mean location of X2 upstream of the confluence (DFG 2001). The final summer townet index for 2000 was 8.0, a decline from the 11.9 index for the 1999 summer townet. Both of these indices represent an increase from the 1998 index of 3.3. These higher townet indices were followed by the 2001 (3.5), 2002 (4.7), 2003 (1.6), 2004 (2.9) and 2005 (0.3) indices which were well below the pre-decline average of 20.4 (1959-1981, no sampling in 1966-68) (DFG 2005).

The second longest running survey (since 1967), the fall midwater trawl survey (FMWT), measures the abundance and distribution of late juveniles and adult delta smelt in a large geographic area from San Pablo Bay upstream to Rio Vista on the Sacramento River and Stockton on the San Joaquin River (Stevens *et al.* 1990, DFG 1999). The FMWT indicates the abundance of the adult population just prior to upstream spawning migration (DFG 1999). The index calculated from the FMWT uses numbers of sampled fish multiplied by a factor related to the volume of the area sampled (DFG 1999). Until recently, except for 1991, this index has declined irregularly over the past 20 years (DFG 1999). Since 1983, the delta smelt population has exhibited more low FMWT abundance indices, for more consecutive years, than previously recorded (DFG 1999). The 1994 FMWT index of 101.2 was a continuation of this trend (DFG 1999). This occurred despite the high 1994 summer townet index for reasons unknown (DFG 1999). The low 1995 summer townet index value of 3.3 was followed by a high FMWT index of 839 reflecting the benefits of higher flows due to an extremely wet year (DFG 1999, 2001). The 1999 FMWT index of 717, which is an increase from 1998's index (417.6), is the third highest since the start of decline of delta smelt abundance in 1982 (DFG 1999). The FMWT abundance index (127) for 1996 represented the sixth lowest on record (DFG 1999). The 1997 abundance index (360.8) almost tripled since the 1996 survey, despite the low summer townet index (4.0) (DFG 1999, 2001).

Both 2001 TNS and FMWT abundance indices for delta smelt decreased from 2000 (Souza and Bryant 2002, DFG 1999 and 2001). The 2001 TNS delta smelt index (3.5) is less than 1999 (11.9) and 2000 (8.0) but comparable to recent years (1995, 1997, and 1998) when the index ranged from 3.2 to 4.0 (Souza and Bryant 2002, DFG 2001). The 2001 FMWT delta smelt index (603) decreased by 20% from 2000 (756) (Souza and Bryant 2002, DFG 2001). Both surveys exhibited an overall trend of decline in the last three years, but this decline seems more pronounced in the TNS where the 2001 delta smelt index is 95% lower than the greatest index of record (62.5) in 1978 (Souza and Bryant 2002, DFG 2001). The 2002 TNS was 4.7 and then dropped to 1.6 in 2003. The 2002 FMWT index (139) was the seventh lowest on record and the 2003 index was 210. The 2004 TNS index increase to 2.9 but then fell in 2005 to 0.3. The 2004 and 2005 FMWT abundance indices fell to their lowest levels of 74 and 26 respectively. The lowest indices on record for both surveys occurred in 2005 (DFG 2005).

In response to the recent dramatic declines of several species in the Delta, the Interagency Ecological Program (IEP) was instructed to prepare and implement a series of studies to define and understand the nature of the declines, known as the Pelagic Organism Decline (POD). A conceptual model has been constructed based on three factors acting individually or in concert to lower pelagic productivity. They are: 1) contaminants, 2) introduced or invasive species, and 3) water project operations including diverting water for use in Southern California. A triage approach was chosen for 2005 to gain preliminary information that could identify potential causes of these population declines, and to help prioritize future investigations (DFG and DWR 2005).

The Delta Smelt Larval Survey (DSLS), an additional survey initiated in 2005 by DFG, will help determine timing, distribution, and abundance of larvae within the upper San Francisco Estuary. The new survey will also help estimate larval delta smelt losses and determine the magnitude of entrainment of larval delta smelt at the CVP and SWP intakes.

Swimming Behavior. Observations of delta smelt swimming in a swimming flume and in a large tank show that these fish are unsteady, intermittent, slow speed swimmers (Swanson and Cech 1995). At low velocities in the swimming flume (<3 body lengths per second), and during spontaneous, unrestricted swimming in a 1 m tank, smelt consistently swam with a "stroke and glide" behavior. This type of swimming is very efficient; Weihs (1974) predicted energy savings of about 50% for "stroke and glide" swimming compared to steady swimming. However, the maximum speed smelt are able to achieve using this mode of swimming is less than 3 body lengths per second, and the fish did not readily or spontaneously swim at this or higher speeds (Swanson and Cech 1995). Although juvenile delta smelt appear to be stronger swimmers than adults, forced swimming at 3 body lengths per second in a swimming flume was apparently stressful; the smelt were prone to swimming failure and extremely vulnerable to impingement (Swanson and Cech 1995). Delta smelt swimming performance was limited by behavioral rather than physiological or metabolic constraints (Brett 1976).

Summary of the Five Year Review. In summary, the threats of the destruction, modification, or curtailment of its habitat or range resulting from extreme outflow conditions, the operations of the State and Federal water projects, and other water diversions as described in the original listing remain. The only new information concerning the delta smelt's population size and extinction probability indicates that the population is at risk of falling below an effective population size and therefore in danger of becoming extinct. Although the Vernalis Adaptive Management Program and Environmental Water Account have helped to ameliorate these threats, it is unclear how effective these will continue to be over time based on available funding and future demands for water. In addition, there are increased water demands outside the CVP and the SWP, which could also impact delta smelt. The increases in water demands are likely to result in less suitable rearing conditions for delta smelt, increased vulnerability to entrainment, and less water available for maintaining the position of X2. The importance of exposure to toxic chemicals on the population of delta smelt is highly uncertain. Therefore, a recommendation to delist the delta smelt is inappropriate.

In addition, many potential threats have not been sufficiently studied to determine their effects, such as predation, disease, competition, and hybridization. Therefore, a recommendation of a change in classification to endangered is premature.

In his August 24, 2003, letter, the foremost delta smelt expert, Dr. Peter B. Moyle, stated that the delta smelt should continue to be listed as a threatened species (Moyle 2003). In addition, in their January 23, 2004, letter, DFG fully supported that the delta smelt should retain its threatened status under the Act (DFG 2004).

Delta Smelt Critical Habitat

In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation and that may require special management considerations or protection (50 **CFR** §424.12(b)).

The Service is required to list the known primary constituent elements together with the critical habitat description. Such physical and biological features include, but are not limited to, the following:

1. space for individual and population growth, and for normal behavior;

2. food, water, air, light, minerals, or other nutritional or physiological requirements;

3. cover or shelter;

4. sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and

5. generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration. Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay.

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

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

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

The Service's 1994 and 1995 biological opinions on the operations of the CVP and SWP provided for adequate larval and juvenile transport flows, rearing habitat, and protection from entrainment for upstream migrating adults (Service 1994c, 1995). Please refer to 59 **FR** 65255 for additional information on delta smelt critical habitat.

Giant Garter Snake

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

Description. The giant garter snake is one of the largest garter snakes species reaching a total length of approximately 64 inches. 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 thought to have extended from the vicinity of Chico, 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 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 (Service 1993). The 13 populations largely coincide with historical flood basins and 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, (9) Caldoni Marsh/White Slough, (10) East Stockton--Diverting Canal & Duck Creek, (11) North and South Grasslands, (12) Mendota, and (13) Burrel/Lanare.

