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:
1-1-05-F-0029

JUN 27 2007

Mr. Michael Finan
Chief, Delta Office
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Subject: Biological Opinion on the Proposed City of Stockton's Delta Water Supply Project, San Joaquin County, California

Dear Mr. Finan:

This is in response to your November 17, 2004, request for formal consultation with the U.S. Fish and Wildlife Service (Service) on the proposed construction of a water pumping plant, raw water pipelines, water treatment plant, and treated water distribution pipelines for delivery of water to the City of Stockton in San Joaquin County, California. Your request was received in this Field Office on November 19, 2004. This document represents the Service's biological opinion on the effects of the action on the threatened delta smelt (*Hypomesus transpacificus*) and threatened giant garter snake (*Thamnophis gigas*). This document is issued pursuant to section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*)(Act).

This biological opinion is based on: (1) your letter with enclosures; (2) the revised February 2006 biological assessment, revised February 2006 wetland delineation report, and the October 2005 modeling technical appendix to the Draft Environmental Impact Report; (3) a letter from the Environmental Science Associates dated February 24, 2006, and received on February 28, 2006, providing some of the additional information previously requested by the Service; (4) a letter from ESA to the Service dated September 5, 2006, proposing an operation scenario for the protection of delta smelt; (5) several informal and formal meetings, phone conversations, and electronic mail between the Service and the applicant and applicants consultants; and (6) other information available to the Service.

Tiering the proposed Stockton Delta Water Supply Project to the Intra-Service Biological and Conference Opinion for adverse effects to the giant garter snake

The May 31, 2001, *Intra-Service Biological and Conference Opinion* (Service File 1-1-00-F-0231) is the opinion of the Service's Sacramento Fish and Wildlife Office (SFWO) on the issuance of an incidental take permit for implementation of the San Joaquin Multi-Species Conservation Plan (SJMSCP) pursuant to section 10(a)(1)(B) of the Act in accordance with section 7 of the Act. The Service has issued an incidental take permit for 15 federally-listed species to various entities, including the City of Stockton, under authority of this section 10(a)(1)(B) for a period of 50 years. The permit analyzed take for the giant garter snake from urban development and infrastructure expansion occurring in the City as described in the SJMSCP; however, this take was permitted to non-Federal entities. This biological opinion utilizes the pertinent effects analysis from the *Intra-Service Biological and Conference Opinion* for impacts to giant garter snake from the construction of the (1) intake structure, (2) treated and raw water pipelines, and (3) water treatment plant. The *Intra-Service and Biological and Conference Opinion* specifically excluded "water diversion and conveyance" as a covered action, so effects to giant garter snake, delta smelt, and delta smelt critical habitat from the proposed operation of the intake are considered separately in this biological opinion.

The implementation of the SJMSCP will result in conversion and loss of a maximum of 14,202 acres of natural habitat and 57,635 acres of agricultural land within an approximately 900,000-acre planning area. Permitted activities as described in Section 8.2 of the SJMSCP include but are not limited to urban development; aggregate mining; highway construction and maintenance; culvert replacement; excavating for inspection, repair and/or replacement; maintenance of drainages along rights of ways; and maintenance of river crossings for utilities such as aqueducts. Direct and indirect effects from all of the above activities could result in killing or injury to SJMSCP-covered species, damage to covered plants and their habitat, harm to covered wildlife species resulting from habitat loss, and harassment due to noise of machinery and other activity associated with land clearing and construction.

Consultation History

November 19, 2004: The Service received a letter from the Corps, dated November 17, 2004, requesting formal consultation for the City of Stockton's Delta Water Supply Project. Enclosed with the letter were relevant reports providing a description of the proposed project, the area that would be affected by the proposed action, listed species and designated habitat present within the project area, and a description of effects on listed species.

September 9, 2005: Ryan Olah of the Service sent an electronic mail to Michael Finan of the Corps requesting additional information on fish screen design, in water footprint, and compensation for loss of shallow water habitat and giant garter snake habitat.

November 30, 2005: The Service sent a letter to the Corps requesting additional information for the City of Stockton's Delta Water Supply Project.

February 28, 2006: Chris Nagano of the Service received a letter dated February 24, 2006, from Michele S. Stern with ESA that partially provided the additional information requested in the Service's November 30, 2006, letter to the Corps. Enclosed with the letter were the February 2006 revised biological assessment, the October 2005 Modeling Technical Appendix to the Draft Environmental Impact Report developed by MWH, and the February 2006 Stockton Delta Water Supply Project Revised Wetland Delineation Report developed by ESA.

April 12, 2006: Peter Johnsen of the Service sent an electronic mail to Ms. Stern requesting clarification of the exact scope of the proposed project, information on effects from pile driving, proposed protection measures for delta smelt larvae, and growth inducement.

May 18, 2006: Representatives from the City of Stockton, ESA, Walter Yep, Inc., the National Marine Fisheries Service, and the Service met to discuss the section 7 consultation process, final Delta intake description, project related effects on listed species, need for additional information, and the schedule for completion of the biological opinion.

May 25, 2006: Mr. Johnsen informed Ms. Stern that growth inducing effects would be covered under the existing San Joaquin Habitat Conservation Plan.

August 14, 2006: The Service received a Technical Memorandum written by Chuck Hanson on the seasonal distribution of delta smelt near the proposed intake site as an attachment in an electronic mail from Ms. Stern to Mr. Johnsen.

August 21, 2006: Andrew Draper with MWH, Robert Granberg of the City of Stockton, Chuck Hanson with Hanson Environmental, Leslie Moulton with ESA, Ms. Stern, and Mr. Johnsen met to discuss effects to Delta hydrology and water quality, fish screen, measures to minimize take of delta smelt larvae, and compensation for effects to giant garter snake habitat. Mr. Hanson presented the proposed pumping reduction and curtailment period for protection of delta smelt. The City of Stockton proposed to maintain a 50 percent pumping rate from March 15 through April 15 and May 21 through June 20, and a 100 percent curtailment from April 16 through May 20. It was discussed if it would be possible to compensate for effects to giant garter snake through the existing San Joaquin Habitat Conservation Plan. Mr. Johnsen requested additional analysis of operations.

September 5, 2006: As an attachment to an electronic mail from Ms. Stern, Mr. Johnsen received an electronic copy of a September 5, 2006, letter to the Service describing the proposed operation scenario to minimize take of delta smelt.

September 8, 2006: Mr. Johnsen received an electronic mail from Ms. Stern regarding SDWP effects on the location of X2, on water exports at the state and Federal Delta water diversion facilities, and the Environmental Water Account.

September 26, 2006: Mr. Johnsen received an electronic mail from Ms. Stern with an attached letter from MWH dated September 20, 2006, containing information on annual average changes in flow in the Delta.

December 11, 2006: Representatives for the City of Stockton, and Service and HDR staff made a site visit to the SDWP project site.

February 14, 2007: The Habitat Technical Advisory Committee for the SJMSCP approved coverage for the Project for the construction of the intake structure, treated and raw water pipelines, and water treatment plant. Effects resulting from the operation of the intake were not considered in the Intra-Service Biological and Conference Opinion; thus, they will be assessed and covered separately in this biological opinion.

April 27, 2007: The Service issued a letter to Mr. Granberg requesting that the City pay the updated SJMSCP compensation fees that went into effect on April 1, 2007. The City had paid their fees on March 30, 2007, prior to the updated fee going into effect. However, the SJMSCP was amended in 2006 to require payment of the fee no greater than 30 days prior to groundbreaking. The City would not have their federal and state permits in time to begin groundbreaking within 30 days of April 1, 2007.

May 3, 2007: Mr. Steve Mayo of the San Joaquin Council of Governments (SJCOG) e-mailed Mr. Granberg explaining that they would reimburse the fees, and that fee payment would be accepted when all required state and federal permits are received.

BIOLOGICAL OPINION

Description of the Proposed Project

The City of Stockton (City) proposes to install a new water intake facility on the San Joaquin River, new pipelines to convey the raw water to a new WTP in the area north of the City of Stockton Metropolitan Area (COSMA), and new treated water pipelines to deliver water to the City's current water distribution system in San Joaquin County, California (the Stockton Delta Water Supply Project (DWSP)). The DWSP is designed as a conjunctive use water supply program for the COSMA, which will integrate surface water and ground water management under one program. The City anticipates that the DWSP would be expanded incrementally to keep pace with the COSMA's needs, based on the timing of existing supply reductions and increased demand over time.

The City's water rights application with State Water Resources Control Board (SWRCB) addresses a long-term planning horizon through 2050, requesting an ultimate diversion of 125,900 acre feet (AF) a year. However, the SWRCB bifurcated the water rights application into two separate applications, application 30531A and 30531B. Application 30531A covers only the initial phase of the DWSP up to 30 million gallon per day (mgd; 47 cubic feet per second (cfs)) (33,600 AF/year) and the place of use is confined to the current 1990 General Plan Boundary. The proposed project includes a new screened intake facility with a capacity to pump 47 cfs on the San Joaquin river, a new 54-inch diameter pipeline to convey Delta water to a new 30 mgd capacity water treatment plant (WTP) located just north of the COSMA, and new treated water pipelines to deliver water to the City's existing water distribution system.

The intake and pump station will be constructed in two 80 mgd increments. The new water intake facility will be designed to facilitate these expansion and to avoid extensive future construction in the river and sloughs. The initial capacity of the DWSP will be 30mgd, with staged incremental expansions to an ultimate capacity of 160 mgd (250 cfs). For initial construction of the intake and pump station facility, piles would be driven for the ultimate 160 mgd capacity; concrete work would support an 80 mgd capacity; and mechanical would support the initial 30 mgd capacity. The WTP will be constructed for an initial capacity to treat and deliver up to 30 mgd or 33,600 AF per year.

Two parallel pipelines will eventually be installed to convey raw water from the intake to the WTP for the treatment of 160 mgd. The proposed project, however, includes only the installation of a 54-inch diameter pipeline to convey water for the treatment of up to 60 mgd. A 72-inch diameter pipeline will be installed parallel to the 54-inch pipe when and if the WTP is expanded to a 160 mgd capacity. Because the intake screen and pipeline will not be sized to accommodate the 160 mgd diversion during the initial phase of the DWSP, additional permitting in the future would trigger section 7 consultation.

Existing interties with the California Water Service Company (Cal Water) will be used to distribute the DWSP's treated water throughout Cal Water's service area within the COSMA. The groundwater component will include coordinated groundwater and surface water management. Ultimately, groundwater levels will be injected into the groundwater basin underlying the COSMA, for later extraction during periods of limited surface supply. The construction of facilities and distribution system for injection of ground water is, however, not part of the proposed action.

The project is located north and northwest of the City of Stockton, California. The project boundary includes the pumping facility at Empire Tract; the alignment for the raw-water pipeline along Eight Mile Road to the WTP west of Sacramento Road; the WTP site located just west of Sacramento Road and approximately 0.5 mile north of Eight Mile Road; and the treated water pipe alignments along Davis Road, Sacramento Road, and West Lane south of Eight Mile Road. The UTM for the Intake Structure is NAD 83, zone 10, 631848E 4211720N and the UTM for the WTP is 647820E 4214688N. Construction is anticipated to start in 2007 with a target date for initial operation of the SDWP in 2009

<u>Intake Structure and Pump Station Facilities</u>

The proposed intake site is on the southwestern tip of Empire Tract adjacent to the San Joaquin River, California. The general area designated for the intake structure is on a bend of the river, which creates two shorelines (south and west banks of Empire Tract). The selected intake site is located approximately 350 feet from the edge of the dredged Stockton Deep Water Ship Channel. Water flows at the south bank location average 15,010 cfs (tidally driven), which will assist in maintaining the desired sweeping velocity of 0.4 fps across the intake fish screen. Medford Island is located to the west across from the intake site. Several smaller islands, tidal influenced wetlands, and shallow water areas are located west of the deep-water ship canal between the project site and Medford Island.

The proposed in-bank intake and pump station facility will utilize flat plate screens and will be sized to accommodate the ultimate 160 mgd intake capacity predicted for year 2050. The proposed construction of the intake and pump station will create two individual units, each sized to handle an 80 mgd capacity. The fish screen and intake channel for the pump station facility will be built into the levee bank of the existing levee. The proposed construction footprint for the in-bank facility will encompass approximately 5.7 acres (250 feet wide by 1,000 linear feet of riverbank). Of this, approximately 1.57 acres of terrestrial habitat and 0.44 acre of perennial stream habitat in the San Joaquin River, including 176 feet of river bank shoreline will be permanently removed by the finished facility.

In order to accomplish this, a setback levee on the land side of the existing levee will be constructed to provide flood protection to Empire Tract. The area between the existing levee and the setback levee will be backfilled with earthen fill (6,900 cubic yards) to provide a level area above the flood elevation for access to the pump station and ancillary facilities and structures. Preconstruction dredging will remove approximately 6,700 cubic yards of native river bank and channel bottom material. The waterside portion of the construction area will then be isolated from the main channel by permanent sheet pile wing walls and temporary cofferdam of sheet piles driven into the bottom of the channel across the mouth of the water intake channel. Approximately 833 cubic yards of rock riprap will be placed along the permanent wing walls of the intake structure. The area within the cofferdam and the existing levee will be pumped dry to allow for construction activities to occur. The void between the existing levee and the newly placed wing walls will be filled with imported material (1,300 cubic yards) and compacted to provide support for the intake structure. The dredging, cofferdam installation, removal of water from behind the cofferdam and backfilling of soil is expected to take approximately 60 days to complete.

Within the area identified as the footprint for the intake structures, a network of 14-inch diameter pre-stressed concrete piles will be driven into the soil to a depth of 75 feet. These concrete piles will provide support to the poured concrete slab foundation of the intake facility and the related concrete structural elements of the fish screen and pumping platform. The number of piles driven will be sufficient for both of the 80 mgd pumping modules. The City proposes to drive all piles during the period from July 1 through November 30. The concrete work proposed for the current consultation will allow for only one of the 80 mgd modules to be built. The second intake module, should it be built, will be permitted under a future consultation. However, to avoid redeploying the pile driving equipment a second time, all piles for both modules will be driven in one mobilization of the pile driving rig.

The proposed in-bank intake will extend into the river approximately 60 feet from the levee face and will be approximately 350 feet from the Stockton Deep Water Ship Channel. Placement of the cofferdam during construction will require approximately a 20-foot clearance for working space.

Fish Screen Design

The vertical screen height of the fish screen will be 15 feet with a nominal structure length of 120 feet (at 160 mgd build out). The fish screen may be slightly angled away from vertical to better conform to the established slope of the levee. The fish screen will be designed to meet the current fish screen criteria established by the National Marine Fisheries Service (NMFS), the Service, and the California Department of Fish and Game (CDFG). The proposed screen will have the following structural operational characteristics:

Screen Orientation. The screen will be oriented so that the screen face will be parallel to river flow; upstream and downstream transitions will minimize eddies.

Approach Velocity. A uniform approach velocity of less than 0.2 fps as well as an adjustment for flow patterns will be provided across the face of the screen. For an ultimate capacity of 160 mgd, a minimum of 1,240 square feet of screen area will be provided, excluding the area for structural supports.

Screen Cleaning. The entire fish screen will be capable of completing an automatic cleaning cycle once every five minutes. The screen will be cleaned with either an automatic rotating brush or hydraulic screen cleaner.

Sweeping Velocity. The sweeping velocity design criteria for river intakes is at least twice the approach velocity (i.e., 0.4 fps or higher). Except during periods of tidal flow reversal, sweeping flow velocity will be at least two times the approach velocity. With a river channel cross-sectional flow area of approximately 18,000 square feet, flow rates must exceed 7,200 cfs to meet the sweeping velocity criteria of 0.4 fps. This occurs about 80 to 85 percent of the time at the intake site. The City plans to work with the Corps, NMFS, the Service, and CDFG to develop site-specific requirements for the DWSP.

Screen Openings. The opening size of the screen will not exceed 1.75 millimeters (mm); the minimum open area will be 27 percent of the screen's surface area.

Screen Materials. The screen will be fabricated of rigid, corrosion-resistant material with no sharp edges or projections (e.g., stainless-steel or copper-nickel alloy using wedge wire).

Pumping and Electrical Requirements

Electric pumps will lift water from the intake and deliver it to the proposed WTP, pumping it approximately 51 feet above sea level in the process. The transfer of this water will be through the initial installation of a 54-inch-diameter pipe to the WTP.

For the initial pump station capacity of 30 mgd, the total connected electrical load for the intake facility would be approximately 850 kilovolt-amperes (kVA). Ultimate electrical capacity for the intake pump station and interim phasing would depend on the timing for construction of the parallel 72-inch-diameter raw water pipeline. An upgrade to the electrical infrastructure would be required to efficiently meet the facility's initial and ultimate needs.

High voltage electrical transmission lines are located west and parallel to I-5. Electrical service requirements at the WTP would be even higher than at the intake pumping station, so developing primary service voltage for the WTP would provide an opportunity to coordinate service to the intake pumping station. Electrical service for the intake pump station will be routed to a new substation near the intake site from the substation located at Eight Mile Road and I-5. Overhead poles are located in the road right-of-way from the northwest corner of I-5 and Eight Mile Road to the intake site.

Water Pipelines

Raw Water Pipelines

Approximately 67,000-foot (12.7-mile) of raw water pipelines will be constructed to connect the intake facility with the WTP. In open areas with sufficient space, an 80-foot-wide construction corridor would be used to maximize construction efficiency. In areas encumbered by existing improvements, high-volume roadways, or environmentally sensitive areas, a narrower construction corridor will be used. The minimum width for a practicable construction corridor would be 47 feet, which will provide space for the width and turning movements of equipment such as a large excavator. It is anticipated that the initial raw water pipeline could be constructed in about 12 to 13 months.