The known range of the giant garter snake has changed little since the time of listing. In 2005, giant garter snakes were observed at the City of Chico's wastewater treatment facility, approximately ten miles north of what was previously believed to be the northernmost extent of the species' range (D. Kelly pers. comm. 2006; E. Hansen pers. comm. 2006). The southernmost known occurrence is at the Mendota Wildlife Area in Fresno County. No sightings of giant garter snakes south of Mendota Wildlife Area within the historic range of the species have been made since the time of listing (Hansen 2002).

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 (Service 1999). Essential habitat components consist of: (1) wetlands with adequate water during the snake's active season (early-spring through mid-fall) to provide food and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat during the active season; (3) upland habitat with grassy banks and openings in waterside vegetation for basking; and (4) higher elevation uplands for over-wintering habitat with escape cover (vegetation, burrows) and underground refugia (crevices and small mammal burrows) (Hansen 1988). 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).

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 (Fitch 1941). Because the giant garter snake's historic prey species are either declining, extirpated, or extinct, the predominant food items are now introduced species such as carp (*Cyprinus carpio*), mosquito-fish (*Gambusia affinis*), larval and sub-adult bullfrogs (*Rana catesbiana*), and Pacific chorus frogs (*Pseudacris regilla*) (Fitch 1941; Hansen 1988; Hansen and Brode 1980, 1993; Rossman *et al.* 1996).

Reproductive Ecology. The giant garter snake breeding season extends through March and April, and females give birth to live young from late July through early September (Hansen and Hansen 1990). Although growth rates are variable, young typically more than double in size by one year of age, and sexual maturity averages three years in males and five years for females (Service 1993b).

Movements and Habitat Use. The giant garter snake is highly aquatic but also occupies a terrestrial niche (Service 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.* 1995; 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). While individuals usually remain in close proximity to wetland habitats, the Biological Resource Division of the U.S. Geological Survey (BRD) has documented snakes using burrows as much as 165 feet away from the marsh edge to escape extreme heat, and as far as 820 feet from the edge of marsh habitat for over-wintering habitat (Wylie *et al.* 1997).

In studies of marked snakes in the Natomas Basin, snakes moved about 0.25 to 0.5 miles per day (Hansen and Brode 1993). Total activity, however, varies widely between individuals; individual snakes have been documented to move up to 5 miles over a few days in response to dewatering of habitat (Wylie *et al.* 1997) and to use up to more than 8 miles of linear aquatic habitat over the course of a few months. Home range (area of daily activity) averages about 61 acres in both the Natomas Basin and the Colusa National Wildlife Refuge (NWR) (Wylie 1998a; Wylie *et al.* 2002), yet can be as large as 9,252 acres (Wylie and Martin 2004).

Rice fields have become important habitat for giant garter snakes, particularly associated canals and their banks for both spring and summer active behavior and winter hibernation (Hansen 2004; Wylie 1998b). While within the rice fields, snakes forage in the shallow water for prey, utilizing rice plants and vegetated berms dividing rice checks for shelter and basking sites (Hansen and Brode 1993). In the Natomas Basin, habitat used consisted almost entirely of irrigation ditches and established rice fields (Wylie 1998a; 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 vegetative cover exceeds 50 percent in the area (Wylie 1998b).

Predators. Giant garter snakes are killed and/or eaten by a variety of predators, including raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), opossums (*Didelphis virginiansa*), bull frogs (*Rana catesbiana*), hawks (*Buteo* sp.), egrets (*Casmerodius albus, Egretta thula*), river otters (*Ludra canadensis),* and great blue herons (*Ardea herodias*) (Dickert 2003; Wylie *et al.* 2003c; G. Wylie pers. comm. 2006). Many areas supporting snakes have been documented to have abundant predators; however, predation does not seem to be a limiting factor in areas that provide abundant cover, high concentrations of prey items, and connectivity to a permanent water source (Hansen and Brode 1993; Wylie *et al.* 1995).

Reasons for Decline and Threats to Survival. The current distribution and abundance of the giant garter snake is much reduced from former times (Service 1999). Prior to reclamation activities beginning in the mid- to late-1800s, about 60 percent of the Sacramento Valley was subject to seasonal overflow flooding providing expansive areas of snake habitat (Hinds 1952). Now, less than 10 percent, or approximately 319,000 acres, of the historic 4.5 million acres of Central Valley wetlands remain (U.S. Department of Interior 1994), of which very little provides habitat suitable for the giant garter snake. Loss of habitat due to 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 (Hansen 1980; Hansen and Brode 1980).

Valley flood 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 (U.S. Department of Interior 1994). Further, the implementation of CVP has resulted in conversion of native habitats to agriculture, and has facilitated urban development through the Central Valley (Service 1999). For instance, residential and commercial growth with the Central Valley is consuming an estimated 15,000 acres of Central Valley farmland each year (American Farmland Trust 1999), with a project loss of more than one million acres by the year 2040 (USGS 2003). Environmental impacts associated with urbanization include loss of biodiversity and habitat, alternation 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, Yuba City, the Sacramento area, Galt, Stockton, Gustine, and Los Banos.

Ongoing maintenance of aquatic habitats for flood control and agricultural purposes eliminates or prevents the establishment of habitat characteristics required by snakes (Hansen 1988). Such practices can fragment and isolate available habitat, prevent dispersal of snakes among habitat units, and adversely affect the availability of the snake's food items (Hansen 1988; Brode and Hansen 1992). For example, tilling, grading, harvesting and mowing may kill or injure giant garter snakes (Service 2003; Wylie *et al.* 1997). Biocides applied to control aquatic vegetation reduce cover for the snake and may harm prey species (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 constriction sites, can entangle and kill snakes (Stuart *et al.* 2001; Barton and Kinkead 2005). Livestock grazing along the edges of water sources degrades water quality and can contribute to the elimination and reduction of available quality snake habitat (Hansen 1988; E. Hansen, pers. comm.. 2006), and giant garter snakes have been observed to avoid areas that are grazed (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, 2004b).

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

Nonnative predators, including introduced predatory game fish, bullfrogs, and domestic cats, can threaten snake populations (Dickert 2003; Hansen 1986; Service 1993; Wylie *et al.* 1996; 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).

The disappearance of giant garter snakes from much of the west side of the San Joaquin Valley was approximately contemporaneous with the expansion of subsurface drainage systems in this area, providing circumstantial evidence that the resulting contamination of ditches and sloughs with drainwater constituents (principally selenium) may have contributed to the demise of giant garter snake populations. Dietary uptake is the principle route of toxic exposure to selenium in wildlife, including giant garter snakes (Beckon *et al.* 2003). Many open ditches in the northern San Joaquin Valley carry subsurface drainwater with elevated concentrations of selenium, and green sunfish (*Lepomis cyanellus*) have been found to have concentrations of selenium within the range of concentrations associated with adverse affects on predator aquatic reptiles (Hopkins *et al.* 2002; Saiki 1998). Studies on the effects of selenium on snakes suggest that snakes with high selenium loads in their internal organs can transfer potentially toxic quantities of selenium to their eggs (Hopkins *et al.* 2004) and also demonstrate higher rates of metabolic activity than uncontaminated snakes (Hopkins *et al.* 1999).