The alignment of the pipeline will follow the western edge of Empire Tract northwards from the intake facility to Eight Mile Road, paralleling the inside of the levee along Little Connection Slough for approximately 1.5 miles. At Eight Mile Road, the pipeline alignment will turn east and parallel the northern side of the road for approximately 2.1 miles before crossing under Honker Cut. The pipeline will continue east for another 2.25 miles before crossing under Bishop Cut. From this point, the pipeline will continue approximately 6 miles east to Sacramento Road before turning north to the proposed location of the WTP.

A 54-inch-diameter pipeline would be installed to provide for the initial 30 mgd WTP and future expansion to a 60 mgd capacity. When the demands for water reach the level that additional capacity in excess of the 60 mgd is needed, an additional 72-inch pipeline will be installed parallel to the existing 54-inch pipeline alignment. The applicant anticipates that this enlargement of the carrying capacity of the raw water pipelines will be considered under a future biological opinion which addresses the co-occurring enlargement of the diversion capacity at the intake structure.

The majority of the raw water pipelines would be installed using open cut trenching using conventional cut and cover construction techniques. Where minor ditch crossings (less than 15 feet in width) are required, the ditches would be temporarily dammed prior to open cut trenching. In areas where open cut trenching is not possible due to limited construction area, geotechnical conditions, or sensitive areas (i.e., at the intersection of Empire Tract Road and Eight Mile Road and at Bishop Cut, Honker Cut, the Union Pacific Railroad tracks, and Interstate 5), trenchless construction techniques (e.g., jack and bore, horizontal directional drilling, or microtunneling) would be employed.

The width and depth of the trench would vary, depending on the location along the route. In agricultural areas where the pipeline would not be in a road right-of-way, it would be buried with a minimum cover of seven feet. In other areas, the pipeline will be buried at a minimum of five feet to avoid potential conflicts with existing and future adjacent utilities. The trench for the 54-inch pipeline will be approximately seven to eight feet wide. Excavated soil will be hauled to a suitable temporary storage area with no or low biological sensitivity until it is returned to the construction site. Stored soil will be protected from wind and rain erosion, sedimentation, and runoff. Soil in excess of backfill requirements will be hauled to a suitable disposal area or made available for other uses.

In areas with shallow groundwater levels, dewatering would be required. If the groundwater seepage cannot be contained onsite, it will be pumped into holding tanks (Baker tanks or other suitable receptacles) where the sediment will be separated from the groundwater and the "clean" groundwater redistributed into surrounding upland areas or irrigation ditches. The return water will comply with the Central Valley Regional Water Quality Control Board (Regional Board) before being discharged. Surface areas disturbed by the open trenching activities will be restored to their original condition. Unpaved areas will be replanted with grasses, shrubs, and trees as required.

Trenchless construction techniques will be used when sensitive surface obstructions or otherwise difficult conditions preclude the open trench techniques previously described. Typically, trenchless construction techniques require that the bore of the tunnel pass under the sensitive surface obstruction, such as the waterways of Bishop and Honker Cuts, and resurface on the opposite side of the obstruction. Bore and jack and microtunneling boring are two of the techniques being considered for channel crossings. Typically, a bore pit would be constructed on each side of the waterway. These pits, approximately 25 to 30 feet long by 10 to 15 feet wide, would be excavated with a backhoe outside of the natural channel boundaries. Depth of the pits will depend on final pipeline depth below grade. The boring equipment is lowered into the pit and the drilling bore is advance into the substrate. Once a tunnel is constructed, the pipes are installed. Spoils from the excavation will be placed alongside the pits outside of the channel for future use as fill. Minimum buffer zones for entry and exit point on either side of the stream and a minimum vertical Clarence beneath the streambed will be maintained to avoid or minimizes the potential environmental impacts resulting from the crossing activities. At this time, the setback distance and minimum boring depths required to maintain this safety margin have not been determined.

Any groundwater encountered during drilling would be pumped out of the bore pits and discharged per Regional Board requirements. The procedure employed would be determined during final design. Upon completion of the pipeline installation, the excavated areas would be backfilled, compacted, re-contoured, and restored to natural conditions.

HDD is a specialized boring technique that can be used to drill an arc that would travel under larger waterbodies such as Honker or Bishop Cuts. Lubrication containing water and bentonite clay, referred to as drilling mud, would be used to aid the drilling and to coat the walls to maintain the opening. A wire line magnetic guidance system would be used to ensure that the angle, depth, and exit point abide by the detailed engineering plans drawn up for the crossing. Once the hole is approximately 12 inches larger than the pipe, the pipeline is pulled through the drilled hole from the point of entry to the point of exit. The workspace requirements for the HDDs extend to an area 200 feet wide by 200 feet long. It may be needed to excavate mud pits to retain the drilling mud exiting from the bore opening at either end of the crossing.

Treated Water Pipelines

At the initial plant capacity of 30 mgd, a 54-inch diameter pipeline would connect the process area of the WTP to the existing distribution system. Approximately 38,730 feet (7.3 miles) of piping would be required. The treated water pipeline would parallel the east side of Lower Sacramento Road south to the south side of Eight Mile Road. A minimum 10-foot horizontal separation would be provided between the raw water and treated water pipelines to meet California Department of Health Services standards and to facilitate construction.

From the intersection of Lower Sacramento and Eight Mile Roads, the pipeline would connect with the existing distribution system as follows:

- From the intersection of Lower Sacramento and Eight Mile Roads, south along Lower Sacramento Road to Wakefield Road
- From the intersection of Lower Sacramento and Eight Mile Roads, east along Eight Mile Road to West Lane, then south on West Lane to Wakefield Road
- From the intersection of Lower Sacramento and Eight Mile Roads, west along Eight Mile Road to Davis Road, then south on Davis Road to about Whistler Way
- From the intersection of Eight Mile and Davis Roads, west along Eight Mile Road to Trinity Parkway

The minimum width of the construction corridor would be between 37 and 47 feet, depending on pipe diameter and construction means and methods. Thus, the total footprint will be approximately 42 acres (47-foot wide corridor X 38,730 feet). Two staging areas for storing equipment and materials and for parking a construction office trailer would be required along the pipeline alignment.

The majority of the treated water pipelines would be installed using open cut trenching as described for the raw water pipelines. In developed areas, a vertical or near-vertical trench would be constructed to limit replacement of the structural road and reduce the width of the construction corridor. Trench depth will range from five to 12 feet, depending on pipe diameter and depth of cover. All excavation is expected to be above groundwater; however, limited perched groundwater may be encountered near slough crossings. Typical open cut installation rates would vary from 300 to 400 feet per day, depending on the number of utilities encountered during excavation, required traffic control, and hours of work.

In areas where open cut trenching is impossible due to a limited construction area, geotechnical conditions, or sensitive areas (i.e., Interstate 5 at Eight Mile Road; Pixley Slough at Davis Road, Eight Mile Road, and Lower Sacramento Road; Union Pacific Railroad tracks at Eight Mile Road; and Bear Creek at West Lane), trenchless construction techniques would be employed as described for raw water pipelines.

Water Treatment Plant

The WTP will be located approximately three miles east of Interstate 5 and 0.5 mile north of Eight Mile Road along Lower Sacramento Road. The facility will be constructed on a 126-acre parcel, with 56 acres devoted to the plant development and 86 acres left as farmland. The City anticipates that it will take approximately two years to complete the construction of the WTP.

Raw water will enter the plant via the proposed 54-inch-diameter pipeline. The water will be treated either by (1) conventional treatment using ozone or deep bed granular activated charcoal or (2) a membrane filtration treatment with a pretreatment of powdered activated charcoal. Both treatment types will utilize grit basins, flash mix (coagulation), flocculation/sediment basins, and clearwell storage. The WTP will operate continuously, 24 hours per day, year round at various flow rated during the year with ongoing operation and maintenance protocols. Treated water will be distributed through existing and newly constructed delivery pipelines to supply the water needs of the COSMA. Because there is no public sewer in the vicinity of the WTP site, domestic waste from the operations and administration building will be disposed of using onsite treatment methods such as a septic tank and leach field.

Operations of the DWSP Intake

The City will manage and operate the DWSP intake to minimize entrainment of delta smelt egg and larvae during the spring by reducing or curtailing diversion. The City no longer proposes a flexible reduction or curtailment period. Instead the City proposes to each year reduce pumping by half during the periods March 15 through April 15 and May 21 through June 15, and to curtail all pumping during the period April 16 through May 20 (Stern in lit. September 5, 2006). During the reminder of the year the City will divert up to its full capacity of 47 cfs.

Conservation Measures

The City will compensate for impacts and conversion of giant garter snake and delta smelt habitat, an estimated total of 181.5 acres, as a result of construction of the facilities by paying a fee as determined by the San Joaquin Council of Governments (SJCOG) as designated in the SJMSCP and *Intra-Service Biological and Conference Opinion* prepared by the Service (Service 2001). In addition, the City will abide by the giant garter snake and delta smelt "Incidental Take Minimization Measures" issued by the SJCOG, including restricting construction to the giant garter snake active period (May 1 – October 1) for all areas within 200 feet of potential giant garter snake aquatic habitat, which includes the intake structure.

Action Area

The action area includes all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.2). The physical location of the DWSP is on the southwestern tip of Empire Tract in the Sacramento-San Joaquin Delta, the inner portion of the Empire Tract along Eight Mile Road, and an area extending approximately three mile east of I-5. The intake will be located on the southern shore of Empire Tract, slightly east of Federal navigation marker "11" on the Stockton Deep Water Ship Channel (DWSC). The raw water pipelines will cross Honker Cut and Bishop Cut slightly north of the alignment of the

Eight Mile Road bridges over these waterways. The alignment then would turn north and parallel the west side of Lower Sacramento Road to the proposed WTP site. The proposed WTP site is located on the west side of Lower Sacramento Road, just north of Stockton and approximately three miles east of Interstate 5. The proposed treated-water pipeline would parallel the east side of Lower Sacramento Road south to the south side of Eight Mile Road. From the intersection of Lower Sacramento and Eight Mile Roads, the pipeline would go south along Lower Sacramento Road, and east and west along Eight Mile Road to connect with the existing City and California Water Service Company distribution systems. These four locations will be the sites of any direct effects from the construction phase of the project.

The operations phase of the DWSP will affect the delta smelt and critical habitat designated for the delta smelt in several locations but at variable levels. The most direct and significant effect to the delta smelt will be at the site of the intake screen itself, where water is withdrawn from the Delta. Lower levels of effects will be present within the water conveyance systems of the Central Valley (i.e. the Sacramento River below Shasta Dam, the Feather River below Oroville Dam, and the American River below Folsom Dam), and will be dependent upon the changes in water delivery required to meet water delivery obligations and water quality standards required of the state and Federal water programs as they compensate for the additional water being diverted fro the DWSP. The computer modeling (CALSIM II) run by the applicant's consultant to compare the effects of the project on the current and future water delivery operations indicates that small impacts related to the DWSP project can be measured even in the reservoir operations of Lake Shasta. However, it should be noted that these effects are relatively minor, and deemed insignificant by the applicant, as far as effects to the water delivery system operations are concerned. The scope and sensitivity of these effects will be discussed in the effects analysis section of this opinion.

One of the objectives outlined in the Final Environmental Impacts Report (ESA 2005) of the Stockton Delta Water Supply project is "to provide adequate water supply to accommodate planned growth." The initial 30 mgd intake operation is expected to meet the water supply needs of build-out anticipated in the 1990 Stockton General Plan. The action area for this biological opinion therefore includes all areas planned for build-out in the 1990 Stockton General Plan.

Status of the Species and Critical Habitat

Delta Smelt

Delta smelt was listed as a threatened species on March 5, 1993 (Service 1993a). 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). Critical habitat for delta smelt was designated on December 19, 1994 (Service 1994a). The final rule designated critical habitat for the delta smelt in the following geographic areas—areas of all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the Delta, as defined in section 12220 of the California Water Code.

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. Adult delta smelt move into freshwater in late fall to spawn (ranging from January to July). Spawning is believed to occur in the Sacramento River, San Joaquin River, and Suisun Marsh based on observations of spent females. Some spawning may also occur in Napa River. Once hatched, most juveniles move downstream into the low saline waters of the lower Delta and Suisun Bay where they maintain growth during the summer and fall. They reach adult size within one year and will move into freshwater to spawn in their first winter. The majority exhibit a one-year life cycle but a small portion of the population may survive to spawn the subsequent year. Depending on season, the delta smelt 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 (California Department of Water Resources (DWR) and Reclamation 1994; Molye 1976; Wang 1991). Delta smelt are also captured seasonally in Suisun Marsh.

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).

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 (CDFG 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 1987-92 drought, 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 CDFG. 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.

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.

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 and Population Dynamics

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 CDFG 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, CDFG 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.

Population Dynamics and Trends

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) (CDFG 2007). The summer townet abundance index measures the abundance and distribution of juvenile delta smelt and provides data on the recruitment potential of the species (CDFG 2007). Since 1983, (except for 1986, 1993, and 1994), this index has remained at consistently lower levels than previously found (CDFG 2007)(Figure 1). These consistently lower levels correlate with the 1983 to 1992 mean location of X2 upstream of the confluence (CDFG 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) (CDFG 2007).

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, CDFG 1999). The FMWT indicates the abundance of the adult population just prior to upstream spawning migration (CDFG 1999). The index calculated from the FMWT uses numbers of sampled fish multiplied by a factor related to the volume of the area sampled (CDFG 1999). Until recently, except for 1991, this index has declined irregularly over the past 20 years (CDFG 1999) (Figure 2). Since 1983, the delta smelt population has exhibited more low FMWT abundance indices, for more consecutive years, than previously recorded (CDFG 1999). The 1994 FMWT index of 101.2 was a continuation of this trend (CDFG 1999). This occurred despite the high 1994 summer townet index for reasons unknown (CDFG 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 (CDFG 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 (CDFG 1999). The FMWT abundance index (127) for 1996 represented the sixth lowest on record (CDFG 1999). The 1997 abundance index (360.8) almost tripled since the 1996 survey, despite the low summer townet index (4.0) (CDFG 1999, 2001).

Both 2001 TNS and FMWT abundance indices for delta smelt decreased from 2000 (Souza and Bryant 2002, CDFG 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, CDFG 2001). The 2001 FMWT delta smelt index (603) decreased by 20% from 2000 (756) (Souza and Bryant 2002, CDFG 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, CDFG 2001). The 2002 TNS was 4.7 and then dropped to 1.6 in 2003. The 2004 TNS index increase to 2.9 but then fell in 2005 to 0.3. The 2002 FMWT index (139) was the seventh lowest on record and the 2003 index was 210. The 2004, 2005, and 2006 FMWT abundance indices fell to their lowest levels of 74, 26, and 41, respectively. The lowest indices on record for both surveys occurred in 2005 (CDFG 2007).

The Delta Smelt Larval Survey (DSLS), an additional survey initiated in 2005 by CDFG, 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.

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, CDFG fully supported that the delta smelt should retain its threatened status under the Act (CDFG 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

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. The snake was 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 (162 centimeters). Females tend to be slightly longer and proportionately heavier than males. The weight of adult female snakes is typically 1.1-1.5 pounds (500-700 grams). Dorsal background coloration varies from brown to olive with a cream, yellow, or orange dorsal stripe and two light colored lateral stripes. Some individuals have a checkered pattern of black spots between the dorsal and lateral stripes. Background coloration and prominence of the checkered pattern and three yellow stripes are geographically and individually variable; individuals in the northern Sacramento Valley tend to be darker with more pronounced mid-dorsal and lateral stripes (Hansen 1980; Rossman *et al.* 1996). Ventral coloration is variable from cream to orange to olive-brown to pale blue with or without ventral markings (Hansen 1980).

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). By 1971, so much wetland habitat had been reclaimed, that the California Department of Fish and Game (CDFG) classified the giant garter snake as a rare animal and conducted a series of field surveys. The results of these surveys indicate that snake populations were distributed in marsh wetlands, tributary streams, and portions of the rice productions zones of the Sacramento Valley in Butte, Glenn, Colusa, Sutter, Yolo and Sacramento Counties, in the Delta region along the eastern fringes of the Sacramento-San Joaquin River Delta in Solano, Contra Costa, Sacramento, and San Joaquin Counties, and in the San Joaquin Valley in San Joaquin, Stanislaus, Merced, Mendota, and Fresno Counties (Hansen 1988; 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.

A population is a group of organisms that interbreed and share a gene pool. The boundaries of a population, both in space and time, are generally not discrete and, in practice, as usually defined by the researcher (Krebbs 1994). The gene pool and breeding patterns of the 13 giant garter snake populations identified in the final rule remain unstudied and unknown. What was described as "13 populations" should therefore be described more accurately as sub-populations and occurrences that note observations of individuals about which much remains unknown (Service 2003).

Surveys over the last 25 years suggest that sub-populations of giant garter snake in the northern parts of its range (i.e., Butte, Colusa, and Sutter Counties) are relatively large and stable (Wylie *et al.* 1997; Wylie *et al.* 2003a, 2004a). Habitat corridors connecting sub-populations, however, are either not present or not protected, and urban encroachment increases as a serious threat (Service 2003). Sub-populations in Yolo, Sacramento, Solano, and San Joaquin Counties areas are small, fragmented, and threatened by urbanization (Hansen 2004; Service 2003). Those sub-populations in the San Joaquin Valley, however, are most vulnerable having suffered near-devastating declines and possible extirpations over the last two decades (including populations in Stanislaus, Merced, Madera and Fresno Counties) (Dickert 2002, 2003; Hansen 1988; Williams and Wunderlich 2003). The southern sub-populations are extremely small, distributed discontinuously in isolated patches, and therefore are highly vulnerable to extinction by random environmental, demographic, and genetic processes (Goodman 1987).

Habitat Requirements

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 2003). The snake feeds on small fishes, tadpoles, and frogs (Fitch 1941; Hansen 1988; Hansen and Brode 1980, 1993). 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). Historically, giant garter snake prey likely consisted of Sacramento blackfish (*Orthodon microlepidots*), thick-tailed chub (*Gila crassicauda*), and red-legged frog (*Rana aurora*) (Rossman *et al.* 1996; Service 2003). Because these prey species are no longer available (chub extinct, red-legged frog extirpated from the Central Valley, blackfish declining) 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 and Brode 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). Brood size is variable, ranging from 10 to 46 individual young, with a mean of 23 individuals (Hansen and Hansen 1990). At birth, young average about 8.1 inches (20.6 centimeters) snout-to-vent length and 3 to 5 grams. 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 1993).

Movements and Habitat Use

The giant garter snake is highly aquatic but also occupies a terrestrial niche (Service 2003; Wylie *et al.* 2004a). Aquatic habitat includes remnant native marshes and sloughs, restored wetlands, low gradient streams, and agricultural wetlands including rice fields and irrigation and drainage canals. Terrestrial habitat includes adjacent uplands which provide areas for basking, retreats, and over-wintering. Basking takes place in tules, cattails, saltbush, and shrubs over-hanging the water, patches of floating vegetation including waterweed, on rice checks, and on grassy banks (Service 2003). The snake typically inhabits small mammal burrows and other soil and/or rock crevices during the colder months of winter (i.e., October to April) (Hansen and Brode 1993; Wylie *et al.* 1996; Wylie *et al.* 2003a). It 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 (50 meters) away from the marsh edge to escape extreme heat, and as far as 820 feet (250 meters) from the edge of marsh habitat for over-wintering habitat (Wylie *et al.* 1997). Snakes typically select burrows with sunny exposures along south and west facing slopes (Service 1993).

In studies of marked snakes in the Natomas Basin, snakes moved about 0.25 to 0.5 miles (0.4 to 0.8 kilometers) per day (Hansen and Brode 1993). Home range (area of daily activity) averages about 0.1 mile^2 (25 hectares) in both the Natomas Basin and the Colusa National Wildlife Refuge (NWR) (Wylie 1998a; Wylie *et al.* 2002). Total activity, however, varies widely between individuals; individual snakes have been documented to move up to 5 miles (8 kilometers) over a few days in response to dewatering of habitat (Wylie *et al.* 1997) and to use up to more than 8 miles (12.9 kilometers) of linear aquatic habitat over the course of a few months, and to have a home range as large as 14.5 miles^2 (3744 hectares) (Wylie and Martin 2004).

In agricultural areas, snakes were documented using rice fields in 19-20 percent of the observations, marsh habitat in 20-23 percent of observations, and canal and agricultural waterway habitats in 50-56 percent of the observations (Wylie 1998b). In the Natomas Basin, habitat used consisted almost entirely of irrigation ditches and established rice fields (Wylie 1998a; Wylie *et al.* 2004b). 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; more than 31 percent of observations were in uplands (Wylie 1998b). Snakes observed in uplands during the active season were consistently near vegetative cover, particularly where cover exceeded 50 percent in the area within 1.6 feet (0.5 meter) of the snake (Wylie 1998b).

Snakes will move into restored habitat after two years. At the Colusa NWR, after two years, restoration area population estimates increased from 30 snakes per kilometer to 59-95 snakes per kilometer (Wylie *et al.* 2004a). At the Colusa Basin Drainage Canal, snakes were given three upland restoration treatments, 1) soil planted with native grasses over rock riprap, 2) soil planted with native grasses without rock, and 3) rock riprap only; snakes were most commonly found at the soil over rock riprap treatment (Wylie and Martin 2004).

Predators

Giant garter snakes are 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*), and great blue herons (*Ardea herodias*) (Dickert 2003; Service 2003; Wylie *et al.* 2003c). 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.* 1996).

STKN-16

Reasons for Decline and Threats to Survival

The current distribution and abundance of the giant garter snake is much reduced from former times (Service 2003). Less than 10 percent, or approximately 319,000 acres (129,000 hectares), of the historic 4.5 million acres (1.8 million hectares) of Central Valley wetlands remain (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). These lakebeds once supported vast expanses of ideal snake habitat, consisting of cattail and bulrush dominated marshes (Service 2003). Cattail and bulrush floodplain habitat also historically typified much of the Sacramento Valley (Hinds 1952). 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). 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 Central Valley Project (CVP), planned by the State of California, and built and operated by the Federal Bureau of Reclamation, is the largest water management system in California. CVP and the historic water development activities that preceded it have not only resulted in the loss of all but approximately 10 percent of wetlands, they have created an ecosystem altered to such an extent that remaining wetlands, like agriculture, depend on managed water (U.S. Department of Interior 1994). The historic disturbance events associated with seasonal inundation that occur naturally in dynamic riverine, riparian, and wetland ecosystems have been largely eliminated. In addition to the highly managed water regimes, implementation of CVP has resulted in conversion of native habitats to agriculture, and has facilitated urban development through the Central Valley (Service 2003). In 1992, Congress enacted the Central Valley Project Improvement Act (CVPIA), the concerns of which include pricing and management of Central Valley water and attempting to mitigate for project impacts on fish, wildlife, and associated habitat. CVPIA, however, has been largely ineffective thus far, addressing primarily only the water needs of publicly-owned wetlands, which account for less than one-fourth of the wetlands in the Central Valley (Service 2003).

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). In the future, this transformation is expected to accelerate. 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). 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). The loss of rice land resulting from residential and commercial growth compounds the impact of direct habitat loss resulting from development itself.

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.* 1996). Rodent control threatens the snake's upland estivation habitat (Wylie *et al.* 1996; 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). Materials used in construction projects (e.g., erosion control netting) can entangle and kill snakes (Stuart *et al.* 2001). 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). Fluctuation in rice and agricultural production affects stability and availability of habitat (Wylie and Casazza 2001; Wylie *et al.* 2003b, 2004b).

Other land use practices also currently threaten the survival of the snake. Nonnative predators, including introduced predatory game fish, bullfrogs, and domestic cats, can threaten snake populations (Dickert 2003; 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). Recreational activities, such as fishing, may disturb snakes and disrupt basking and foraging activities. 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. Degraded water quality continues to be a threat to the species both on and off refuges.

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. Green sunfish (*Lepomis cyanellus*) in this drainwater have been found to have concentrations of selenium ranging from 12 to 23 µp/g (Saiki 1998), within the range of concentrations associated with adverse affects on predator aquatic reptiles (Hopkins *et al.* 2002). Since 1996, subsurface drainwater has been discharged, via the Grassland Bypass Project into Mud Slough North, where selenium concentrations in small fish, including mosquito fish, frequently reach 10-15 µp/g (Beckon *et al.* 2003).

The Central Valley contains a number of endangered ecosystems due to its fertile soils, amiable climates, easy terrains, and other factors that historically have encouraged human settlement and exploitation (Noss *et al.* 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 (Service 2003). Rapidly expanding cities within the snake's range include Chico, Yuba City, the Sacramento area, Galt, Stockton, Gustine, and Los Banos.

Status with Respect to Recovery

The revised draft recovery plan for the giant garter snake subdivides its range into three proposed recovery units (Service 2003): (1) Northern Sacramento Valley Recovery Unit; (2) Southern Sacramento Valley Recovery Unit; and (3) San Joaquin Valley Recovery Unit.

The Northern Sacramento Valley Unit at the northern end of the species' range contains sub-populations in the Butte Basin, Colusa Basin, and Sutter Basin (Service 2003). 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 northern most recovery unit is known to support relatively large, stable sub-populations of giant garter snakes (Wylie *et al.* 1996; Wylie *et al.* 2002; Wylie *et al.* 2004a). Habitat corridors connecting subpopulations, however, are either not present or not protected.

The Southern Sacramento Valley Unit includes sub-populations in the American Basin, Yolo Basin, and Delta Basin (Service 2003). The status of Southern Sacramento Valley sub-populations is very uncertain; each is small, highly fragmented, isolated, and threatened by urbanization (Hansen 2004; Service 2003; Wylie *et al.* 2004b). 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 includes sub-populations in the San Joaquin Basin and Tulare Basin. The San Joaquin Valley Unit 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; Wylie 1998a). Giant garter snakes currently occur in the northern and central San Joaquin Basin within the Grassland Wetlands, Mendota Area, and Burrel/Lanare Area. Agricultural and flood control activities are presumed to have extirpated the snake from the Tulare Basin (Hansen 1995); however, comprehensive surveys for this area are lacking and where habitat remains, the giant garter snake may be present (Service 2003).

Since 1995, BRD has been studying life history and habitat requirements of the giant garter snake within a few of the "13 populations" identified in the 1993 listing. 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.* 1996; 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).

Until recently, there were no post-1980 sightings of giant garter snakes from Stockton southward, and surveys of historic localities conducted in 1986 did not detect any snakes (Hansen 1988).

Since 1995, however, surveys conducted by CDFG in cooperation with BRD around Los Banos and the Volta Wildlife Area in the Grasslands, and Mendota Wildlife Area in the Mendota Area have detected snakes, but in small numbers much lower than those found in Sacramento Valley sub-populations (Dickert 2002, 2003; Williams and Wunderlich 2003; Wylie 1998a). The estimated total population size for the Volta Wildlife Area is 45 individuals, approximately only 5.6 snakes per mile (3.5 snakes per kilometer). Such low numbers are illustrative of a tenuously small snake population. Also, one-third of the giant garter snakes found had lumps on their bodies suggestive of a parasitic nematode infection (Dickert 2003); further study is underway. Ten of the 31 snakes found in 2003, however, weighed less than 40 grams indicating that giant garter snakes have been breeding at the Volta Wildlife Area. These results demonstrate that giant garter snakes are still extant in the northern San Joaquin Valley, but probably in extremely low numbers/densities. All sub-populations are isolated from each other with no protected dispersal corridors. Few opportunities for re-colonization of small sub-populations that may become extirpated exist given the isolation from larger populations and lack of dispersal corridors between them.

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 Northern Sacramento Valley Recovery Unit is known to support relatively large, stable giant garter snake populations. Habitat corridors connecting sub-populations, even in the Northern 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.

Environmental Baseline

<u>Delta Smelt</u>

Two annual monitoring efforts, the Spring Kodiak Trawl (SKT) and the 20-mm surveys, document the distribution of delta smelt adults and larvae, respectively, in the Central and South Delta (CDFG 2007). In addition, salvage at the SWP and CVP are used as an indicator of delta smelt presence in the South Delta. Based on the available data, the Service is reasonably certain that the delta smelt occur within the action area.

Distribution

Adult delta smelt movements upstream into the Delta from Suisun Bay starts in November/December and adults may be present through May. Salvage of adult delta smelt at the pumping facilities commonly occurs in January and occasionally in early December, showing known timing of movement of delta smelt into the South Delta. However, delta smelt likely to move into the Delta earlier than this. Salvage of adult delta smelt usually tapers off in April and rarely occurs after May. The annual SKT samples pelagic fish at several fixed stations in the Delta and usually starts in mid-January and ends in May. Stations within the Central and South Delta include stations located from the mouth of San Joaquin River through the Stockton Deep

Chip Channel south to the City of Stockton, in Middle and Old Rivers, and in Franks Tract. Of these, station 906 is located just downstream from the construction site while station 910 is located upstream (Figure 1).

The SKT surveys shows that the delta smelt can be distributed throughout the Central and South Delta, but the range and distribution of delta smelt vary widely between years. For instance, the 2007 SKT did not sample delta smelt at stations in the Central and South Delta while the 2004 SKT sampled delta smelt throughout the South Delta, including stations 906 and 910 (CDFG 2007). The factors affecting distribution may include flows in Old and Middle Rivers and flow changes in the San Joaquin River (USGS unpublished data). Further, there is a large inherent variation in the survey and the SKT may not be representative of distribution during low abundance. For instance, delta smelt were salvaged at the state and Federal pumping facilities in 2007 despite the failure to sample delta smelt in the SKT (CDFG 2007, Gartz in lit. 2007). This shows that some delta smelt had entered the South Delta in 2007. In addition, larvae may be sampled at upstream stations in the San Joaquin River even though no adult have been sampled at these stations.

Adult delta smelt is believed to spawn in the central Delta sloughs from February through August based on presence and growth rate of larvae. However, little is known of the microhabitat where spawning occurs but it has been assumed that the delta smelt spawn 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.

Once hatched, river flows and tides disperse and transport larvae throughout the Delta and eventually to the low salinity zone (2 parts per million) in the lower Delta and Suisun Bay. The CDFG annually conducts larvae and juvenile surveys, the 20-mm survey, at fixed stations throughout the Delta from March and into July (Figure 2). The survey, while collecting fish larvae less than 20 mm in size, is only fully efficient in collecting fish larvae that are of 20-mm length or longer. In early spring and summer, the delta smelt larvae and juveniles are found in the San Joaquin, Old, and Middle Rivers; by Clifton Court forebay; Franks Tract; and by the mouth of the San Joaquin River. Larvae and juveniles are commonly collected in San Joaquin River just down stream of Empire Tract (station 906) and may be collected as far upstream as the Stockton Deep Water Channel by the City of Stockton (station 912). With the exception of 2006 and 2007, when no larvae where sampled in the south Delta, the 20-mm trawl has captured larvae in the South Delta starting mid-March. Delta smelt larvae/juveniles may continue to be sampled through July. However, by mid-June, the 20-mm trawl rarely samples juveniles at stations located by or upstream of Empire Tract (CDFG 2007). Results from the 20-mm trawl shows that the juveniles continue to grow in the Central and South Delta and the majority of juvenile delta smelt sampled are 20 mm or longer by mid-June.

The summer townet abundance index is conducted during June through August throughout the Delta and measures the abundance and distribution of juvenile delta smelt. Distribution data from this survey shows that the delta smelt in summer is concentrated around Susisun Bay with no delta smelt being sampled in the south Delta (CDFG 2007).

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).

Abundance

The number of adult delta smelt entering the Central and South Delta vary between years, and is likely dependent on both the overall delta smelt abundance and the proportion of the overall population that enters the San Joaquin River portion of the delta relative to the Sacramento River portion. However, it seems reasonable to assume that overall abundance also will influence central and south Delta abundance. The summer townet (STN) survey abundance index has, except for three years since 1983 (1986, 1993, and 1994), remained at consistently lower levels than experienced previously (Figure 1). Besides measuring abundance and distribution, the summer townet abundance index also provides data on the recruitment potential of the species. The fall midwater trawl (FMWT) provides an indication of the abundance of the adult population just prior to upstream spawning migration. Indicia for the delta smelt FMWT index can vary dramatically between years, e.g. the 1993 index was 1073 while the 1994 index dropped to 102 (Figure 2). Some of this variation is likely related to inherent variation in the sampling method. However, as noted in the status of the species section, peak delta smelt indicia have been consistently lower after 1983 than pre 1983. Further, delta smelt indicia from 2001 to current have consistently been among the lowest ever recorded (Figure 1 and 2). The FMWT index does not provide information on specific areas of the Delta, and how the index relates to adult delta smelt abundance in the Central and South Delta is not clear.

The distribution of delta smelt in the Delta will also affect the abundance of the fish in the Central and South Delta. For instance, in 2004 adult delta smelt seemed distributed throughout the Delta, including station 906 and 910, while in 2007 most adult delta smelt were mainly found in Montezuma Slough, Sacramento River, and Sacramento Deep Water Ship Channel of the north Delta (SKT survey: CDFG 2007). Thus, the combination of a very low overall population abundance and patchy distribution likely resulted in very low numbers of adult delta smelt in the South Delta during 2005/2006 and 2006/2007.

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). There is a relationship between the portion of the delta smelt population west of the Delta as sampled in the STN survey and the natural logarithm of Delta outflow from 1959 to 1988 (Department of Water Resources and U.S. Bureau of Reclamation 1994). This relationship indicates that the STN 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, and 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.

Giant Garter Snake

The proposed project is located within the Delta Basin snake population, in the Southern Sacramento Valley Recovery Unit (Service 2003). Twenty-five California Natural Diversity Database (CNDDB) (2007) 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). 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 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).

None of the potential habitat in the Action Area has been surveyed for the presence of giant garter snakes. According to the California Natural Diversity Database (CNDDB 2007), a giant garter snake skin was found on Medford Island, approximately 1.5 miles away from the proposed intake structure. CNDDB contains records of giant garter snakes at the White Slough Wildlife Management Area and Caldoni Marsh, approximately 2.5 miles north of Eight Mile Road. These occurrences are presumed to be extant. A giant garter snake was observed in 1976 at the intersection of Eight Mile Road and the Western Pacific Railroad tracks in the immediate vicinity of the pipeline construction area. The current status of this occurrence is unknown.

Snakes have been documented to move up to 5 miles (8 kilometers) over a few days in response to dewatering of habitat (Wylie *et al.* 1997) and to use up to more than 8 miles (12.9 kilometers) of linear aquatic habitat over the course of a few months, and to have a home range as large as 14.5 miles^2 (3744 hectares) (Wylie and Martin 2004). Although giant garter snakes are typically absent from larger rivers (R. W. Hansen 1980, Rossman and Stewart 1987, Brode 1988, G. Hansen 1988), individuals may occur in the San Joaquin River that have been washed down during heavy rainfall events from ditches and sloughs at higher elevations. 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.

Factors Affecting the Snake within the Action Area:

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 1993). 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 (9 hectares) of aquatic and 53 acres (22 hectare) of upland snake habitat, as well as temporary alteration of over 1,700 acres (688 hectares) of aquatic and 650 acres (263 hectares) 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.