Status with Respect to Recovery. The draft recovery plan for the giant garter snake subdivides its range into three proposed recovery units (Service 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 (Service 1999; Service 2006). Protected snake habitat is located on State refuges and refuges of the Sacramento National Wildlife Refuge (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.* 2002; 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 encroachment.

The Mid-Valley Unit includes sub-populations in the American, Yolo, and Delta Basins (Service 1999; Service 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 (E. Hansen 2002, 2004; Service 1993b; Wylie 2003; Wylie and Martin 2004; Wylie *et al.* 2004b; Wylie *et al.* 2005; G. Wylie pers. comm. 2006). The American Basin sub-population, although threatened by urban development, receives protection from the Metro Air Park and Natomas Basin Habitat Conservation Plans, which share a regional strategy to maintain a viable snake sub-population in the basin.

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 1998a). Giant garter snakes currently occur in the northern and central San Joaquin Basin within the Grassland Wetlands of Merced County and the Mendota Wildlife Area of Fresno County; however, these sub-populations remain small, fragmented, and unstable, and are probably decreasing (Dickert 2003, 2005; G. Wylie pers. comm., 2006).

The South Valley Unit included sub-populations in the Tulare Basin, however, agricultural and flood control activities are presumed to have extirpated the snake from the Tulare Basin (Hansen 1995). Comprehensive surveys for this area are lacking and where habitat remains, the giant garter snake may be present.

Since 1995, BRD has studied snake sub-populations at the Sacramento, Delevan, and Colusa NWRs and in the Colusa Basin Drain within the Colusa Basin, at Gilsizer Slough within the Sutter Basin, at the Badger Creek area of the Cosumnes River Preserve within the Badger Creek/Willow Creek area of the Delta Basin, and in the Natomas Basin within the American Basin (Hansen 2003, 2004; Wylie 1998a, 1998b, 2003; Wylie *et al.* 1995; Wylie *et al.* 2002; Wylie *et al.* 2003a, 2004a; Wylie *et al.* 2003b, 2004b). These areas contain the largest extant giant garter snake sub-populations. Outside of protected areas, however, snakes are still subject to all threats identified in the final rule. The other sub-populations are distributed discontinuously in small, isolated patches, and are vulnerable to extirpation by stochastic environmental, demographic, and genetic processes (Goodman 1987).

The revised draft recovery criteria require multiple, stable sub-populations within each of the three 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 (Service 2003). Currently, only the Sacramento Valley Recovery Unit is known to support relatively large, stable giant garter snake populations. 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.

Summary of the Five Year Review. The abundance and distribution of giant garter snakes has not changed significantly since the time of listing. Although some snakes have been rediscovered in several southern populations that were thought to be extirpated, these populations remain in danger of extirpation because their numbers remain very low and the habitat is of low quality.

By far the most serious threats to giant garter 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. The remaining threats (such as from introduced predators, roads, erosion control) are secondary to such habitat loss although habitat fragmentation could become a critical issue in the snake's survival should large scale habitat changes occur. 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.

Because the giant garter snake continues to be threatened by various forms of habitat loss, we believe that it continues to meet the definition of a threatened species and recommend that its status be unchanged.

Environmental Baseline

Delta Smelt

Adult delta smelt spawn in central Delta sloughs from February through August in shallow water areas having submersed aquatic plants and other suitable substrates and refugia. These shallow water areas have been identified in the Delta Native Fishes Recovery Plan (Recovery Plan) (Service 1996) as essential to the long-term survival and recovery of delta smelt and other resident fish. A no net loss strategy of delta smelt population and habitat is proposed in this Recovery Plan.

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

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

The results of seven surveys conducted by the IEP corroborate the dramatic decline in delta smelt. Existing baseline conditions, as mandated for delta smelt under the Service's consultations on CVP operations (Service 1994b, 1995), provide sufficient Delta outflows from February 1 through June 30 to allow larval and juvenile delta smelt to move out of the "zone of influence" of the CVP and SWP pumps, and provide them low salinity, productive rearing habitat. This zone of influence has been delineated by DWR's Particle Tracking Model and expands or contracts with CVP and SWP combined pumping increases or decreases, respectively (DWR and Reclamation 1993). With tidal effects contributing additional movement, the influence of the pumps may entrain larvae and juveniles as far west as the Confluence.

According to seven abundance indices designed to record trends in the status of the delta smelt, this species was consistently at low population levels during the last ten years (Stevens *et al.* 1990). These same indices also show a pronounced decline from historical levels of abundance (Stevens *et al.* 1990). The summer townet abundance index constitutes one of the more representative indices because the data have been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959). The summer townet abundance index measures the abundance and distribution of juvenile delta smelt and provides data on the recruitment potential of the species. Except for three years since 1983 (1986, 1993, and 1994), this index has remained at consistently lower levels than experienced previously. As indicated, these consistently lower levels correlate with the 1983 to 1992 mean location of X2 upstream of the Confluence, Chipps and Roe islands.

The second longest running survey (since 1967), the fall midwater trawl survey (FMWT), measures the abundance and distribution of late juveniles and adult delta smelt in a large geographic area from San Pablo Bay upstream to Rio Vista on the Sacramento River and Stockton on the San Joaquin River (Stevens *et al.* 1990). The fall midwater trawl provides an indication of the abundance of the adult population just prior to upstream spawning migration. The index that is calculated from the FMWT survey uses numbers of sampled fish multiplied by a factor related to the volume of the area sampled. Until recently, except for 1991, this index has declined irregularly over the past 20 years. Since 1983, the delta smelt population has exhibited more low fall midwater trawl abundance indices, for more consecutive years, than previously recorded. The 1994 FMWT index of 101.7 is a continuation of this trend. This occurred despite the high 1994 summer townet index for reasons unknown. The 1995 summer townet was a low index value of 319 but resulted in a high FMWT index of 898.7 reflecting the benefits of large transport and habitat maintenance flows with the Bay-Delta Accord in place and a wet year. The abundance index of 128.3 for 1996 represented the fourth lowest on record. The abundance index of 305.6 for 1997 demonstrated that the relative abundance of delta smelt almost tripled over last years results, and delta smelt abundance continued to rise, peaking in 1999 to an abundance index of 863, only to fall back down to the low abundance. The lowest indices on record for both surveys occurred in 2005. The summer townet index was 0.3 and the fall midwater index was 26 (DFG 2005). The 2006 summer townet .index for delta smelt is 0.4. Additional sampling outside of the historical sampling area indicates that this index may be biased low due to fish outside the sampling area (DFG 2006).

The project is within delta smelt critical habitat. Service and DFG studies have recorded delta smelt in vicinity of the project site and other study sites. Therefore, the Service considers that delta smelt occur within the action area.

Giant Garter Snake

The overall status of the giant garter snake has not improved since its listing. Based on scarcity of suitable habitat and limited population size, at listing, threats to the Delta Basin population were considered imminent (Service 1993b). The status of the Delta Basin sub-population has been, and continues to be, impacted by past and present Federal, state, private, and other human activities.