Effects of the Proposed Project on Delta Smelt and its Critical Habitat

The effects of the proposed project will fall into two main categories: the short-term construction related effects and the persistent long-term effects of the DWSP operations. The short-term effects are related to construction of facilities and pipelines, long-term effects relates to diversion of Delta water and loss of habitat at the DWSP intake.

Construction of DWSP Facilities

Construction of the DWSP intake includes dredging of the river channel bottom and bank, installation of wing walls and a cofferdam, application of rock rip-rap to the wing walls, and dewatering of the construction zone. These construction activities could adversely affect delta smelt by entrainment, injury or death by high energy sound waves, and by mobilizing sediment. As noted above, about 6,700 cubic yards of material will be dredged and this activity could result in dredging equipment entraining delta smelt, resulting in injury or death. However, the project's in-water work is of short duration (i.e. expected to last approximately 11 weeks) and is scheduled to occur from July 1 through November 30. This will minimize effects from construction since delta smelt is not expected to be present or be present in small numbers in the San Joaquin River during the period from August through November. However, delta smelt are commonly present in June and July and some delta smelt may be present year round. Further, if the timeline of the construction activities slip so that construction is initiated later in the work window, the risk of exposing delta smelt to adverse conditions of the construction activities increase due to the higher probability of delta smelt entering the action area during upstream spawning movements starting in early winter.

Disturbance and Loss of Habitat

Construction of the intake structure would involve the limited dredging of material in the San Joaquin River and adjacent levee and placing fill including concrete and riprap. Approximately 6,900 cubic yards of material will be dredged and about 2133 cubic yards of fill will be placed in the San Joaquin River. The maximum permanent impact to riverine and shallow water habitat is anticipated to be 0.44 acre. Approximately 761 linear feet of San Joaquin River shoreline would be affected.

The removal of shallow water edge habitat and riparian vegetation, sources of zooplankton and maroinvertebrate production, respectively, may result in the loss of foraging opportunities. It may also cause a reduction in shade that would contribute to increased water temperatures within the San Joaquin River, providing increased susceptibility to disease and introduced species competition. Increased erosion after removal of riparian vegetation would lead to sedimentation in the aquatic environment. These factors may result in reduced viability for the delta smelt. SJCOG will use the fees that the City of Stockton paid to participate in the SJMSCP to purchase similar habitat and manage this habitat for the benefit of the covered species to compensate for the effects from the construction of the intake structure.

Effects of Sediment Mobilization and Contaminants

Dredging and pile driving will mobilize sediment and this can be harmful to delta smelt, their prey species, and the habitat they depend on. In-water construction would be isolated by a cofferdam and consequently minimize effects from mobilized sediment on delta smelt. However, preconstruction dredging and cofferdam construction are expected to temporarily increase suspended sediment concentrations within a localized area of the lower San Joaquin River. The area temporarily affected would be about 5.7 acres in size (approximately 250 feet wide and 1,000 feet long, based on experience at the recently constructed fish screen in the Sacramento River). These effects would occur for about 60 days for about eight to 10 hours per day, when cofferdam construction activity may disturb sediments and increase turbidity. The proposed instream work window for the DWSP intake, July 1 to November 30, will minimize the duration that delta smelt exposure to mobilized sediments.

Increased turbidity can harm fish directly by damaging gills or indirectly by reducing a fish's ability to detect and avoid a predator. However, the activity is expected to increase turbidity level with less than ten percent of background level. Smelt species distribution is commonly associated with higher turbidity water and it is unlikely that a ten percent increase above existing background levels will adversely affect the delta smelt.

Bottom sediment may also contain toxins (Hunt *et al.* 2001) that could be mobilized during dredging. For instance, substances found in sediment from the San Joaquin River and its tributaries include polycyclic aromatic hydrocarbons (PAHs), and DDT and its degradates (Pereira *et al.* 1996). Suspended sediments contained elevated amounts of chlordane, a chemical group widely applied for control of termites and other pests until the late 1980s, while trace levels of triazine herbicides atrazine, and simazine were present in the water at most sites. Hunt *et al.* (2001) found chlordane and a variety of other compounds in sediment throughout the Delta at levels toxic to aquatic organisms, and Werner *et al.* (2000) identified significant mortality and reproductive toxicity in zooplankton that were consistent with level of pesticides in the water samples. An immense variety of substances could also be introduced during accidental spills of materials. Such spills can result from small containers falling over, or from accidents resulting in whole loads being spilled. Large spills may be partially or completely mitigated by clean-up efforts, depending on the substance.

Exposure pathways to contaminants include uptake through gills, dermal contact, direct ingestion, ingestion of contaminated soil or plants, or consumption of contaminated prey. Exposure to contaminants could cause short- or long-term morbidity, possibly resulting in reduced productivity or mortality. Carcinogenic substances could cause genetic damage resulting in sterility, reduced productivity, or reduced fitness among progeny. Contaminants also may have the same effect on prey species. This could result in reduced prey abundance and diminished local carrying capacity. The effects of contaminants may be difficult to detect. Morbidity or mortality likely would occur after the animals had left the contaminated site, and more subtle effects such as genetic damage could only be detected through intensive study and monitoring.

Based on delta smelt surveys by the CDFG, delta smelt are expected to either not be present at the construction site or be present in very low numbers during the period from August through October (CDFG 2007). Thus, delta smelt exposure to mobilized sediment from instream activities will be limited to larvae and juveniles in July and adult delta smelt in November. Even during those times only a low number of delta smelt, a fraction of the population, would be expected to be exposed to sediment mobilization related to construction activities. If the construction schedule is changed, then a considerably lager number of delta smelt could be exposed. Dredging and pile driving could result in a reduction in prey since the level of contaminants in the Delta could be toxic to zooplankton (Werner *et al.* 2000, Hunt *et al.* 2001). However, prey species such as zooplankton is expected to be replaced by upstream sources, surrounding sloughs and shallow water habitat, or be brought in from downstream areas by tidal movement by the time of delta smelt up-estuary movements in late fall/early winter. The area expected to be affected by the sediment plume is small relative to the total area of the south Delta and any effect on aquatic organisms is not expected to result in a measurable overall reduction in food available for delta smelt.

Effects of Acoustic Noise from Pile Driving

The installation of the sheet pile cofferdam and wing walls along the perimeter of the intake structure work zone will require the use of a percussion pile driver or vibratory pile driver to drive the steel sheet into the substrate of the river bottom. The wing walls will extend out 60 feet from the existing levee bank into the channel of the San Joaquin River at an angle. The cofferdam will close off the mouth of the intake structure, allowing the workspace behind it to be dewatered. Following the installation and dewatering of the work area, concrete pilings will be driven into the excavated work area to support the intake structure and fish screen racks.

High levels of acoustic noise have been shown to have adverse effects upon fish within close proximity of the noise source. The City has indicated that the pile driving activity for the sheet pile installation will take place over a period of three weeks. Sheet and concrete piles are driven into the substrate until predetermined level of resistance is encountered by the hammer. Energy transferred to the pile by the hammer is partially redirected as acoustic energy and heat as the pile loses energy to the surrounding medium (i.e., soil or rock). The energy can be transmitted directly from the piles to the surrounding water, via air surrounding the pile to the water, or being transmitted through the soil to the water column.

As sound propagates away from the source, several factors change its amplitude (Burgess and Blackwell 2003). These factors include spreading of the sound wave over a wider area (spreading loss), sound energy waves transition from one medium to another (*e.g.* from air to water), loss to friction between the water or sediment particles that vibrate with the passing sound wave (absorption), scattering and reflection from boundaries and objects in the sound's path, and constructive and destructive interference with reflections of the sound off surfaces such as the seafloor or water surface. The sound level measured at any give point along the path or the propagated sound wave includes all of these effects and is termed the received level. Thus, variables that affect the received level include the distance from the source, the density of the media such as saltwater versus freshwater (i.e., salinity), the amount of air in the water, bottom substrate composition and texture, salinity stratification and size and number of waves on the water surface, objects in the sound waves path, and ambient noise. Because of the many variables affecting propagation and loss of sound energy, it is difficult to estimate the sound level that will be measured at any given point.

The project location has several factors which may alter the transmission of the propagated sound waves into the channel of the San Joaquin River during the pile driving activities. The channel depth varies over a wide range in the reach adjacent to the project site. Along the levee bank, the depth drops of rapidly to approximately 20 feet in depth. The dredged ship channel, which is approximately 35 feet deep at low tide, passes to the south of the project site. These changes in bottom contours will create conditions that will attenuate the propagation of sound through the channel (null spots). In addition, ambient noise from the river flow, boat traffic, and irregular surfaces such as the rip rapped surface of the levees may create additional acoustic signals that muffle or cancel out the acoustic signal from the pile driving actions (masking). Installation of the concrete support pilings for the intake structure is anticipated to take place in dewatered work area behind the cofferdam. The dewatered cofferdam is expected to provide for sound attenuation and the acoustic noise derived from the pile driving of the concrete support piles is expected to primarily be propagated through the soil to the aquatic environment, rather than through the air.

Based on previous results from pile driving, the Service believes that the source acoustic signal will be in excess of 180 decibel (dB)(re: 1 μPa) for percussion hammers. Data derived from concrete piles driven at the Pier 95 Amport facility and the Concord Naval Weapons Depot in Susisun Bay both indicated pile driving noise levels exceeded 170 to 180 dB re: 1 uPa 10 meters from the pile at three meters depth. A report by Burgess and Blackwell (2003) indicated that vibratory installation of a sheet pile wall in upland position generated sound levels of approximately 140 dB re: 1 re: 1 μPa in the adjacent waterway at a distance of 200 feet, indicating that noise was transmitted through the soil to the water column. All underwater sound measurements discussed in this document are in reference to 1 re: 1 μPa and thus the reference to 1 re: 1 μPa will be omitted hereafter.

High underwater sound pressure levels have been known to cause swim bladder rupture, hemorrhaged eyes and internal organs, loss of hearing, temporary stunning, and alterations in behavior of fish (e.g., Yelverton *et al.* 1975; Turnpenny *et al.* 1994; Hastings *et al.* 1996a and b). However, Hastings and Popper (2005, 2006) concluded, based on an extensive literature review, that the available scientific and commercial data are inadequate for providing more than very preliminary conclusions on the effects of pile driving noise on fish.

Sound is the major form of communication underwater, so a functioning auditory system is believed to be essential for fish to survive. Damage to the auditory system may adversely affect a delta smelt's ability to orient itself, detect predators, locate prey, or sense their acoustic environment. Little is known about the effect of pile driving on the auditory system of fish and hearing damage depends on the auditory threshold, which varies from species to species. However, studies show that elevated sound can affect the hearing capabilities of fish much the same way as for other vertebrae. Experiments exposing oscar (*Astronotus ocellatus)* to continuous sound for one hour at 180 dB_{peak} at 300 Hz found destruction of sensory cells in the fish's inner ear (Hastings *et al.* 1996b). McCauley *et al.* (2003) found indication that high-energy noise sources (at approximately 180 dB_{max}) can ablate the sensory hairs on the inner ear epithelial tissue of pink snapper (*Chrysophrys auratus*).

Sound pressure waves from pile driving can result in damage and injury to organs and tissue of fish. Fishes with swimbladders (which include the delta smelt) are sensitive to underwater impulsive sounds (i.e., sounds with a sharp sound pressure peak occurring in a short interval of time) because of swimbladder resonance, which is believed to occur in the frequency band of most sensitive hearing (usually 200 to 800 Hz). Pathologies associated with very high sound levels are collectively known as barotraumas.

Barotraumas include hemorrhage and rupture of internal organs, including the swimbladder and kidneys of the fish. The injury is caused as sound waves passes through the fish, thereby resulting in the resonance of the fish swimbladder. The swimbladder is a gas-filled organ in the center of the body cavity bordered by the kidney above and the liver and other internal organs below. Because of the acoustic impedance of aquatic animal tissue nearly matches that of water, sound energy from an underwater source readily enters their body. As the sound wave passes through the fish, the swimbladder starts to resonance resulting in rhythmic expansion and retraction of the swimbladder. At relatively low sound levels the swimbladder expands and retract without causing damage. At high sound pressure levels associated with pile driving, the abrupt and repeated expansion and retraction of the swimbladder hammer internal organs, tear at adjacent connected tissue, and rupture capillaries.

Another mechanism of injury and death is "rectified diffusion," which is the formation and growth of bubbles in tissue caused by oscillation in the sound pressure as the sound wave passes the fish. The acoustic oscillation causes bubble growth in tissue because of the rapid change in pressure much like diver's disease or bends. As the pressure wave passes though the fish, the high pressure component of the wave shifts to the low pressure component causing gases dissolved in the blood or tissue to come out of physical solution and form gas bubbles. These bubbles increase in size as pressure waves continues to pas through the fish and will eventually cause inflammation, cellular damage, and blockage or rupture of capillaries, veins, and arteries. Hastings (2002) expects little to no physical damage to aquatic animals for peak sound pressures below 190 dB, the threshold for rectified diffusion. However, much uncertainty exists as to the level of adverse effects to fish exposed to sound between 180 and 190 dB_{peak} due to species-specific variables.

Recent pile driving experiments using juvenile steelhead (*O. mykiss*) and surfperch (family Embiotocidae) found no barotraumas with exposure to peak sound pressure levels as high as 211 dB (Caltrans 2004) and no statistically significant mortality at sound exposure levels (SEL) as high as 182 dB re: $1\mu Pa^2$ s (Caltrans 2004). Interim recommendations by Popper *et al.* (2006) suggest using a combined single strike criteria for pile driving noise; a peak sound pressure of 208 dB_{peak} and an SEL of 187 dB $1\mu Pa^2$ s. However, the effects to fishes of the high sound pressure levels produced by impact driving of piles depend on several factors, including the size and species of fish. Smaller fish are commonly more vulnerable to injury from sound pressure waves than larger fish. Most studies on the effect on fish and threshold sound pressure levels in California have been centered on regulations based on protection of salmonids. Depending on the time of pile driving, delta smelt in the channel adjacent to the pile driving will range in size from about 30 mm in July to 40 to 70 mm adults in November. Thus, it is expected that the effect on the delta smelt will be higher than that on the larger juvenile salmonids. Based on this information and that more information is needed to understand the effect of pile driving on delta smelt and fish in general, the Service has established the threshold for physical harm at 180 dB_{peak} for this project. Thus, driving of sheet piles and concrete piles is expected to injure or kill any delta smelt that are present within the channel at the project location during pile driving.

In addition to direct trauma, introduction of sound into aquatic environments may mask important signals as well as elevate stress levels, thereby affecting fitness and increasing likelihood of predation (Hastings and Popper 2005). Sound pressure levels expressed as "root-mean-squared" (rms) values are commonly used in behavioral studies. Sound pressure levels in excess of 150 dB_{rms} are expected to cause temporary behavioral changes such as elicitation of a startle response or behavior associated with stress. These sound pressure levels are not expected to cause direct permanent injury, but may decrease a fish's ability to avoid predators. Observations by Feist, *et al.* (1992) suggest that sound levels in this range may disrupt normal migratory behavior of juvenile salmon. They also noted that when exposed to the sounds from pile driving, juvenile pink and chum salmon were less likely to startle and flee when approached by an observer than were those that were shielded from the sounds. Sound may similarly affect the delta smelt. Based on this information, the Service has established the threshold for behavioral disruption at 150 dB_{rms} for the proposed DWSP project.

Effects of dewatering

Once the sheet piles are established, the City proposes to dewater the work area enclosed by the cofferdam. Delta smelt may enter the work area behind the cofferdam before the cofferdam is completed. Thus, as the cofferdam is dewatered, delta smelt enclosed by the cofferdam will succumb. To minimize loss of listed species during dewatering, the City proposes to capture and relocate fish within the cofferdam as it is dewatered. However, capture, handle, transport, and release of the delicate delta smelt may also result in some injury or mortality and expose the fish to predators as they are released back into the river. The delta smelt is also likely to be disoriented when released, thereby increasing their vulnerability to predators. Thus, even though capturing and relocating the fish will reduce loss, the proposed dewatering is still expected to result in some mortality of delta smelt if present within the cofferdam. However, delta smelt is not expected to be present at the intake site if construction activities are conducted during the proposed work window.

<u>Operation of the DWSP Intake</u>

Operation of the DWSP Intake facility will affect the delta smelt directly through entrainment of fish and indirectly by changes in hydrology. The former will be localized and concentrated to delta smelt in the near vicinity of the intake while the latter could affect delta smelt throughout the South and Central Delta.

Effects of Entrainment

The fish screen for the DWSP were designed utilizing the criteria recommended for protection of juvenile salmonids and delta smelt (Service 1995, CDFG 2000b). The flat plate style fish screens will be installed at a slight angle from vertical, facilitating cleaning and debris removal. It will be oriented parallel to the ambient flow in the river for both upstream and downstream directions of tidal flow (i.e., essentially parallel to the bank). Transitions from the upstream and downstream wing walls will be constructed so as to minimize the creation of eddies or turbulent flow that could concentrate delta smelt or provide a predator holding zone for ambush attacks of delta smelt passing by the screen. The screen is designed to have an approach velocity equal to or less than 0.2 fps (~ 6 cm/s). Tuning vanes behind the screen will allow for adjustment of the approach velocity to equalize flow patterns across the face of the screen and to minimize any "hot" spots which may occur. The screen will be designed to have openings no more than 1.75 mm wide.

The fish screen's 1.75 mm screen mesh is expected to exclude from the intake delta smelt that are 25-mm long or longer. Thus, operating the DSWP intake will directly affect the delta smelt by entraining delta smelt less than 25-mm long (larvae) and impinging larger delta smelt to the fish screen (juveniles and adults). To minimize impingement fish screen is designed to meet criterion for protection of delta smelt with approach velocities not exceeding 0.2 fps and sweeping velocities exceeding 0.4 fps (~ 12 cm/s) (Service 1995, CDFG 2000b).

Effects to Juvenile and Adult Delta Smelt. The degree at which 25-mm long or longer delta smelt will contact and impinging with the fish screen and consequently be injured depends on the exposure time to the screen, screen approach and sweeping velocity, and the behavior of the fish (Swanson *et al.* 2005, White *et al.* 2007). Studies of fish behavior to the flow plume in experimental chambers showed that delta smelt at 40 to 60 mm length swam against the water current in near-screen flows and that the fish increased their swimming efforts as a response to higher sweeping velocities (Swanson *et al.* 1998, 2005). The fish also swam faster (more effort) during day than during the night. In the experiments, delta smelt were transported with the current when sweeping velocities exceeded their swimming capacity. Consequently, the time it takes for a delta smelt to pass by a screen of a finite length is related to sweeping velocity, and screen passage velocity should be higher during night than during day. However, delta smelt also swam closer to the channel bottom and farther away from the screen at higher sweeping velocities, probably seeking a velocity refuge (Swanson *et al.* 1998). Thus it seems like the fish at times are trying to hold position against the current by increasing swimming velocity and seeking areas with less water velocity.

The exposure time to the proposed DWSP intake fish screen can be estimated based on the sweeping velocity and length of the fish screen. For the 30 mgd build out, the fish screen needs to be a minimum 235 square feet large to achieve an approach velocity of 0.2 fps at the pumping rate of 47 cfs (CDFG 2000). Thus, the Service estimates the screen will be from 15- to 30-foot long. The designed sweeping velocity for the Stockton DWSP is 0.4 fps. However, due to tidal flow in the San Joaquin River at the site of the DWSP, the sweeping velocity can only be met approximately 80 to 85 percent of the time at the intake site. These departures from the necessary sweeping velocity occur during slack tide periods when the tidal flow changes from flood tide to ebb tide. The amount of time during the day when the sweeping flow does not meet the design criteria of the fish screen is equal to approximately four hours, with approximately two hours of not demonstrable sweeping velocity at all (15 minutes of slack water before and after the peak tidal oscillation, four times a day). The designed sweeping velocities are at or lower than the expected swimming velocity for delta smelt. Thus, an adult delta smelt is expected to maintain position during targeted sweeping flows or move against the flow. Estimated maximum screen passage velocity for an adult delta smelt (i.e., the distance the fish move along the screen per time unit) during the day at zero sweeping velocity is about 20 cm/s (Swanson *et al.* 2005). This relates to a minimum exposure time of two and a half minutes for an adult delta smelt swimming along a 30-meter long screen during tidal change. At night, under experimental conditions with sweeping flows of 0 cm/s, delta smelt maintained their position or moved pass the screen at an "upstream" direction at a velocity of about 10 cm/s (Swanson *et al.* 2005). At sweeping velocities of 31 and 62 cm/s, delta smelt was carried with the currents at higher screen passage velocities during night than during the day. Thus, the delta smelt is expected to be exposed to the screen for a substantially longer duration during the night than during the day.

The delta smelt is also expected to show some behavioral response to tidal fluctuations (Bennett *et al.* 2002). Adult delta smelt moving upstream to spawn are believed to use the tidal fluctuation to support upstream movement. Delta smelt are believed to move into the water column and swim with the current during flood tide and hold position by swimming against the current during ebb tide. The delta smelt may also move closer to the bottom or banks to seek velocity refuge during ebb tide. Thus, the delta smelt is expected to be briefly exposed to the DSWP intake during flood tide while they may be exposed to the intake for considerable time during ebb tide.

Fish close to the fish screen are exposed to periodic contact with the screen and may be impinged against it. Experiments in the Fish Treadmill at the University of California, Davis, exposed delta smelt to a simulated fish screen in a large annular flume (Swanson *et al.* 1998, 2005; White *et al.* 2007). Delta smelt experienced brief contact with the screen at all flow treatments and screen contact rates increased with both approach and resultant velocity (the vector sum of the sweeping and approach velocities). However, contact duration was shorter in the absence of sweeping flow than under high-velocity flow conditions (White *et al.* 2007). Contact rates increased during night, consistent with the observed reduction in swimming velocity, but not with temperature (Swanson *et al.* 2005). Mean contact rate with a 6 cm/s approach velocity and 31 cm/s (~ 1.0 fps) sweeping velocity ranged from 0.023 to 0.047 contacts per fish per minute (White *et al.* 2007). At zero sweeping velocity the contact rate was 0.028. Most delta smelt contacted the screen broadside with the tail first. In 34 percent of recorded incidents, the fish impacted the screen head first (White *et al.* 2007).

The behavioral response to the simulated fish screen and experimental velocities was somewhat similar to what has been observed with juvenile Chinook salmon. However, the two species differed markedly in their response to flow velocities and effects of screen contact and injuries. Contact with the screen decreased with increasing flow and swimming velocity for Chinook salmon while it increased for delta smelt; delta smelt also experienced more high velocity screen contact. The difference may be a result of swimming behavior and strength between the two species. Further, while the rate of contact for Chinook salmon during night was similar to contact rate for delta smelt during day, delta smelt sustained more injuries and had a higher mortality rate. Injuries included scale loss, fin damage, abrasions, hemorrhage, and stress. The magnitude of injury to delta smelt depended on the frequency of contact and severity of contact, the former being a function of exposure time and flow and the latter mainly of approach velocity (Swanson *et al.* 1998, 2005). However, low injury rate was sustained at velocity treatments similar to design flows proposed for the DWSP and no fish were impinged. Based on results from the Fish Treadmill studies, Swanson *et al.* (2005) estimated five percent mortality at night and zero mortality during day for a 100 meter long screen with approach and sweeping velocities similar to the designed flow for the DWSP intake fish screen. The mortality rate may, however, be higher for fish smaller than those used in these experiments.

The mainstem San Joaquin River channel at the intake location is about 600 feet wide at its narrowest point and only delta smelt a few feet from the screen will be in danger of being impinged on the fish screen. The face of the intake with the screen will provide a vertical clean surface to a depth of 15 feet and therefore not provide habitat features that would attract delta smelt. Since delta smelt is expected to use the open water of the river channel, only a fraction of juvenile and adult delta smelt using the channel will be directly affected by the proposed DWSP intake.

Larvae Delta Smelt. The length of time a larvae is exposed to the fish screen is based on the sweeping velocity and the length of the fish screen. With an estimated fish screen length of 30 feet the estimated exposure time will be 75 seconds based on the 0.4 sweeping velocity. The distance a passive particle is affected by the water intake is a function of pumping capacity and the effective surface area that the particle is passing through, which determine the approach velocity of particles at different distances from the screen face under different pumping rates. The City estimates that the area of influence for a passively drifting delta smelt larvae is two feet or closer from the screen (ESA 2006b).

The number of larvae entrained at the DWSP intake location will depend on the volume of water being diverted and the average number of larvae or juveniles in a given volume of water (i.e., delta smelt density) at any given time. Larvae density near the proposed DWSP diversion will vary from year to year according to overall numbers of delta smelt in the Delta and the proportion of females spawning in the central and south Delta. However, the proportion of the total population presented at the intake location is expected to be low. For instance, a total of 102 delta smelt were sampled in the 20-mm trawl at the station near the proposed diversion site (station 906: Figure 4) in 1999 but this represented only 10 percent of the 1,020 delta smelt sampled in the whole of the Delta the same year. Similarly in a year with low abundance, such as 2005, only 5 delta smelt were collected at station 906 by the 20-mm trawl compared to a total of 598 delta smelt larvae sampled for the whole Delta.

Number of delta smelt larvae and juveniles collected in the 20-mm trawl usually peaks late April and early May (Stern in lit. September 5, 2006). The proposed reduction in pumping between March 15 to April 15 and between May 21 and June 20 and closedown of pumps between April 16 and May 20 will significantly reduce delta smelt exposure to water diversions. For instance, in 2005 larvae were collected at stations 906 and 910 between March 14 and May 23, the period when pumping restrictions would have been in place. During the years of survey, larvae have never been collected at station 906 after June 21 (DFG 2007).

The size of larva fish vulnerable to entrainment at a fish screen is a function of the slot opening of the screen mesh and size (length and depth) of the fish. Entrainment of delta smelt larvae at fish screens has not been studied, and the relationship between fish length and the effectiveness of various mesh openings in physically excluding fish from entrainment differs for fish species with different body shapes. Hanson Environmental and ESA (Stern in lit. February 24, 2006 – Attachment B) therefore used the data developed for larval bay anchovy (*Anchoa mitchilli*) to analyze entrainment of delta smelt larvae at the DWSP intake since larvae of this species resembles the body shape of delta smelt.

Stern (in lit. February 24, 2006 – Attachment B) assumed that screens with a 2 mm screen mesh will exclude zero percent of delta smelt larvae 4 mm long or less, 56 percent of larvae 5 to 7 mm long, 78 percent of larvae 8 to 10 and 11 to 14 mm long, and 80 percent of larvae 15 mm and greater in length. Using results from the CDFG 20-mm surveys and the Delta Smelt Larvae Survey (DSLS) conducted in 2005, Hanson Environmental and ESA (2006) estimated that the highest larvae densities in the vicinity of the proposed DWSP intake occurred between mid-March to mid-June. Applying these results to delta smelt and using larvae densities recorded from CDFG's 20-mm surveys, Hanson Environmental, Inc. calculated entrainment of different size classes assuming a curtailment of pumping from April 15 to May 15 and a diversion of 100.6 AF/day for the remaining year (Stern in lit. February 24, 2006 – Attachment B)(Table 1). However, the number entrained is expected to be substantially lower because Hanson Environmental, Inc. did not include a lowered pumping rate from March 15 to April 15 and from May 16 to June 15 or the proposed 100 percent curtailment that extended to May 20. Given calculations based on the 20-mm survey data and two 50 percent curtailment periods, an average of 1,247 delta smelt would have been entrained each year from 1995 through 2006 with a range of 0 delta smelt in 1995, 1998, and 2006 to 3,690 delta smelt in 1999. The number of larvae being entrained is expected to be somewhat proportional to overall abundance of the seasons overall spawning abundance indicated by the FMWT index (Table 2). During the years 2002 to 2006, the period of reduced delta smelt abundance based on the FMWT index, the estimated number of larvae that would have been entrained range between 0 in 2006 and 2007 to a maximum of 924 in 2003 (Table 2). A delta smelt female spawn from 1,200 to 2,600 eggs and even the larger estimate of entrained larvae would represent only a small fraction of the total population of delta smelt larvae produced during a season. The number of larvae exposed to the DWSP intake is expected to be low in the future because of the recent observed reduction in abundance of larvae at the intake location. Thus, with the proposed pumping operations, the number of larvae entrained as a consequence of the proposed action is expected to range between 0 and 200 with zero or only a few larvae being entrained during years with very low abundance.

The above calculations are based on the proposed initial 30 mgd diversion. Increases in the pumping rate will increase the estimated number of delta smelt entrained in the DWSP intake facility. However, future expansion of the DWSP in not covered in this biological opinion and the effects of diversion rates above the 30 mgd on delta smelt have not been estimated. Consequently, future expansions will require separate biological opinions to assess the effects on delta smelt.

Effects of Changes in Delta Hydrology

The applicant used CALSIM II for their hydrological modeling. Geographically, the model covers the drainage basin of the Delta and SWP exports to the water users. CALSIM II typically simulates system operations for a 73-year period using a monthly time step. The historical flow record of October 1921 to September 1994 is used to represent the possible future range of water supply conditions. Assumptions about facilities, land use, water supply contracts, etc. is kept constant over the 73-year simulation period and represent a fixed level of development (LOD). To estimate effects from the project on Delta hydrology, the model was run with and without the proposed project included. All of the assumptions except the action itself are kept the same during the two model runs. Once the model runs are completed, the results for simulations with the proposed project included can be compared with simulations without the proposed project. Model runs are best interpreted using long-term or year type average statistics. Thus, the model is limited in its use to measure effects to the delta smelt on a time scale that is relevant to the species. However, monthly results are still useful for general comparison of alternatives.

Hydrological modeling by the applicant shows that the diversion of 30 mgd at a rate of up to 47 cfs will result in small but measurable changes in Delta hydrology (MVH 2005). These changes could potentially adversely affect delta smelt through changes in water quality and increased chance of entrainment at the State and Federal intake facilities at Banks and Tracy, respectively.

QWEST is an index of the net San Joaquin River flow at Jersey Point. The flow rate and diversion are indicative of the water balance in the central and southern Delta. Net reverse flow past Jersey Point indicates that higher salinity water is being drawn into the interior Delta as a result of high depletions and exports compared to Delta inflows and cross-Delta flows. QWEST can be used as an indicator of changes in habitat conditions and delta smelt survival.

Modeled changes in QWEST are a direct consequence of DWSP diversion. Changes in annual flows are slight but measurable over all water year types and can be significant in certain months. For instance, QWEST decreases relative to baseline for the 2003 LOD by 112 cfs of the average net negative 378 cfs December flow. For the 2015 LOD cumulative condition analysis, QWEST decreased under the DWSP by 17 cfs or 4 percent of the average annual net flow. The largest change in net San Joaquin River average monthly outflow for the 2015 LOD occurs in August with a decrease in outflow by 46 cfs from a baseline outflow of negative 2,610 cfs. The computer simulation modeling by the applicant has indicated that the DWSP diversion effect on reduction in net Delta outflow on the San Joaquin River is subtle, yet has pervasive effect on average annual flows at San Joaquin River at Anticoh, Old River at San Joaquin confluence, and Ran Joaquin River at San Andreas Landing. Effects follow consistent trends base on the projected growth trends of the future level of development forecasts.

Delta smelt distribution, especially larvae distribution, is affected by the hydrology in the delta. During the larval and juvenile phases, river flows of sufficient magnitude and duration facilitate down-estuary movement from spawning habitats in the Delta. Larvae originating in Sacramento River can be brought into the central Delta via Three Mile Slough or back up through the San Joaquin River by flood tides. Larvae in the lower San Joaquin River can be transported through the mouth of Old and Middle Rivers towards the water export facilities in the south Delta.

The tidal flow in the delta varies greatly over the tidal cycle and a passive particle will slush back and forth with the tide but water exports can result in a net movement into the south Delta. At the 30 mgd buildout, the change in QWEST of the DWSP is small compared to total annual outflow and the DWSP diversion minimal compared to total tidal flows but the change in QWEST flows will affect net particle movement in the central Delta. This will result in a slightly increased residence time during positive QWEST and an increased net movement into the central Delta during negative QWEST flows. Therefore the proposed DWSP could result in a slight increase in larvae entrainment at the CVP and SWP export facilities during some water years since delta smelt larvae are mostly transported passively with flow and tide. However, the proposed restrictions on pumping from April 15 through June 15 will avoid or minimize any effects of the DWSP on QWEST.

Adult delta smelt migrating up the Delta likely also respond to subtle changes in Delta flows and salinity. Reduction in San Joaquin River flows together with increased flow from the Sacramento River through Three Mile Slough may attract adult delta smelt into the central Delta where they are more susceptible to enter Old River and eventually being entrained in the state and Federal Delta water diversions. The small changes seen in the modeled delta flows for the 30 mgd SDWP diversion are not likely to affect delta smelt movements into the Delta. However, the full buildout to 160 mgd could have substantial effect on delta smelt distribution during spawning movements into the Delta.

Effects on Critical Habitat

Critical habitat is not likely to be adversely modified or destroyed as a result of the proposed project. The primary constituent elements essential to the conservation of the species will not be affected by the proposed project. The initial 30 mgd diversion at the SDWP pumping facility will result in an insignificant loss of physical habitat in the delta. River flows and water in the delta will continue to be adequate to provide spawning, rearing and foraging habitat for the smelt. The salinity of the delta will not be modified beyond the normal fluctuations as a result of this project, as the location of X2 during February through June will not change significantly as a result of this project. No breeding habitat will be affected by the proposed project, and the sustainability of the food base for delta smelt will not be changed by the proposed project. In addition, adequate flows and reduced exports during the delta smelt spawning and rearing seasons will protect delta smelt.

Effects of the Proposed Action on Giant Garter Snake

Effects of the Construction

Direct effects:

No direct effects to giant garter snakes are anticipated as a result of the initial 30 mgd operation of the intake. The fish screen size and approach velocity is designed to avoid entrainment of delta smelt, which are much smaller in size, so no entrainment of giant garter snakes is expected to occur.

Direct effects to giant garter snakes as a result of the construction of the intake, pipelines, and water treatment plant will be avoided by implementation of the "Incidental Take Minimization Measures" as outlined in the SJMSCP. Restricting construction to during the species active period (May 1 – October 1) will allow for giant garter snakes to disperse out of the construction area to avoid direct mortality. SJCOG will use the fees that the City of Stockton paid to participate in the SJMSCP to purchase similar habitat and manage this habitat for the benefit of the covered species to compensate for the effects from the construction of the intake structure, the pipelines, and the water treatment plant.

Indirect effects:

One of the objectives outlined in the Final Environmental Impacts Report for the Stockton Delta Water Supply project (ESA 2005) is "to provide adequate water supply to accommodate planned growth." The initial 30 mgd intake operation is expected to meet the water supply needs of build-out anticipated in the 1990 Stockton General Plan. The pumping of water out of the Delta will result in an increased availability of drinking water, with subsequent growth-inducing effects on federally-listed species, including the giant garter snake. Incidental take that occurs as a result of the necessitated residential development may be covered under the SJMSCP, but it is possible that some of the proponents of this development will opt out of participating in the SJMSCP. In this case, giant garter snakes may be affected by habitat loss, modification, or fragmentation, or direct mortality, and any resulting take would not be covered under the SJMSCP.