A number of State, local, private, and unrelated Federal actions have occurred within the action area and adjacent regions affecting the environmental baseline of the species. Some of these projects have been subject to prior section 7 consultation. These actions have resulted in both direct and indirect effects to snake habitat within the region. Projects affecting the environment in and around the action area include the improvement of the Northgate Boulevard/Arden-Garden Connector Intersection, the widening of Bond Road, construction of the Interstate 5/Consumnes River Boulevard Interchange, the Freeport Regional Water Diversion project, the Rivermont Drive Bridge project, the Rio Vista Northwest Wastewater Treatment project, the widening of

Calvine Road, and the Kramer Ranch North project. In the past ten years, the Service has authorized take resulting in the permanent loss of more than 21 acres of aquatic and 53 acres of upland snake habitat, as well as temporary alteration of over 1,700 acres of aquatic and 650 acres of upland snake habitat in the Delta Basin.

Numerous recent development projects have been constructed in or near snake habitat in the rapidly developing areas in and around the cities of Sacramento, Elk Grove, Galt, and Stockton. Urban and commercial development results in direct habitat loss and also may expose snakes to secondary effects including water pollution from urban run-off and increased vehicular mortality, both of which act in concert with rapid habitat loss and degradation to further threaten the snake in the Delta Basin. Also, development promotes road widening and bridge replacements, such as those authorized under section 7, which result in direct alteration of snake habitat. Most documented snake localities and/or movement corridors have been adversely impacted by development, including freeway construction, flood control projects, and commercial development. Further, several former localities are known to have been lost and/or depleted to that extent that continued viability is in question (Brode and Hansen 1992). The scarcity of remaining suitable habitat, flooding, stochastic processes, and continued threats of habitat loss pose a severe imminent threat to giant garter snakes in the Delta Basin.

Ongoing agricultural and flood control activities in the Delta Basin may decrease and degrade the remaining snake habitat affecting the environmental baseline for the snake. Such activities are largely not subject to section 7 consultation. Although rice fields and agricultural waterways can provide valuable seasonal foraging and upland habitat for the snake, agricultural activities such as waterway maintenance, weed abatement, rodent control, and discharge of contaminants into wetlands and waterways can degrade snake habitat and increase the risk of snake mortality (Service 2003). On-going maintenance of agricultural waterways can also eliminate or prevent establishment of snake habitat, eliminate food resources for the snake, and fragment existing habitat and prevent dispersal of snakes (Service 2003).

Flood control and maintenance activities which can result in snake mortality and degradation of habitat include levee construction, stream channelization, and rip-rapping of streams and canals (Service 2003). Flood control programs are administered by the U.S. Army Corps of Engineers (Corps), and the Corps has typically consulted on previous projects and is expected to continue to do so for future projects. The ongoing nature of these activities and the administration under various programs, however, makes it difficult to determine the continuing and accumulative effects of these activities.

In addition to projects already discussed, projects affecting the environment in and around the action area include transportation projects with Federal, county, or local involvement. The Federal Highway Administration and/or the Corps have consulted with the Service on the issuance of wetland fill permits for several transportation-related projects within the Delta Basin that affected snake habitat. The direct effect of these projects is often small and localized, but the effects of transportation projects, which improve access and therefore indirectly affect snakes by facilitating further development of habitat in the area and by increasing snake mortality via vehicles, are not quantifiable.

The proposed project is located within the Delta Basin snake population, in the Mid Valley Recovery Unit (Service 1999). Twenty-five CNDDB (2006) records are known from the Delta Basin. These records include Laguna Creek, Morrison Creek, Snodgrass Slough, Beach Lake, creeks in the City of Elk Grove, Badger and Willow Creeks, Consumnes River Preserve, Caldoni Marsh, White Slough, Duck Creek and other locations within the Basin.

During a field reconnaissance in April 2002, a giant garter snake was observed on the southwestern levee of Webb Tract. Since then, habitat evaluations and snake surveys have been conducted on Webb Tract and Bacon Island (Patterson 2004; Patterson and Hansen 2003). Potential snake habitat in the area exists in the form of contiguous linear irrigation canals and ditches. However, although both islands possess the essential snake habitat components, two years of surveys resulted in no further sightings or capture of giant garter snakes.
Recent genetic work on giant garter snake population structure indicates three genetic entities within the species which follow the pattern of subdivision revealed by the snake's mitochondrial DNA and color pattern variants: north, central, and south (Paquin 2001; Paquin *et al.* 2006). Interestingly, evidence of historical gene flow between northern and southern populations exists; however, mitochondrial DNA data reveal that the central population, analogous to the Delta Basin, is genetically isolated from both northern and southern populations. High frequencies of unique mitochondrial DNA haplotypes in the central population increase the conservation value for the Delta Basin, particularly as a source for giant garter snake genetic diversity.

Laguna and Morrison Creek, Duck Creek, the Elk Grove creeks, as well as Beach Lake, Snodgrass Slough, Caldoni Marsh, White Slough and associated tributaries, are important snake habitat and movement corridors for the animal. Such waterways and associated wetlands provide vital permanent aquatic and upland habitat for snakes in areas with otherwise limited habitat. The recovery strategy for the snake includes maintenance and/or creation of habitat corridors between existing sub-populations to enhance population interchange and offset threats to the species (Service 2003).

According to the CNDDB (2006), the nearest snake record to the proposed project site is within 9 miles from the proposed project footprint. Snakes have been documented to move up to 5 miles over a few days in response to dewatering of habitat (Wylie *et al.* 1997) and to use up to more than 8 miles of linear aquatic habitat over the course of a few months (Wylie and Martin 2004). The action area contains habitat components that can be used by the snake for feeding, resting, mating, and other essential behaviors, as well as for a movement corridor. Because of the biology and ecology of the snake, the presence of suitable habitat within the proposed project, and observations of the species, the Service has determined that the snake is reasonably certain to occur within the action area.

Effects of the Proposed Action

Delta smelt

The proposed project will result in direct effects to approximately 0.7 acres of shallow water habitat SWH. SWH is defined as all waters between Mean High Water and 3-meters below Mean Lower Low Water mark. These waters are within the photic zone and are highly productive. A shadow zone is the shadow created by a structure placed over or in the waterways within the range of the delta smelt within the SWH zone. This causes a loss of productivity, thinning and loss of aquatic vegetation and prevention of its growth. The acquisition, conservation, funding, and management of at least 2.1 acres (3:1 ratio) of shallow water habitat at a mitigation bank or other location approved by the Service, DFG, and NMFS will minimize the effects of this loss of habitat. Areas of habitat modification have been reduced from those estimated in the ASIP due to design improvements based in input from the Anadromous Fish Screen Program Technical Team.

In water construction activities and maintenance would increase exposure of delta smelt and other species to sound pressure levels, turbidity, suspended sediment, and possibly other contaminants. While these levels are estimated to occur below levels that have been reported to cause adverse effects to Chinook salmon little is known about the sensitivity on delta smelt. The dewatering of the cofferdam has the potential to strand delta smelt and its food source. These effects would be minimized by working in the in-water work window and implementing the conservation measures in the project description.

The proposed fish screen and intake would physically exclude delta smelt from the area and modify habitat. The intake structure will modify hydraulic and habitat conditions adjacent to the intake structure and could attract predatory fish. Habitat modification in the immediate vicinity of the intake structure include changes in current patterns, sediment deposition, erosion, and riprap as part of construction and channel bank stabilization. The proposed project would minimize some of these effects by reducing pumping from the unscreened Rock Slough intake structure where predatory fish densities are high.