Indirect effects from the construction of the intake, pipelines, and water treatment plant are analyzed in the *Intra-Service Biological and Conference Opinion* (Service 2001). Those effects applicable to the proposed action include habitat fragmentation, edge effects, changes in hydrology, displacement of individuals, and temporary harassment from the presence of people and equipment.

Effects of Interrelated and Interdependent Activities

Upgrades to the electrical infrastructure are necessary for the operation of the water treatment plant and intake pumps. Construction of these upgrades has the potential to affect the giant garter snake if poles, substations, or any other related structures are constructed in giant garter snake habitat. SJMSCP coverage can be sought when design specifications are finalized, and will be subject to conditions of coverage, including adherence to "Incidental Take Minimization Measures" and fee payment to SJCOG. It is possible these upgrades could require permits from other federal agencies, which would necessitate section 7 consultation with that agency if these upgrades may affect the giant garter snake.

Cumulative Effects

Cumulative effects include the effects of State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered for this biological opinion. Future 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.

Non-Federal actions that may affect the action area include ongoing agricultural activities and increased urbanization. Agricultural activities in the Delta affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reduction in water flow in stream channels flowing into the Delta. The approximately 1,800 agricultural diversions in the Delta (DWR 1993) will continue to entrain an unquantified number of delta smelt each year and agricultural drainage returns reduces water quality and contain herbicide and pesticide compounds that could affect delta smelt survival and reproductive success. Stormwater from urban areas containing toxic compound is and will continue to be discharged into the Delta.

The Delta and East Bay regions, which include portions of Contra Costa, Alameda, Sacramento, San Joaquin, Solano, Stanislaus, and Yolo counties, are expected to increase in population by nearly three million people by the year 2020. Increase in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water uses and stormwater runoff patterns. Industrial and residential developments and expansions will also result in development of upland and riparian habitat supporting the giant garter snake. Many these activities are expected to not go through any consultation process with the Service.

Conclusion

After reviewing the current status of the delta smelt and the giant garter snake, the environmental baseline for the action area, the effects of the proposed project, and the cumulative effects, it is the Service's biological opinion that the City of Stockton's water supply project as proposed, is not likely to jeopardize the continued existence of the delta smelt or the giant garter snake. The proposed action is located in delta smelt critical habitat, but will not be adversely modified by the proposed action.

This conclusions are based on the following considerations: (1) In-water construction and its potential effects will occur at a time of year when delta smelt is unlikely to be present within the project area; (2) conservation and performance measures are in place to ensure impacts are minimized on all aspects of the project; (3) work area isolation and fish removal will occur; (4) the fish screen will prevent adult delta smelt and juveniles larger than 20 mm from being entrained at the DWSP intake; (5) entrainment of larvae and juveniles will be minimized by reduced pumping and pumping curtailment during the period of peak abundance of larvae and juveniles; (6) the proportion of the delta smelt larvae and juvenile population exposed to the pumps is expected to be low; (7) the expected survival of delta smelt larvae and juveniles in the south Delta at baseline conditions is low and estimated loss of larvae at the DWSP intake is therefore not believed to affect larvae expected survival to maturity; (8) expected contribution to population growth by a larvae is low and the low number expected to be entrained is therefore not expected to significantly affect the delta smelt population; and (9) the effects of this action are not likely to impair currently properly functioning habitats for the delta smelt and the giant garter snake, appreciably reduce the functioning of already impaired habitats, or retard the long-term progress of impaired habitats toward proper functioning condition essential to the long-term survival and recovery of the populations of the delta smelt and the giant garter snake.

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 the Corps 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. The Corps has a continuing duty to regulate the activity that is covered by this incidental take statement. If the Corps (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

Delta Smelt

The Service expects that incidental take of adult delta smelt and juveniles larger than 20 mm long will be difficult to detect or quantify for the following reasons: the small size of eggs, larvae, and fish; their occurrence in aquatic habitat makes them difficult to detect; and the low likelihood of finding dead or impaired specimens. Direct take of delta smelt from the construction of the proposed water intake and fish screen activities (*e.g.* entrainment of the dredge, exposure to resuspended sediment, acoustic noise for the pile driving actions) is not expected to occur if construction actions are implemented in the middle of the construction window (i.e., August 1 through October30) and construction actions are completed by November 30. The exposure risk to delta smelt increases should construction activities be initiated earlier than August 1 since juveniles and adults may still be in the vicinity of the water intake site or if construction activities continue after October 1 since up-estuary migration by adult delta smelt could start in November.

Incidental take from operation of the water intake is calculated for the initial proposed water diversion level of 30 mgd. The Service understands that increases in the diversion rate beyond 30 mgd will trigger new consultations with the Corps and the City of Stockton. Direct take of larvae and juveniles in the form of mortality will occur from entrainment at the water intake and of adult delta smelt in the form of injury and harassment from impingement on the fish screen. Entrainments of delta smelt do not necessarily index how facility operations affect the delta smelt population. In years when delta smelt are numerous and widely distributed, high entrainment rates may not be of great concern. Conversely, during years when there are few delta smelt and they are distributed in areas vulnerable to entrainment at the DWSP intake, even low salvage may be of great concern. Entrainment of larvae is of lesser concern than entrainment of prespawning adults as prespawning adults are individually more important to the perptuaiton of the species. No adults or juveniles larger than 20 mm are expected to be entrained at the DWSP intake. The larvae entrainment were calculated from the density of larvae captured in the biweekly DFG 20-mm trawls at stations adjacent to the proposed intake facility location during the years 1995 to 2006. These densities were then applied to calculate entrainment at the DWSP at a pumping rate of 30 mgd and pumping curtailment during April 16 through May 15. However, about half of this number is expected to be entrained at any give density during any given year since the calculation did not take into account the proposed longer curtailment period (April 16 through May 20) and the reduced pumping rate before and after this period. An upper incidental take limit is then provided based on the relationship between estimated take and the previous years FMWT index. However, with the expected efficiency of the screen similar to the similar fish screen at the Contra Costa Water District diversion in Old River, the number of larvae entrained is expected to be close to zero unless the overall delta smelt population increases substantially and the majority of spawning occurs in the South Fork Mokelumne River, by Empire Tract, and/or in the San Joaquin River upstream of Empire Tract..

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. About 0.44 acre of shallow water habitat will become unsuitable as a result of the proposed project. The Service further estimates take of delta smelt larvae incidental to operation of the intake facility will not exceed 25 following a year with a low pre-spawn delta smelt population abundance as indicated by a FMWT index of 50 or lower. Incidental take of delta smelt larvae may increase as population abundance increase and is estimated to range from 0 to an upper limit of 200 if the previous FMWT index falls between 51 and 100, from 0 to an upper limit of 700 if the FMWT index falls between 101 and 500, and from 0 to an upper limit of 3,500 following a year with high abundance of pre-spawning delta smelt indicated by an FMWT index higher than 500. In addition, an unquantifiable but anticipated small number of delta smelt juveniles and adults within two feet of the screen may be injured or harassed as a result of impingement on the fish screen. The Service has developed the following incidental take statement based on the premise that the reasonable and prudent measures will be implemented. Upon implementation of the following reasonable and prudent measures, incidental take associated with the construction of the intake facility in the form harm of delta smelt caused by the loss of 0.44 acre of shallow water habitat will become exempt from the prohibitions described under section 9 of the Act. Upon implementation of the following reasonable and prudent measures, the Corps and the City of Stockton will become exempt from the prohibitions described under section 9 of the Act for the above described incidental take associated with construction activities and operation of the DWSP intake facility for the 33 mgd diversion in the form of kill, injury, and harassment of delta smelt.

Giant Garter Snake

Incidental take associated with the construction of the intake structure, raw and treated water pipelines, and water treatment plant will be covered under the section 10(a)(1)(B) permit for the SJMSCP. The total amount of incidental take authorized for the SJMSCP is outlined in Table 36 of the *Intra-Service Biological and Conference Opinion*. No new circumstances as identified at 50 C.F.R. 402.16 have occurred that would alter the non-jeopardy determination for the covered species we made in the *Intra-Service Biological and Conference Opinion* and associated incidental take permit. Therefore, the biological opinion remains valid. The habitat acreage converted as a result of the proposed action will be deducted from the amount of habitat specified in Table 36.

The Service does not anticipate that the operation of the intake will incidentally take any giant garter snakes by direct mortality or injury from the operation of the intake. The Service expects that incidental take in the form of harm or harassment is unlikely to occur if all "Conservation Measures" as outlined in the *Project Description* and "Incidental Take Minimization Measures" required by the SJMSCP are correctly implemented. Therefore, no incidental take is authorized from the operation of the intake. If take of giant garter snakes or any other federally-listed species is expected to occur as a result of upgrades to the electrical infrastructure, reinitiation of this consultation will be necessary (see "Reinitiation – Closing Statement" at the end of this biological opinion).

Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the delta smelt. The proposed project is within critical habitat designated for the delta smelt. However, the Service determined in the accompanying biological opinion that the proposed project will not result in destruction or adverse modification of critical habitat designated for the delta smelt.

In the *Intra-Service Biological and Conference Opinion*, the Service determined that this level of take is not likely to result in jeopardy to the giant garter snake. Critical habitat has not been proposed or designated for the giant garter snake; therefore none will be affected.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize incidental take of listed species:

1. The City of Stockton shall implement measures to avoid or minimize adverse effects to the delta smelt and the giant garter snake.

2. The City of Stockton shall ensure their compliance with the *Project Description* of this biological opinion.

Terms and Conditions

To be exempt from the prohibitions of section 9 of the Act, the Corps 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 will implement Reasonable and Prudent Measure number one (1):

   a. The City of Stockton shall minimize the potential for take of the delta smelt and modification/loss of this species' habitat by implementing the Stockton Delta Water Supply Project, including the conservation measures as described in the biological assessment, as described in the *Project Description* section of this biological opinion with the inclusion of or modifications by Terms and Conditions of this biological opinion.

   b. The City of Stockton shall minimize the potential for take of the giant garter snake resulting from project related activities by implementation of the Stockton Delta Water Supply Project, including the conservation measures as described in the biological assessment, as describe in the *Project Description* section of this biological opinion with the inclusion of or modifications by Terms and Conditions of this biological opinion.

   c. The City of Stockton shall include Special Provisions that include the avoidance and minimization measures, and Terms and Conditions of this biological opinion in the solicitation for bid information. In addition, the City of Stockton will educate and inform contractors involved in the project as to the requirements of the biological opinion.

   d. Prior to initiation of ground breaking, the City of Stockton biologist or a Service-approved biologist will conduct an education and training session for all construction personnel. All individuals who will be involved in the site preparation or construction shall be present, including the project representative(s) responsible for reporting take to the Service and the California Department of Fish and Game. Training sessions shall be repeated for all new employees before they access the project site. Sign up sheets identifying attendees and the contractor/company they represent shall be provided to the Service with the post-construction compliance report. The training will consist of a brief presentation by the on-site biologist who will explain endangered species concerns to all contractors, their employees, and agency personnel involved in the project. The program will include a description of the giant garter snake and delta smelt, species habitat needs, an explanation of their protection under the Act, a description of the measures being taken to reduce effects to the species during project construction and implementation, the penalties for non-compliance, and the boundaries (work area) of the project.. The applicant shall submit written proof of the training to the San Joaquin Valley Branch of Endangered Species Program at the Sacramento Fish and Wildlife Office within ten (10) working days of the completion of training. Any deviation from these and other non-discretionary measures must be approved by SJCOG and the Service prior to implementation.

e. To ensure that the incidental take limit is not exceeded and to evaluate the effectiveness of minimization measures, the City of Stockton shall develop and implement a plan to monitor and quantify entrainment of delta smelt at the DWSP intake. The monitoring shall occur over a ten year period from the start of operation of the DWSP intake. In addition to quantifying take of delta smelt larvae and juveniles, the monitoring shall assess the effectiveness of the proposed period of curtailment and reduced pumping, and evaluate if other periods would provide better protection of delta smelt. An annual report shall be sent to Ryan Olah, Branch Chief of the Coast Bay Delta Branch at the Sacramento Fish and Wildlife Office.

f. The fish screen shall be operated in accordance with criteria described in this biological opinion and in consultation with the Service as long as the diversion is in use. When and if the City of Stockton chooses to increase the design intake of the diversion over the initial nominal capacity of 30 mgd, the Corps and the City of Stockton shall enter into formal reinitiation of this consultation with the Service.

g. Pile driving shall not start before August 1 and be completed by October 30.

h. A Service-approved biologist must be on site to monitor project activities; and shall have the authority to stop project activities – when listed species are encountered, unintended direct or indirect effects to listed species habitat occurs, or if activities are not in conformance with the minimization measures as delineated in this project description – until appropriate corrective measures are taken. If a listed animal is observed within a designated work area and cannot be avoided, all work shall stop until the animal leaves the work area or until it is captured and relocated by a biologist with a valid section 10(a)(1)(A) permit issued by the Service to outside of the work area to avoid injury or mortality.

i. The City will follow all the "Incidental Take Minimization Measures" developed by SJCOG for giant garter snakes. These measures shall include, but not be limited to:

  i. conduct pre-construction surveys within 24 hours of initial ground disturbance

  ii. restrict construction, spoils, and equipment staging areas to outside of aquatic and upland habitat (within 200 feet of aquatic habitat) for giant garter snakes

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iii. conduct an environmental awareness training for all construction workers which includes education on the federally-listed species in the area and the importance of their conservation

iv. restrict all work to during the active period for the giant garter snake (May 1 – October 1).

j. The City will install a barrier designed to exclude giant garter snakes around all construction or equipment staging areas designated as aquatic or upland (within 200 feet of aquatic) habitat. Temporary fencing is allowed, but the fence must have an anchored base to prevent giant garter snakes from traveling underneath it and entering the construction area.

k. All disturbed habitat must be restored or replaced consistent with the Service's *Guidelines for Restoration and/or Replacement of Giant Garter Snake Habitat and Standard Avoidance and Minimization Measures During Construction Activities in Giant Garter Snake (Thamnophis gigas) Habitat* (attached).

l. Sensitive habitat areas shall be delineated with high visibility temporary orange-colored fence at least four (4) feet in height, flagging, or other barriers. Such fencing shall be inspected by the Service-approved biologist and maintained daily until completion of the project. The fencing will be removed only when all construction equipment is removed from the site. No project activities shall occur outside the delineated project construction area.

m. A storm water management/erosion control plan shall be developed and implemented during the rainy season (or onset of rain) that include temporary onsite silt traps and/or basins with multiple discharge points to natural drainages and energy dissipaters. Stockpiles of loose material shall be covered and runoff diverted away from exposed soil material. If work stops because of to rain, a positive grading away from slopes shall be provided to carry the surface runoff to areas where the flow would be controlled, such as the temporary silt basins. Sediment basins/traps shall be located and operated to minimize the amount of sediment transported offsite. Any trapped sediment shall be removed from the basin or trap and placed at a suitable location onsite, away from concentrated flows, or removed to an approved disposal site.

n. Temporary erosion control measures shall be implemented until perennial revegetation or landscaping is established and can minimize sediment discharges into nearby waterways. For construction within 500 feet of a water body, appropriate erosion control measures shall be implemented upstream adjacent to the water body.

o. Erosion protection shall be provided on all cut-and-fill slopes. Revegetation shall be facilitated by mulching, hydroseeding, or other methods and shall begin as soon as possible after the completion of grading and before the onset of the rainy season (i.e., by October 15).

p. The BMPs selected and implemented for the project shall be operational before major earthwork begins. The construction phase facilities shall be maintained regularly and cleared of accumulated sediment as necessary. Effective mechanical and structural BMPs that will be implemented for the Proposed Action include the following:

i. Mechanical storm water filtration measures, including oil and sediment separators or absorbent filter systems such as the Stormceptor® system, can be installed within the storm drainage system to filter storm water prior to its discharge.

ii. Vegetative strips, high-infiltration substrates, and grassy swales shall be used where feasible throughout the development to reduce runoff and provide initial storm water treatment.

iii. Roof drains shall discharge to natural surfaces or swales where possible to avoid excessive concentration and channelization of storm water.

iv. Permanent energy dissipaters shall be included for drainage outlets.

v. The water quality detention basins shall be designed to provide effective water quality control measures including the following:

(a.) Maximize detention time to allow settling of fine particles

(b.) Establish maintenance schedules to periodically remove sediments, excessive vegetation, and debris that may clog basin inlets and outlets

(c.) Maximize the detention basin elevation to allow the greatest amount of infiltration and settling prior to discharge

q. Fueling and maintenance of mechanical equipment shall occur in areas where oil or other chemical cannot drain into wetlands, streams, or other aquatic landscape features. Fueling and maintenance areas shall be encircled with structures or material to contain a potential spill. The applicant will prepare a spill prevention and clean-up plan.

r. Hazardous materials such as fuels and solvents used on construction sites shall be stored in covered containers and protected from rainfall, runoff, vandalism, and accidental release to the environment. All fuels and solvents shall be stored in an area with an impervious surface and a containment capacity equal to the volume of the stored materials. A stockpile of spill cleanup materials shall be readily available at all construction sites. Employees shall be trained in spill prevention and cleanup, and individuals shall be designated as responsible for prevention and cleanup activities.

s. Equipment shall be properly maintained in designated areas with runoff and erosion control measures to minimize accidental release of pollutants.

t. The SWPPP will specify measures for removing sediment from water pumped during trench dewatering before the water is released to waterways.

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2. The following Terms and Conditions will implement Reasonable and Prudent Measure number one (2):

   a. If requested, before, during, or upon completion of ground breaking and construction activities, the City of Stockton shall allow access by Service and/or California Department of Fish and Game personnel to the project site to inspect project effects to the delta smelt, giant garter snake, and their habitats.

   b. The City of Stockton shall comply with the *Reporting Requirements* in this biological opinion.

Reporting Requirements

The Service and the California Department of Fish and Game must be notified within one (1) working day of the discovery of death or injury to a delta smelt or giant garter snake that occurs due to project related activities or is observed at the project site. Injured giant garter snake must be cared for by a licensed veterinarian or other qualified person(s), such as the Service-approved biologist. Notification must include the date, time, and location of the incident or of the finding of a dead or injured animal clearly indicated on a USGS 7.5 minute quadrangle and other maps at a finer scale, as requested by the Service, and any other pertinent information. Dead individuals of any of these two listed species must be sealed in a zip-lock® plastic bag containing information on date and time when the animal was found, the location where it was found, and the name of the person who found it written on 100% rag content paper with permanent ink, and the bag containing the specimen frozen in a freezer located in a secure site. The Service contacts are Chris Nagano, Deputy Field Supervisor at the Sacramento Fish and Wildlife Office at telephone 916/414-6600, and Scott Heard, Resident Agent-in-Charge of the Service's Law Enforcement Division at telephone 916/414-6660.

The City of Stockton shall submit a post-construction compliance report prepared by the on-site biologist to the Sacramento Fish and Wildlife Office within sixty (60) calendar days of the date of the completion of construction activity. This report shall detail (i) dates that construction occurred; (ii) pertinent information concerning the success of the project in implementing avoidance and minimization measures with an explanation of failure to meet such measures, if any; (iii) known project effects on the delta smelt and/or the giant garter snake, if any; (v) occurrences of incidental take of these listed species, if any; and (vi) other pertinent information.

The City shall submit a report to the Service documenting the restoration of all impacted giant garter snake habitat in accordance with the *Guidelines for Restoration and/or Replacement of Giant Garter Snake Habitat.* This and all subsequent reports should reference the Service File No. 1-1-05-F-0029 and be submitted to the Service, Attention: San Joaquin Valley Branch immediately upon completion of restoration and/or monitoring.

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 Corps and the City of Stockton should develop and implement restoration measures in areas designated in the Delta Fishes Recovery Plan (Service 1996).

2. The City of Stockton should assist the Service in implementing recovery actions identified in the *Draft Recovery Plan for the Giant Garter Snake (Thamnopsis gigas)* (U.S. Fish and Wildlife Service 1999).

2. The Corps should develop procedures that minimize the effects of all other in-water activities on the delta smelt.

3. The Corps should support and promote aquatic and riparian restoration within the Delta region, and encourage its contractors to modify operation and maintenance procedures through the Corps' authorities so that those actions avoid or minimize negative impacts to delta smelt and giant garter snake.

4. Sightings of any listed or sensitive animal species should be reported to the California Natural Diversity Database of the California Department of Fish and Game. A copy of the reporting form and a topographic map clearly marked with the location the animals were observed also should be provided to the Service.

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 with the Corps on the Stockton Delta Water Project in San Joaquin, California. 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; (2) new information reveals effects of the proposed action 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 listed species or critical habitat that was not considered in this opinion; or (4) a new species or critical habitat is designated that may be affected by the proposed 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 Stockton Delta Water Supply Project, please contact Peter Johnsen or Ryan Olah of the Sacramento Fish and Wildlife Office at (916) 414-6625.

Sincerely,

Cliff Nagano

for Cay C. Goude
Acting Field Supervisor

cc:
Jeffery Stuart, National Marine Fisheries Service, Sacramento, California
Scott Wilson, California Department of Fish and Game, Yountville, California
Steve Mayo, San Joaquin Council of Governments, Stockton, California
Robert Granberg, City of Stockton, Stockton, California
Calvin Fong, Walter Yep, Inc., Sacramento, California

Literature Cited

American Farmland Trust. 1999. California's Central Valley Urban Sprawl 2040 Zone of Conflict. Farmland Information Library. 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. Dept. 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 of Advances in 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.

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.

Bennett, W.A., W.J. Kimmerer, J.R. Burau. 2002. Plasticity in vertical migration by native and exotic estuarine fishes in a dynamic low-salinity zone. Limnology and Oceanography 47: 1496-1507.

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

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

Burgess, W.C. and S.B. Blackwell. 2003. Acoustic monitoring of barrier wall installation at the former Rhône-Poulene site, Tukwila, Washington. Prepared for RCI International, Inc., Summer Washington.

Caltrans. 2004. San Francisco – Oakland Bay Bridge east span seismic safety project. Fhiseries and hydroacoustic monitoring program compliance report. June 2004. EA 012023, 04-SF-80 KP 12.2/KP 14.3, 04-ALA-80 KP 0.0/KP 2.1.

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

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

______ 2000b. Fish screen criteria. June 19, 2000. Available from http://www.iep.ca.gov/cvffrt/DFGCriteria2.htm

______ 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.

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

______ 2007. Bay – Delta Monitoring [database on the internet]. Available from http://www.delta.dfg.ca.gov.

California Department of Water Resources (DWR). 1993. Sacramento – San Joaquin Delta Atlas. DWR, Sacramento, California.

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.

California Natural Diversity Data Base (CNDDB). 2007. RareFind 3. California Department of Fish and Game. Sacramento, California.

Dickert, C. 2002. San Joaquin Valley giant garter snake project 2001. California Department of Fish and Game. 14 pp.

_____. 2003. Progress report for the San Joaquin Valley giant garter snake conservation project-2003. California Department of Fish and Game. 37 pp.

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.

Environmental Science Associates (ESA). 2003. Stockton Delta Water Supply Project. Sacramento, California. 25 pp.

_____. 2006a. Stockton Delta Water Supply Project, Final Program Environmental Impact Report, State Clearinghouse No. 2003112060. Sacramento, California.

_____. 2006b. Stockton Delta water supply project. Biological assessment prepared for the City of Stockton. ESA, Sacramento, California. February 2006.

Fitch, H. S. 1940. A biogeographic 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. California Fish and Game 27(2): 1-32.

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 (ed.). Conservation Biology: the science of scarcity and diversity. Sinauer Associates, Inc., Sunderland, Massachusetts.

Hansen, E. C. 2003. Year 2002 investigations of the giant garter snake (*Thamnophis gigas)* in the Middle American Basin: Sutter County, California. Prepared for Sacramento Area Flood Control Agency.

_____. 2004. Year 2003 investigations of the giant garter snake (*Thamnophis gigas)* in the Middle American Basin: Sutter County, California. Prepared for Sacramento Area Flood Control Agency.

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

_____. 1995. Status of the giant garter snake (*Thamnophis gigas*) in the San Joaquin Valley-1995. Final Report for California Department of Fish and Game Standard Agreement No. FG4052IF. Section 6 Project EF94-XX, Objectives 3 and 5, November 1996.

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

Hansen, G. E. and J. M. Brode. 1980. Status of the giant garter snake *Thamnophis couchi gigas*

(Fitch). California Department of Fish and Game, Inland Fisheries Endangered Species Program Special Publication 80-5. Rancho Cordova, California. 14 pp.

_____. 1993. Results of relocating canal habitat of the giant garter snake (*Thamnophis gigas*) during widening of SR 99/70 in Sacramento and Sutter Counties, California. Final report for Caltrans Interagency Agreement 03E325 (FG7550) (FY 87/88-91-92). Rancho Cordova, California. 36 pp.

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

Hanson Environmental, Inc. and ESA. 2006. Stockton Delta Water Supply Project: Seasonal distribution of larval delta smelt in the lower San Joaquin River in the vicinity of the Stockton Delta Water Supply intake structure. Technical Memorandum prepared for the City of Stockton. Project No. 200090. ESA, Sacramento, California. August 2006.

Hastings, M.C. 2002. Clarification of the meaning of sound pressure levels and the known effects of sound on fish. Document in support of Biological Assessment for the new Benicia-Martinez Bridge. August 26, 2002; revised August 27, 2002. 8 pp.

Hastings, M.C., and A.N. Popper. 2005. Effects of sound on fish. Prepared for Jones & Stokes under California Department of Transportation contract no. 43A0139. Sacramento, CA.

Hastings, M.C., A.N. Popper, J.J. Finneran, and P. Lanford. 1996. Effects of low frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish *Astronotus ocellatus*. Journal of the Acoustical Society of America 99: 1759-1766.

Hastings, M.C., A.N. Popper, J.J. Finneran, and P. Lanford. 1996. Effects of underwater sound on hair cells of the inner ear and lateral line of the oscar (*Astronotus ocellatus*). Journal of the Acoustical Society of America 99: 2576-2603.

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., 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 21:906-913.

Hunt, J.W., B.S. Anderson, B.M. Phillips, R.S. Tjeerdema, K.M. Taberski, C.J. Wilson, H.M. Puckett, M. Stephenson, R. Fairey, and J. Oakden. 2001. A large-scale categorization of sites in San Francisco Bay, USA, based on the sediment quality triad, toxicity identification evaluations, and gradient studies. Environmental Toxicology and Chemistry 20: 1252-1265.

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.

Krebbs, C. J. 1994. Ecology: the Experimental Analysis of Distribution and Abundance. Fourth Edition. Harper-Collins College Publishers. 801 pp.

McCauley, R.D., J Fewtrell, and A.N. Popper. 2003. High intensity anthropogenic sound damages fish ears. Journal of the Acoustic Society of America 113: 638-642.

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.

MWH. 2005. Modeling technical appendix to the draft environmental impact report. City of Stockton Delta Water Supply Project. MVH, Sacramento, California. October 2005.

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

Noss, R. F., E. T. LaRoe III, and J. M. Scott. 2003. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation—April 2003. http://biology.usgs.gov/pubs/ecosys.htm

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*. Master of Arts thesis in Biology: Ecology and Systematics; San Francisco State University. 27 pp.

Patterson, L. 2004. Giant garter snake surveys for the In-Delta Storage Program year-end and summary report.

Patterson, L. and E. Hansen. 2003. Giant garter snake surveys on Bacon Island and Webb Tract in 2003. Report to Department of Water Resources. 24 pp.

Pereira, W.E., J.L. Domagalski, F.D. Hostettler, L.R. Brown, and J.B. Rapp. 1996. Occurrence and accumulation of pesticides and organic contaminants in river sediment, water, and clam tissues from the San Joaquin River and tributaries, California. Environmental Toxicology and Chemistry 15: 172-180.

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. 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.

Rossman, D. A., N. B. Ford, and R. A. Seigel. 1996. The garter snakes: evolution and ecology. University of Oklahoma Press, Norman. 331 pp.

Saiki, M. K. 1998. An ecological assessment of the Grassland Bypass Project on fishes inhabiting the Grassland Water District, California. Final Report. U.S. Fish and Wildlife Service, Sacramento, California.

Stitt, E. W., P.S. Balfour, T. Luckau, and T. E. Edwards. 2005. The southern watersnake (*Nerodia fasciata*) in Folsom, California: history, population attributes, and relation to other introduced watersnakes in North America. Final Report to U.S. Fish and Wildlife Service, Sacramento, CA.

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.

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.

Swanson, C., P.S. Young, and J.J. Chech, Jr. 1998. Swimming performance, behaviour, and physiology of delta fishes in complex flows near a fish screen: Biological studies using the Fish Treadmill. Interagency Ecological Program for the Sacramento-San Joaquin Estuary Newsletter 11: 38-42.

Swanson, C., P.S. Young, and J.J. Cech, Jr. 2005. Close encounters with a fish screen: Integrating physiological and behavioral results to protect endangered species in exploited ecosystems. Transactions of the American Fisheries Society 134: 1111-1123.

Sweetnam, D.A. 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 pp. 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.

Turnpenny, A.W.H., K.P. Thatcher, and J.R. Nedwell. 1994. The effects on fish and other marine animals of high-level underwater sound. Fawley Aquatic Research Laboratory, Ltd., Report FRR 127/94, United Kingdom.

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. http://www.doi.gov/oepc/wetlands2/

U.S. Fish and Wildlife Service (Service). 1991. Proposed Rule to List the Giant Garter Snake, *Thamnophis gigas* as an Endangered Species. **Federal Register** 56:67046.

______ 1993a. Endangered and threatened wildlife and plants: Determination of threatened status for the delta smelt. March 5, 1993. **Federal Register** 58:12854-12864.

______ 1993b. Endangered and Threatened Wildlife and Plants: Determination of threatened status for the giant garter snake. **Federal Register** 58:54053-54066.

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

______ 1994b. 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. 52pp., plus figures and attachment.

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

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

______ 2001. Intra-service biological and conference opinion on issuance of an incidental take permit to multiple applicants for a multiple species habitat conservation plan for San Joaquin County, California. Biological opinion. Service File 1-1-00-F-0231. Sacramento, California. 214 pages.

_____. 2003. Revised Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*). U.S. Fish and Wildlife Service, Portland, Oregon. ix + 194 pp.

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

Werner, I., L.A. Deanovic, V. Connor, V. De Vlaming, H.C. Baily, and D.E. Hinton. 2000. Insecticide-caused toxicity to *Ceriodaphnia dubia* (Cladocera) in the Sacramento-San Joaquin River Delta, California, USA. Environmental Toxicology and Chemistry 19: 215-227.

White, D.K., C. Swanson, P.S. Young, J.J. Cech, Jr., ZQ Chen, and M.L. Kavvas. 2007. Close encounters with a fish screen II: Delta smelt behavior before and during screen contact. Transactions of the American Fisheries Society 136: 528-538.

Williams, T. and V. Wunderlich. 2003. Progress report: 2003 San Joaquin Valley giant garter snake conservation project. San Luis National Wildlife Refuge Complex, Los Banos, California.

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

_____. 1998b. Giant garter snake project: 1998 progress report. Dixon Field Station, Biological Resources Division, U.S. Geological Survey, Dixon, California.

_____. 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. Dixon Field Station, Biological Resources Division, U.S. Geological Survey, Dixon, California. 9 pp.

Wylie, G.D. and L. L. Martin. 2004. Results of 2004 monitoring for giant garter snake (*Thamnophis gigas*) for the bank protection project on the left bank of the Colusa Basin Drainage Canal in Reclamation District 108, Sacramento River Bank Protection Project, Phase II. Prepared for: Environmental Planning Section, U.S. Army Corps of Engineers, Sacramento District, November 2004.

Wylie, G.D., T. Graham, M. L. Casazza, M. M. Paquin, and J. Daugherty. 1996. National Biological Service giant garter snake study progress report for the 1995 field season. Preliminary report. Dixon Field Station, Biological Resources Division, U.S. Geological Survey, Dixon, California.

Wylie, G.D., M.L. Cassaza, and J. K. Daugherty. 1997. 1996 Progress report for the giant garter snake study. Preliminary report. Dixon Field Station, Biological Resources Division, U.S. Geological Survey, Dixon, California.

Wylie, G.D., M.L. Casazza, L. Martin, and E. Hanson. 2000. Investigations of giant garter snakes in the Natomas Basin: 2000 field season. Dixon Field Station, Biological Resources Survey, U.S. Geological Survey, Dixon, California. 13 pp.

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

Yelverton, J.T., D.R. Richmond, W. Hicks, K. Saunders, and R. Fletcher. 1975. The relationship between fish size and their response to underwater blast. Topical Report DNA 3677T. Defense Nuclear Agency, Department of Defense, Washington, D.C.

In Litt. References

Gartz, R. May 7, 2007. Electronic mail to the Delta Assessment Team providing weekly information on salvage at the SWP and CVP export facilities.

Stern, M.S. September 5, 2006. Draft letter to Peter Johnsen, U.S. Fish and Wildlife Service, Sacramento, California, outlining the proposed operation scenario for the Stockton Delta Water Supply Project.

Stern, M.S. February 24, 2006. Letter to Chris Nagano, Deputy Assistant Field Supervisor, U.S. Fish and Wildlife Service, Sacramento, California, responding to the Service's November 2, 2005, request for additional information for the City of Stockton's Delta Water Supply Project.

Appendix A: Tables and Figures

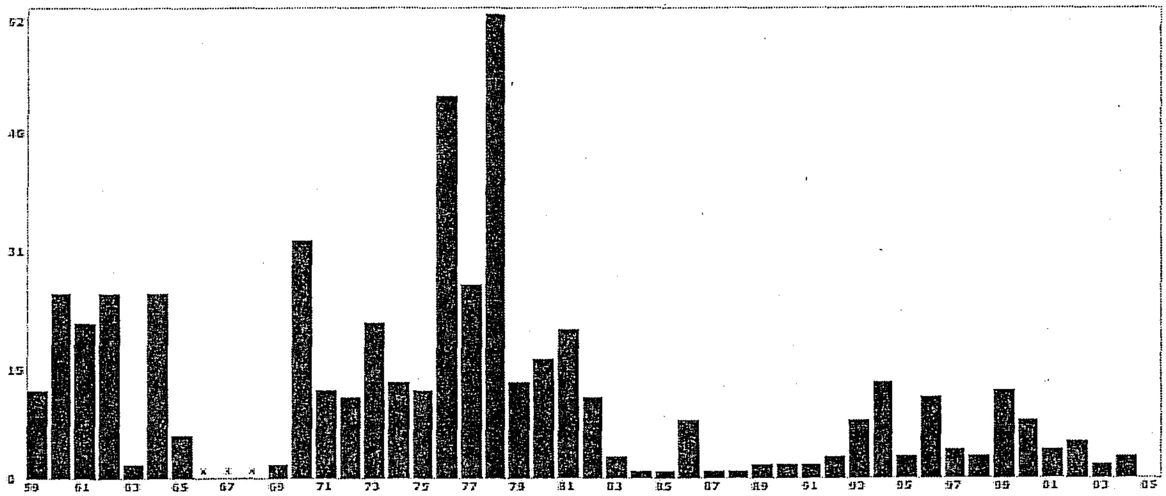

Figure 1. Summer townet (STN) indices from 1959 to 2005 (CDFG 2007).