Although pumping diversions at the proposed intake structure would result in some impingement and entrainment of delta smelt, the modeling shows that the proposed action will reduce CCWD net impingement and entrainment losses as a result from the combination of the use of the positive barrier fish screen, reduced diversions at Rock Slough and Old River intakes, and timing shifts in some CCWD diversions. The operations of the proposed intake structure has the potential to entrain delta smelt eggs and larvae that are not excluded by the fish screen. An indirect effect of increased delta smelt impingement and entrainment from other water diversions could occur if the proposed action substantially modifies delta conditions. Modeling has shown that the proposed action would have minimal effects on other diversions. Shifting the timing of water diversions and/or relocating some diversions from the unscreened intake at Rock Slough to the screened Old River or proposed intakes could reduce entrainment and impingement.

Giant garter snake

Giant garter snakes could be injured or killed during excavation for levee improvements, during construction of proposed intake facilities or during the installation of the proposed pipeline. The entire pipeline length will be about 11,500 feet. The proposed route includes 10 ditch crossings. Any ditches that potentially could be affected by construction conveyance pipeline across

Victoria Island and Byron Tract would be siphoned under, rerouted, crossed over, or replaced. The temporal pipeline construction effects within potential giant garter snake aquatic and upland habitat would be approximately 30 acres. The levees would be temporarily disturbed during installation of the new intake structure. An existing ditch along the toe of the levee would have 900 feet filled but would be replaced with a 1,050-foot long ditch. These effects would be minimized by implementing the conservation measures in the project description.

Mats and rolled erosion control products containing net-like mesh made of fibers such as nylon, plastic or jute twine, which hold materials such as straw and jute, have been found to be hazardous to several species of snakes (Stuart *et al.* 2001, Barton and Kinkead 2005). The snakes' scales catch on the netting, preventing the snakes from escaping by backing out of the mesh; the snakes then move forward into the small mesh opening which can trap the animals. The resulting lacerations from trying to escape and subsequent overheating or exposure to predators can result in death of the snakes (Stuart *et al.* 2001, Barton and Kinkead 2005).

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.

Delta smelt

Any continuing or future non-Federal diversions of water that may entrain adult or larval fish would have cumulative effects to the smelt. Water diversions through intakes serving numerous small, private agricultural lands contribute to these cumulative effects. These diversions also include municipal and industrial uses. State or local levee maintenance may also destroy or adversely modify spawning or rearing habitat and interfere with natural long term habitat-maintaining processes (Service 2000).

Additional cumulative effects result from the impacts of point and non-point source chemical contaminant discharges. These contaminants include but are not limited to selenium and numerous pesticides and herbicides as well as oil and gasoline products associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality for smelt, these contaminants may adversely affect fish reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants, used a substrates for adhesive egg attachment, are lost due to toxic substances.

Other cumulative effects could include: the dumping of domestic and industrial garbage may present hazards to the fish because they could become trapped in the debris, injure themselves, or ingest the debris; golf courses reduce habitat and introduce pesticides and herbicides into the environment; oil and gas development and production remove habitat and may introduce pollutants into the water; agricultural uses on levees reduce riparian and wetland habitats; and grazing activities may degrade or reduce suitable habitat, which could reduce vegetation in or near waterways. These cumulative effects further contribute to reducing the respective environmental baselines for the smelt.

Giant garter snake

Because the giant garter snake inhabits wetlands and adjacent uplands in highly modified portions of the Central Valley, the Service anticipates that a wide range of activities will affect this species. An undetermined number of future land use conversions and routine agricultural practices are not subject to Federal permitting processes and may convert or otherwise alter habitat or disturb, kill, or injure snakes. These cumulative effects include: (1) fluctuations in acres aquatic habitat due to water management or acres of ricelands in production; (2) diversion of water; (3) levee repairs; (4) riprapping or lining of canals and stream banks; (5) dredging, clearing and spraying to remove vegetation adjacent to canals and streams; (7) use of burrow fumigants on levees and other potential upland refugia; (8) release of contaminated runoff from agriculture and urbanization; (9) use of plastic erosion control netting; (10) use of herbicides and pesticides in ricelands and other agricultural lands that provide snake habitat, or which are adjacent to and/or drain into snake habitat; (11) increased vehicular traffic on roads and levees; (12) human intrusion into habitat; and (13) predation by feral animals and pets.

Conclusion

After reviewing the current status of the delta smelt and giant garter snake, environmental baselines for the species, the effects of the proposed action, and the cumulative effects on these species, it is the Service's biological opinion that the proposed construction of the Alternative Intake Project, as described herein, is not likely to jeopardize the continued existence of the delta smelt or giant garter snake. The proposed action is located in delta smelt critical habitat, but will not be adversely modified by the proposed action. Critical habitat for the giant garter snake has not been proposed or designated; therefore, none will be adversely modified or destroyed.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, 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 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.

The measures described below are nondiscretionary and must be implemented by Reclamation so they become binding conditions of any 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 that is covered by this incidental take statement. If Reclamation (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the 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.

Amount or Extent of Take

The Service expects that incidental take of smelt will be difficult to detect or quantify for the following reasons: the small size of smelt eggs and larvae; their occurrence in aquatic habitat makes them difficult to detect; and the low likelihood of finding dead or impaired specimens. Due to the difficulty in quantifying the number of smelt that will be taken as a result of the proposed action, the Service is quantifying take incidental to the project in terms of acres of habitat that will become unsuitable for the species as a result of the action. Therefore, the Service estimates that 0.7 acres of shallow water habitat will become unsuitable as a result of the proposed project. In addition, an unquantifiable number of delta smelt eggs, larvae and adults may be killed, harmed, or harassed as a result of the construction activities and on-going operations of the water diversions at the proposed intake. Upon implementation of the following reasonable and prudent measures, incidental take associated with the construction and implementation of the proposed intake structure the form of 0.7 acres of shallow water habitat will become exempt from the prohibitions described under section 9 of the Act.

The Service anticipates that incidental take of the snake will be difficult to detect or quantify for the following reasons: giant garter snakes are cryptically colored, secretive, and known to be sensitive to human activities. Snakes may avoid detection by retreating to burrows, soil crevices, vegetation, or other cover. Individual snakes are difficult to detect unless they are observed, undisturbed, at a distance. Most close-range observations represent chance encounters that are difficult to predict. It is not possible to make an accurate estimate of the number of snakes that will be harassed or harmed during construction activities. In instances when take is difficult to detect, the Service may estimate take in numbers of species per acre of habitat lost or degraded as a result of the action. Therefore, the Service anticipates that all giant garter snakes inhabiting approximately 30 acres of aquatic and adjacent upland habitat may be harassed or harmed by loss and destruction of habitat as a result of the project. Upon implementation of the following reasonable and prudent measures, incidental take associated with the construction of the proposed project in the form of 30 acres of aquatic and adjacent upland habitat will become exempt from the prohibitions described under section 9 of the Act.

Effect of the Take

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the delta smelt or giant garter snake. The proposed action is located in delta smelt critical habitat but will not be adversely modified. Critical habitat has not been proposed or designated for the giant garter snake; therefore, none will be affected.

Reasonable and Prudent Measures

The Service has determined that the following reasonable and prudent measures are necessary and appropriate to minimize the effects of the proposed project on the snake.

1. CCWD shall implement the project as described in the May 2006 ASIP and this biological opinion.

2. Reduce effects to the delta smelt.

3. Reduce effects to the giant garter snake.

4. Reclamation shall ensure CCWD's compliance with this biological opinion.

Terms and Conditions

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

1. The following Terms and Conditions implement Reasonable and Prudent Measure one (1):

   a. CCWD shall minimize the potential for harm, harassment, or killing of federally listed wildlife species resulting from project related activities by implementation of the Conservation Measures as described in the May 2006 ASIP and appearing in the Project Description of this biological opinion.

   b. CCWD shall make the terms and conditions in this biological opinion a required term in all contracts for the project that are issued by them to all contractors.

2. The following Terms and Conditions implement Reasonable and Prudent Measure two (2):

   a. The project proponent shall avoid areas having emersed or submersed plants to the maximum extent possible.

3. The following Terms and Conditions implement Reasonable and Prudent Measure three (3):

   a. Plastic mono-filament netting (erosion control matting) will not be used for erosion control or other purposes at the proposed project site. Snakes may become entangled in it. Acceptable substitutes include coconut coir matting or tackified hydroseeding.

b. Upon completion of the proposed action, all giant garter snake habitat subject to temporary ground disturbances, including storage and staging areas, temporary roads, etc. must be re-contoured, if appropriate, and revegetated with seeds and/or cuttings of appropriate plant species to promote restoration of the area to pre-project conditions. Areas of temporary disturbance are expected to be returned to pre-project conditions within one season following construction. An area subject to "temporary" disturbance means any area that is disturbed during the project, but that after project completion will not be subject to further disturbance and has the potential to be revegetated. To the maximum extent practicable (i.e., presence of natural lands), topsoil shall be removed, cached, and returned to the site according to successful restoration protocols. Loss of soil from run-off or erosion shall be prevented with straw bales, straw wattles, or similar means provided they do not entangle, block escape or dispersal routes of listed animal species. A biologist shall ensure that areas subject to temporary disturbance have been adequately restored, and this information is included under the final reports described in the Reporting Requirements of this biological opinion.

4. The following Terms and Conditions implement Reasonable and Prudent Measure four (4):

   a. If requested, during or upon completion of construction activities, the on-site biologist, and/or a representative from CCWD shall accompany Service or DFG personnel on an on-site inspection of the site to review project effects to the delta smelt, giant garter snake and their habitats.

   b. Reclamation shall ensure CCWD complies with the Reporting Requirements of this biological opinion.

Reporting Requirements

A post-construction compliance report prepared by the monitoring biologists must be submitted to the Deputy Assistant Field Supervisor of the Endangered Species Division at the Sacramento Fish and Wildlife Office within thirty (30) calendar days of the completion of construction activity or within thirty (30) calendar days of any break in construction activity lasting more than thirty (30) calendar days. This report shall detail (i) dates that groundbreaking at the project started and the project was completed; (ii) pertinent information concerning the success of the project in meeting compensation and other conservation measures; (iii) an explanation of failure to meet such measures, if any; (iv) known project effects on the delta smelt and giant garter snake, if any; (v) occurrences of incidental take of the snake; and (vi) other pertinent information.

Reclamation must require the project applicant to immediately report to the Service any information about take or suspected take of federally-listed species not authorized in this biological opinion. The project applicant must notify the Service within 24 hours of receiving such information. Notification must include the date, time, and location of the incident or of the finding of a dead or injured animal. Injured giant garter snakes must be cared for by a licensed veterinarian or other qualified person, such as the on-site biologist; dead individuals should be preserved according to standard museum techniques and held in a secure location. In the case of a dead animal, the individual animal should be preserved, as appropriate, and held in a secure location until instructions are received from the Service regarding the disposition of the specimen or the Service takes custody of the specimen. Any killed specimens of fish that have been taken should be properly preserved in accordance with Natural History Museum of Los Angeles County policy of accessioning (10% formalin in quart jar or freezing). Information concerning how the fish was taken, length of the interval between death and preservation, the water temperature and outflow/tide conditions, and any other relevant information should be written on 100% rag content paper with permanent ink and included in the container with the specimen. The Service contact persons are Chris Nagano, Deputy Assistant Field Supervisor, at (916) 414-6600, and Scott Heard, Resident Agent-in-charge of the Service's Law Enforcement Division at (916) 414-6660.

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

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of 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 data bases.

1. The Service recommends the Reclamation develop and implement restoration measures in area designated in the Delta Fishes Recovery Plan (Service 1996).

2. The Service recommends the Reclamation develop procedures that minimize the effects of all other in-water activities on delta smelt.

3. The Reclamation should assist in the implementation of the draft, and when published, the final Recovery Plan for the garter snake.

To be kept informed of actions minimizing or avoiding adverse effects or benefiting listed and proposed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

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

If you have any questions regarding this biological opinion on the proposed action, please contact Kim Squires or Ryan Olah of the Sacramento Fish and Wildlife Office at (916) 414-6625.

cc:
Samantha Salvia, Contra Costa Water District, Concord, California
Bruce Oppenheim, NMFS, Sacramento, California
Anna Holmes, California Department of Fish and Game, Stockton, California

LITERATURE CITED

American Farmland Trust. 1999. California's Central Valley Urban Sprawl 2040 Zone of Conflict. Farmland Information Library. Available: http://farm.fic.niu.edu/fic/ft/cv.html

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

______ 1979. Factors influencing the entrapment of suspended material in the San Francisco Bay-Delta Estuary. Pages 143-174 *in* T.J. Conomos, editor. Pacific Division, American Association for the Advancement of Science, San Francisco, California.

______ 1980. The significance of the entrapment zone location to the phytoplankton standing crop in the San Francisco Bay-Delta Estuary. U.S. Department of Interior, Water and Power Resources Service.

Barton, C. and K. Kinkead. 2005. Do Erosion Control and Snakes Mesh? Journal of Soil and Water Conservation 60(2):33A-35A.

Beam, J. A. and T. M. Menges. 1997. Evaluation of management practices on state-owned wildlife Areas and private duck clubs in the Grasslands Basin of the San Joaquin Valley relative to the giant garter snake (*Thamnophis gigas*). Unpublished report. California Department of Fish and Game, Los Banos, California. 9 pp.

Beckon, W. N., M. C. S. Eacock, A. Gordus, and J. D. Henderson. 2003. Biological effects of the Grassland Bypass Project. Ch. 7 *in* Grassland Bypass Project Annual Report 2001-2002. San Francisco Estuary Institute, Oakland, California

Brett, J.R. 1976. Scope for metabolism and growth of sockeye salmon *Oncorhynchus nerka*, and some related energetics. Journal of the Fisheries Research Board of Canada 33:307-313.

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, California. January 1992. 24 pp. + Appendix.

California Department of Fish and Game. 1999. Fall Midwater Trawl [database on the internet]. Available from http://www.delta.ca.gov/data/mwt99/index.html.

______ 2000. 20mm Survey [database on the internet]. Available from http://www.delta.ca.gov/data/20mm/2000/.

______ 2001. 2001 Summer Townet Survey [database on the internet]. Available from http://www.delta.dfg.ca.gov/data/skt/skt2002/index.html.

______ 2004. Comment Letter on the Five Year Status Review of the Delta Smelt. 2 pp.

______ 2005. Fall Midwater Trawl [database on the internet]. Available from http://www.delta.dfg.ca.gov.

______ 2005.Summer Townet Survey [database on the internet]. Available from http://www.delta.dfg.ca.gov.

______ 2006. Summer Townet Survey [database on the internet]. Available from http://www.delta.dfg.ca.gov.

California Department of Fish and Game and California Department of Water Resources 2005. Delta Smelt Action Plan. The Resources Agency, Sacramento, California. 89 pp.

California Department of Water Resources and U.S. Bureau of Reclamation, Mid-Pacific Region 1993. Effects of the Central Valley Project and State Water Project on delta smelt. Sacramento County, California. 134 pp.

______ 1994. Effects of the Central Valley Project and State Water Project on delta smelt and Sacramento splittail. Sacramento, California. 230 pp.

California Natural Diversity Data Base (CNDDB). 2006. RareFind 3. California Department of Fish and Game, Natural Heritage Division, Sacramento, California.

Dege, M., and L. R. Brown. 2004. Effect of outflow on spring and summertime distribution and abundance of larval and juvenile fishes in the upper San Francisco Estuary. American Fisheries Society Symposium 39: 49-65.

California Department of Water Resources and U.S. Bureau of Reclamation, Mid-Pacific Region 1993. Effects of the Central Valley Project and State Water Project on delta smelt. Sacramento County, California. 134 pp.

______ and U.S. Bureau of Reclamation, Mid-Pacific Region 1994. Effects of the Central Valley Project and State Water Project on delta smelt and Sacramento splittail. Sacramento, California. 230 pp.

Dickert, C. 2002. San Joaquin Valley giant garter snake project—2001. Unpublished report. California Department of Fish and Game, Los Banos, California. January 11, 2002. 14 pp.

______ 2003. Progress report for the San Joaquin Valley giant garter snake conservation project—2003. Unpublished report. California Department of Fish and Game, Los Banos

Wildlife Complex, Los Banos, California. 37 pp.

_____ 2005. Giant garter snake surveys at some areas of historic occupation in the Grassland Ecological Area, Merced County and Mendota Wildlife Area, Fresno County, California. California Department of Fish and Game 91(4):255-269.

Erkkila, L.F., J.F. Moffett, O.B. Cope, B.R. Smith, and R.S. Nelson. 1950. Sacramento-San Joaquin Delta fishery resources: effects of Tracy pumping plant and delta cross channel. U.S. Fish and Wildlife Services Special Report. Fisheries 56. 109 pp.

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.

_____ 1941. The feeding habits of California garter snakes. Department of Fish and Game 27(2):2-32.

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

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

Goodman, D. 1987. The demography of chance extinction. Pages 11-19 *in*: M. E. Soulé, editor, Conservation Biology: the science of scarcity and diversity. Sinauer Associates, Inc., Sunderland, Massachusetts.

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. January 30. 18 pp plus appendices.

_____ 2003. Year 2002 investigations of the giant garter snake (*Thamnophis gigas)* in the Middle American Basin: Sutter County, California. Unpublished report prepared for the Sacramento Area Flood Control Agency, Sacramento, California. February 14, 2003. 33 pp.

_____ 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, California. March 10, 2004. 40 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.

_____ 1988. Review of the status of the giant garter snake (*Thamnophis couchi gigas*) and its supporting habitat during 1986-1987. Unpublished (final) report for California Department of Fish and Game, Contract C-2060. Rancho Cordova, California. 31 pp.

_____ 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, California. October 1995. 4 pp.

Hansen, R. W. 1980. Western aquatic garter snakes in central California: an ecological and evolutionary perspective. Unpublished masters thesis, Department of Biology, California State University, Fresno. 78 pp.

Hansen, G. E. and J. M. Brode. 1980. Status of the giant garter snake, *Thamnophis couchi gigas* (Fitch). California Department of Fish and Game, Inland Fisheries Endangered Species Program Special Publication Report. 80-5:1-14.

_____ 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, California. March 3, 1993. 36 pp.

Hansen, R.W. and G. E. Hansen. 1990. *Thamnophis gigas:* Reproduction. Herpetological Review 21(4):93-94.

Herbold, B. 1994. Habitat requirements of delta smelt. Interagency Ecological Studies Program Newsletter, Winter 1994. California Department of Water Resources, Sacramento, California.

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. Elevated Trace Element Concentrations and Standard Metabolic Rate in Banded Water Snakes (*Nerodia fasciata*) Exposed to Coal Combustion Wastes. Environmental Toxicology and Chemistry 18(6):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)*. Environmental Toxicology and Chemistry 21(5):906-913.

Hopkins, W. A., B. Staub, J.A. Baionno, B.P. Jackson, J.H. Row, and N.B. Ford. 2004. Trophic and maternal transfer of selenium in brown house snakes (*Lamprophis fuliginosus*). Ecotoxicology and Environmental Safety 58:285-293.

Knutson, A.C., Jr. and J.J. Orsi. 1983. Factors regulating abundance and distribution of the shrimp *Neomysis mercedis* in the Sacramento-San Joaquin Estuary. Transactions of the American Fisheries Society 112:476-485.

Mager, R. 1993. Delta smelt culturing. Pages 2-3 in W. Kimmerer unpublished minutes of the March 1993 Food Chain Group Meeting. Department of Water Resources. April 22, 1993, memo. 8pp.

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

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

______ 2002. Inland Fishes of California. University of California Press. Berkeley, California. 576 pp.

______ 2003. Comment Letter on the Five Year Status Review of the Delta Smelt. 4pp.

Moyle, P. B. and J. Cech, Jr. 1988. Fishes: An Introduction to Ichthyology. Prentice Hall, Englewood Cliffs, New Jersey. 559 pages.

Moyle, P. B., B. Herbold, D. E. Stevens, and L. W. Miller 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. Transactions of the American Fisheries Society 121:67-77.

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

Orsi, J.J. and W.L. Mecum. 1986. Zooplankton distribution and abundance in the Sacramento-San Joaquin Delta in relation to certain environmental factors. Estuaries 9(4B):326-339.

Paquin, M. M. 2001. Population structure of the giant garter snake, *Thamnophis gigas*. Unpublished masters thesis, Department of Biology: Ecology and Systematics, San Francisco State University. 27 pp.

Paquin, M. M., G. D. Wylie, and E. J. Routman, 2006. Population structure of the giant garter snake, *Thamnophis gigas*. Conservation Genetics 7:25-36.

Patterson, L. 2004. Giant garter snake surveys for the in-delta storage program year-end and summary report. Unpublished report prepared for the Department of Water Resources, Sacramento, California. 18 pp.

Patterson, L. and E. Hansen. 2003. Giant garter snake surveys on Bacon Island and Webb Tract in 2003. Unpublished report prepared for the Department of Water Resources, Sacramento, California. 24 pp.

_____ 2003. Giant garter snake habitat evaluations on Bacon Island and Webb Tract in 2003. Unpublished report prepared for the Department of Water Resources, Sacramento, California. 16 pp.

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

Rossman, D.A., N.B. Ford, and R.A. Seigel. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman. 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.

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, California.

Souza, K. and M. Bryant. 2002. Townet Survey and Fall Midwater Trawl. Interagency Ecological Program for the San Francisco Estuary. Newsletter 15(2):21-24.

Stevens, D. E. 1966. Distribution and food habits of American Shad (*Alosa sapidissima*) in the Sacramento-San Joaquin Delta. Pp. 97-107 in J.L. Turner and D.W. Kelley (eds.). Ecological studies of the San Francisco Bay Estuary. California Fish and Game Bulletin No. 136.

Stevens, D. E. and S. W. Miller. 1983. Effects of river flow on abundance of young chinook salmon, American shad, longfin smelt, and Delta smelt in the Sacramento-San Joaquin river system. North American Journal of Fisheries Management 3:425-437.

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

Stitt, E.W., P.S. Balfour, T. Lucklau, 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 the U.S. Fish and Wildlife Service, Cooperative Agreement No. 11420-1933-CM02. ECORP Consulting, Inc., Roseville, California. 72 pp. + Appendices.

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.

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

Swanson C, T. Reid, P.S. Young, and J.J. Cech. 2000. Comparative environmental tolerances of threatened delta smelt (*Hypomesus transpacificus*) and introduced Wakasagi (*H. nipponensis*) in an altered California estuary. Oecologia 123:384-390.

Sweetnam, D. A. 1992. Delta Smelt Project Update, October 1992. Unpublished report prepared by California Department of Fish and Game, Bay-Delta and Special Water Projects Division, Stockton, California. 7 pp.

_____ 1999. Status of delta smelt in the Sacramento-San Joaquin Estuary. California Fish and Game 85(1):22-27.

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

Turner, J.L. and D.W. Kelly. 1966. Ecological studies of the Sacramento-San Joaquin Delta. California Department of Fish and Game Bulletin No. 136.

U.S. Department of Agriculture [Internet] [cited April 15, 2003]. Available at: http://www.ers.usda.gov/Briefing/Rice/background.htm

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., March, 1994. Access: http://www.doi.gov/oepc/wetlands2/

U.S. Fish and Wildlife Service (Service). 1993a. Endangered and threatened wildlife and plants: Determination of threatened status for the delta smelt. March 5, 1993. **Federal Register** 58(42):12854-12864.

_____ 1993b. Endangered and threatened wildlife and plants; determination of threatened status for the giant garter snake; final rule. *Federal Register* 58(201):54053-54066.

_____ 1994. Endangered and threatened wildlife and plants: Critical habitat determination for the delta smelt. December 19, 1994. **Federal Register** 59(242): 65256-65279.

_____ 1994c. Formal consultation on the 1994 operation of the Central Valley Project and State Water Project: Effects on delta smelt. Sacramento, California. 34 pp, plus figures.

______ 1995. Formal consultation and conference on the effects of long-term operation of the Central Valley Project and State Water Project on the threatened delta smelt, delta smelt critical habitat, and proposed threatened Sacramento splittail. Sacramento, California. 52 pages, plus figures and attachment.

______ 1996. Sacramento-San Joaquin Delta Native Fishes Recovery Plan. Portland, Oregon.

_____ 1999. Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*). U.S. Fish and Wildlife Service, Portland, Oregon. x + 192 pp.

______ 2000. Biological Opinion on Implementation of the CVPIA and Continued Operations and Maintenance of the CVP. Sacramento, California.

______ 2003. Revised Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*). Portland, Oregon. ix + XXX pp.

______ 2004. Five Year Status Review for the Delta Smelt. Sacramento, California. 50 pp.

_____ 2006. Giant Garter Snake *(Thamnophis gigas)* 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 46 pp.

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

______ 1991. Early life stages and early life history of the delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin Estuary, with comparison of early life stages of the longfin smelt, *Spirinchus thaleichthys*. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Sacramento, California. Technical Report 28.

Weihs, D. 1974. Energetic advantages of burst swimming of fish. Journal of Theoretical Biology. 48:215-229.

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, California. 12 pp.

Wylie, G. D. 1998a. Results of the 1998 survey for giant garter snakes in and around the Grasslands Area of the San Joaquin Valley. Unpublished report. U. S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, California. 9 pp.

_____ 1998b. Giant garter snake project: 1998 progress report. Unpublished (preliminary) report. U. S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, California. 4 pp. + Figures.

_____ 2003. Results of the 2003 monitoring for giant garter snakes (*Thamnophis gigas*): bank protection project on the left bank of the Colusa Basin Drainage Canal in Reclamation District 108, Sacramento River Bank Protection Project, Phase II. Dixon Field Station, Biological Resources Division, U.S. Geological Survey, Dixon, California. 13 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 Field Station, Dixon, California. December 20, 2001. 9 pp.

Wylie, G.D. and L.L. Martin. 2003. Surveys for giant garter snakes on USFWS Partners for Fish and Wildlife project sites: 2003 progress report. Unpublished report. U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, California. December 2003. 25 pp.

Wylie, G. D. and L. L. Martin. 2004a. 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, California. November 2004. 18 pp.

Wylie, G. D., T. Graham, M. L. Casazza, M. M. Paquin, and J. Daugherty. 1995. 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, California. 6 pp. + Figures.

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, California. May 1, 1997. 6 pp. + Figures.

Wylie, G. D., M. L. Casazza, and N. M. Carpenter . 2002. Monitoring giant garter snakes at Colusa National Wildlife Refuge: 2001 progress report. Unpublished report. U U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, California. April 2002. 10 pp.

Wylie, G. D., M. L. Casazza, L. L. Martin, and M. Carpenter. 2003a. Monitoring giant garter snakes at Colusa National Wildlife Refuge: 2002 progress report. Dixon Field Station, Biological Resources Survey, U.S. Geological Survey, Dixon, California. 16 pp.

Wylie, G. D., M. L. Casazza, and L. L. Martin. 2003b. Giant garter snake surveys in the Natomas Basin: 2000-2002. Dixon Field Station, Biological Resources Survey, U.S. Geological Survey, Dixon, California. 20 pp.

Wylie, G. D., M. L. Casazza, 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(2): 139-145.

Wylie, G. D., M. L. Casazza, L. L. Martin, and M. Carpenter. 2004a. Monitoring giant garter snakes at Colusa National Wildlife Refuge: 2003 progress report. Dixon Field Station, Biological Resources Survey, U.S. Geological Survey, Dixon, California. 17 pp.

Wylie, G. D., M. L. Casazza, and L. L. Martin. 2004b. Monitoring Giant Garter Snakes in the Natomas Basin: 2003 Results. Dixon Field Station, Biological Resources Survey, U.S. Geological Survey, Dixon, California. 55 pp.

Wylie, G.D., M.L. Casazza, L.L. Martin, and M. Carpenter. 2005. Identification of key GGS habitats and use areas on the Sacramento National Wildlife Refuge Complex. Unpublished report. U.S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, California. 31 pp.

PERSONAL COMMUNICATIONS

Hansen, Eric. 2006. Consulting Environmental Biologist. Provided information on population trends, threats, and recommendations for future actions. May 8, 2006, and August 22, 2006.

Kelly, David. 2006. U.S. Fish and Wildlife Service, Sacramento, California.

Roberts, John. 2006. The Natomas Basin Conservancy, Executive Director. Provided information on population trends, threats, and recommendations for future actions. May 8, 2006, and August 22, 2006.

Wylie, Glenn. 2006. USGS-BRD, Western Ecological Research Center, Dixon Field Station. Provided information on population trends, threats, and recommendations for future actions to benefit the giant garter snake. May 9, 2006.