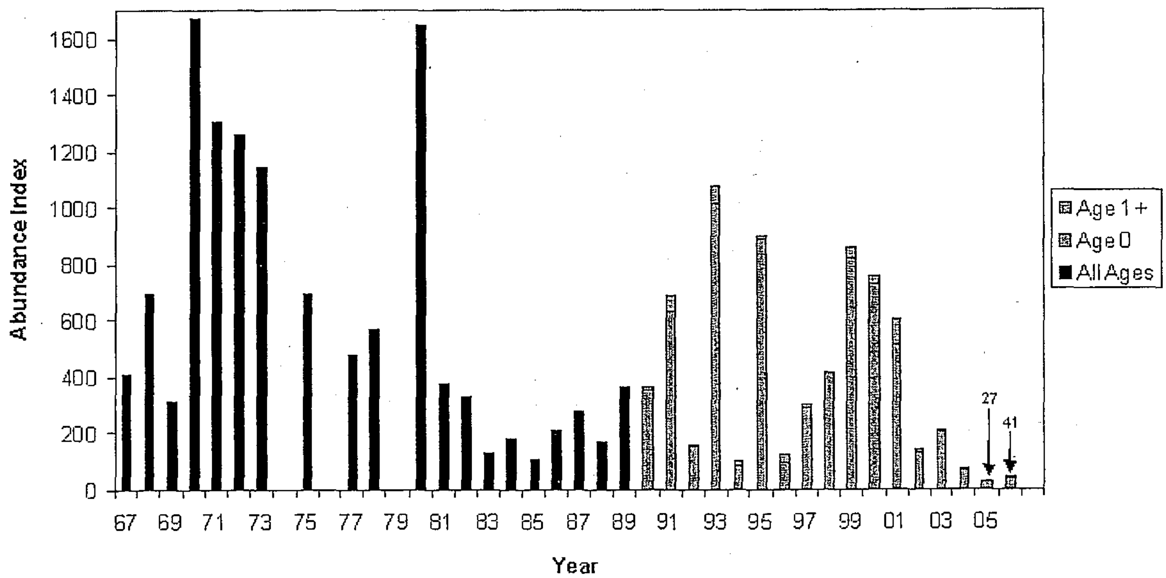

Figure 2. Fall midwater trawl (FMWT) indices from 1967 to 2006 (CDFG 2007).

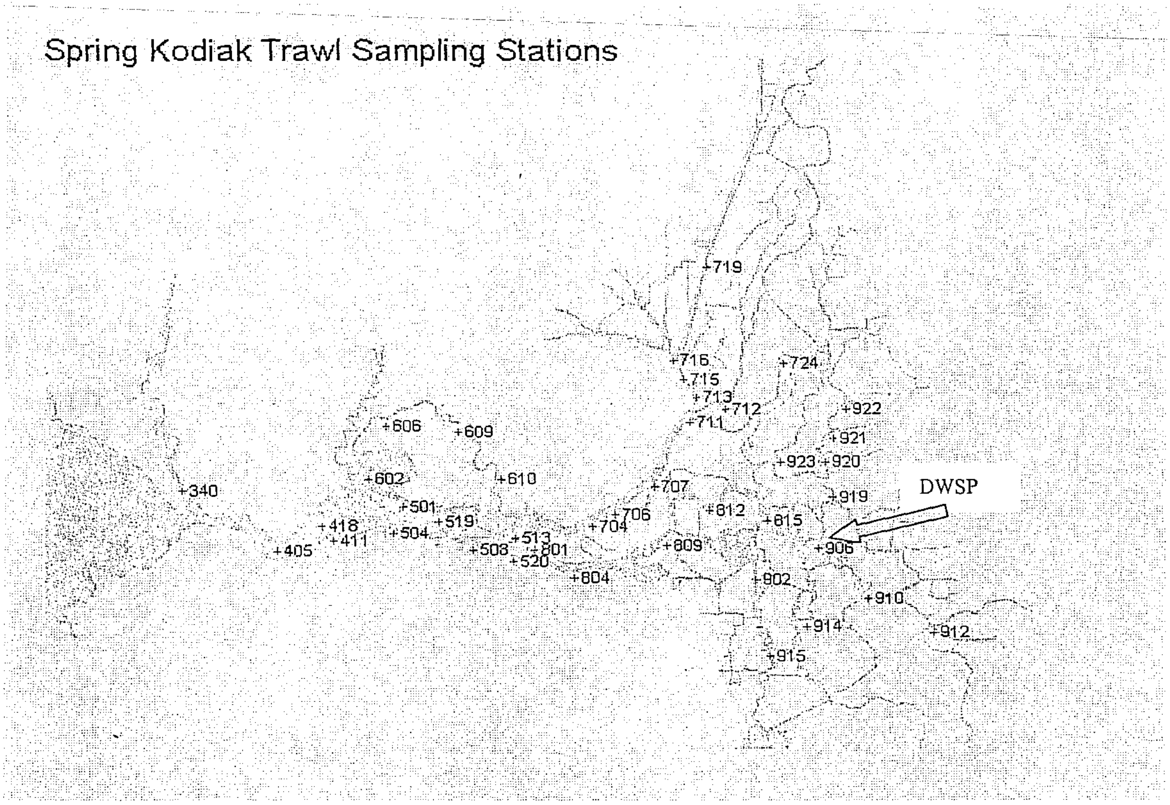

Figure 3. Map of spring kodiak trawl (SKT) stations in the Sacramento - San Joaquin Delta.

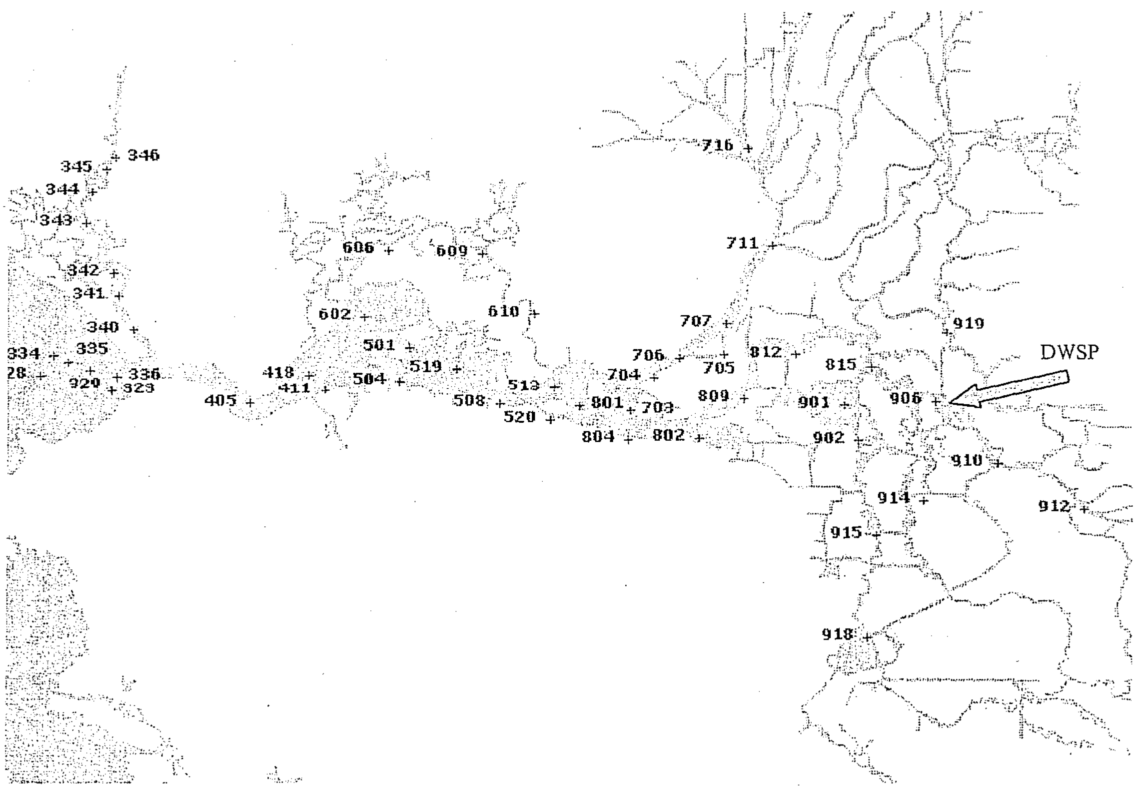

Figure 4. Map of sampling stations for the 20-mm survey in the Sacramento - San Joaquin Delta

Table 1. Number of delta smelt larvae and juveniles that would have been entrained by the SDWP intake as estimated by Hanson Environmental (Stern in lit. February 24, 2006 – Attachment B). The estimate is based on presence and densities of delta smelt in the San Joaquin River near the intake site as recorded by the 20-mm trawl surveys operated by the California Department of Fish and Game during the years 1995 to 2006. The estimates are calculated with 1) a 30 day pumping curtailment from April 15 through May 15 with a diversion of 100.6 AF per day the reminder of the year and 2) no curtailment and 92.05 AF per day.

	Larvae Delta Smelt Size Classes by Length (mm)											
	< 5		5 to 7		8 to 10		11 to 14		>15		Sum all size classes	
	Curtailment		Curtailment		Curtailment		Curtailment		Curtailment		Curtailment	
Year	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
1995	0	0	0	0	0		0		0		0	0
1996	0	0	0	0	214	663	175	287	1009	972	1398	1922
1997	0	0	0	246	158	636	0	0	0	235	158	1117
1998	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	233	340	1462	2063	4481	4977	6235	7380	12411
2000	0	0	299	274	902	1190	659	799	788	1964	2648	4227
2001	0	0	255	1399	258	943	129	974	0	257	642	3573
2002	0	0	229	227	448	778	419	773	190	203	1286	1981
2003	0	0	256	234	313	661	654	1028	624	893	1847	2816
2004	0	0	0	0	0	343	145	678	131	201	276	1222
2005	0	0	270	247	70	113	95	219	0	90	435	669
2006	0	0	0	0	0	0	0	0	0	0	0	0
Sum	0	0	1309	2860	2703	6789	4339	9239	7719	11050	16070	29938
Mean	0	0	109	238	225	617	362	840	643	1005	1339	2495

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Table 2. Estimated entrainment of larvae at the DWSP intake if the facility had been in operation during the years from 1995 through 2007 compared to the previous year's pre-spawning delta smelt abundance indicated by the ascending FMWT index. The estimated take is based on 50 % curtailment during the periods March 15 through April 14 and May 16 through June 15, and 100% curtailment during the period April 15 through May 15. Note that the proposed 100% curtailment lasting from April 15 through May 20 would reduce entrainment even further.

FMWT index	Year	Estimated entrainment	Year
27	2005	0	2006
41	2006	0	2007
74	2004	218	2005
102	1994	0	1995
127	1996	79	1997
139	2002	924	2003
210	2003	138	2004
303	1997	0	1998
420	1998	3690	1999
603	2001	643	2002
756	2000	321	2001
864	1999	1324	2000
899	1995	699	1996

Appendix B: Guidelines for Restoration and/or Replacement of Giant Garter Snake Habitat.

Guidelines for Restoration and/or Replacement of Giant Garter Snake Habitat

Replacement and Restoration Guidelines are provided together, as the two conservation measures may not be mutually exclusive. Replacement of habitat may also require restoration of some areas. Preserved habitat may additionally be improved for giant garter snakes by using some restoration guidelines.

Reference sites

A nearby reference site should be chosen both for restoration of giant garter snake habitat and for creation of replacement habitat. The reference site will be used to determine the success of conservation efforts. For habitat restoration, the pre-project condition may be used as a reference site if adequate documentation exists. For creation of replacement habitat or for restoration where pre-project conditions are not documented, the reference site should be nearby or adjacent to the project site and should represent high quality giant garter snake habitat.

Restoration of giant garter snake habitat

Restoration may include incorporating some of the Replacement Guidelines to enhance habitat value for giant garter snakes. Restoration should follow the guidelines outlined below:

1. Restoring giant garter snake habitat includes minimizing impacts of project activities to the existing habitat. In general, these minimization measures may include using silt fencing, designating environmentally sensitive areas, using protective mats, preventing runoff, and providing worker awareness training. Specific measures to minimize impacts include:

    a. Avoid construction activities within 200 feet from the banks of giant garter snake aquatic habitat. Confine movement of heavy equipment to existing roadways to minimize habitat disturbance.

    b. Construction activity within habitat should be conducted between May 1 and October 1. This is the active period for giant garter snakes and direct mortality is lessened, because snakes are expected to actively move and avoid danger. Between October 2 and April 30 contact the Service's Sacramento Fish and Wildlife Office to determine if additional measures are necessary to minimize and avoid take.

    c. Confine clearing to the minimal area necessary to facilitate construction activities. Flag and designate avoided giant garter snake habitat within or adjacent to the project area as Environmentally Sensitive Areas. These areas should be avoided by all construction personnel.

d. Construction personnel should receive Service-approved worker environmental awareness training. This training instructs workers to recognize giant garter snakes and their habitat(s).

e. 24-hours prior to construction activities, the project area should be surveyed for giant garter snakes. The survey of the project area should be repeated if a lapse in construction activity of two weeks or greater has occurred. If a snake is encountered during construction, activities shall cease until appropriate corrective measures have been completed or it has been determined that the snake will not be harmed. Report any sightings and any incidental take to the Service immediately by telephone at (916) 414-6620.

f. Any dewatered habitat should remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat.

2. Remove all construction debris and stockpiled materials.

3. Re-grade area to preexisting contour, or a contour that would improve restoration potential of the site.

4. Replant and hydroseed the restoration area. Recommended plantings consist of a) wetland emergents, b) low-growing cover on or adjacent to banks, and c) upland plantings/hydroseeding mix to encourage use by other wildlife. Extensive riparian (e.g., shaded riverine aquatic - SRA) plantings are not appropriate because shading may result in lack of basking sites. Native plantings are encouraged except where non-natives will provide additional values to wildlife habitat and will not become invasive in native communities. The applicant should obtain cuttings, plantings, plugs, or seeds, from local sources wherever possible. The applicant should attempt to restore conditions similar to that of adjacent or nearby habitats.

a. Emergent wetland plants recommended for giant garter snake habitat are California bulrush (*Scirpus californicus*), cattail (*Typha* spp.), and water primrose (*Ludwigia peploides*). Additional wetland plantings may include common tule (*Scirpus acutus*), Baltic rush (*Juncus balticus*), or duckweed (*Lemna* spp.).

b. Cover species on or adjacent to the bank may include California blackberry (*Rubus vitifolius*) or wild grape (*Vitis californica*), along with the hydroseeding mix recommended below.

c. Upland plantings/hydroseeding mix: Disturbed soil surfaces such as levee slopes should be hydroseeded to prevent erosion. The Service recommends a mix of at least 20-40 percent native grass seeds [such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wild rye (*Elymus glaucus*), and needle grass (*Nassella* spp.)] 2-10 percent native forb seeds, 5 percent rose clover (*Trifolium hirtum*), and 5 percent alfalfa (*Medicago sativa*). Approximately 40-68 percent of the mixture may be non-aggressive European annual grasses [such as wild oats (*Avena sativa*), wheat (*Triticum* ssp.), and barley (*Hordeum vulgare*)]. The Corps will not include aggressive nonnative grasses, such as perennial ryegrass (*Lolium perenne*), cheatgrass (*Bromus tectorum*), fescue (*Festuca* spp.), giant reed (*Arundo donax*), medusa-head (*Taeniatherum caput-medusae*), or Pampas grass (*Cortaderia selloana*) in the hydroseed mix. The Corps will not include endophyte-infected grasses in the mix. Mixes of one-hundred percent native grasses and forbs may also be used, and are encouraged.

Replacement of giant garter snake habitat

Location

Replacement location should be within the same population cluster boundaries (population clusters are defined in 58 FR 54053) as the habitat lost. For example: The boundaries of the Sacramento Basin population cluster are approximately, Highway 16 to the north, Sacramento River to the west, Twin Cities Road to the south, and the Folsom Aqueduct to the east. Habitat lost within this area must also be replaced within this area.

Habitat components

Giant Garter Snake Habitat. The giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, other waterways and agricultural wetlands such as irrigation and drainage canals and rice fields, and the adjacent uplands. Essential habitat components consist of (1) adequate water during the snake's active period, (early spring through mid-fall) to provide a prey base and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat; (3) upland habitat for basking, cover, and retreat sites; and (4) higher elevation uplands for cover and refuge from flood waters. For the purposes of this programmatic opinion, a basic giant garter snake habitat unit will incorporate 2.00 acres (0.81 hectares) of surrounding upland for every 1.00 acre (0.40 hectare) of aquatic habitat. The 2.00 acres (0.81 hectares) of upland also may be defined as 218 linear feet (66 meters) of bank side habitat which incorporates adjacent uplands to a width of 200 feet (61 meters) from the edge of the bank.

Replacement habitat must provide the above mentioned essential habitat components and include the following:

1. All replacement habitat must include both upland and aquatic habitat components. Upland and aquatic habitat components must be included in the replacement habitat at a ratio of 2:1 upland acres to aquatic acres.

2. A semi-permanent or permanent aquatic habitat which provides water during the active period for giant garter snakes (April through October) with suitable vegetative cover present. Linear or meandering channels with slow flowing water over a mud or silt substrate are preferred.

3. Upland basking and retreat sites with low-growing vegetation cover adjacent to aquatic habitat, and upland retreats and flood refugia with partially buried broken concrete or animal burrows.

4. Small fish and amphibian larvae for foraging, but predatory "game fish" (bass, *Micropterus* spp.; sunfish, *Lepomis* spp.; catfish, *Ictalurus* spp. and *Ameiurus* spp.) absent or controlled.

5. An adequate buffer (at least 200 feet) from roadways to reduce vehicular mortality.

6. Follow planting recommendation provided above under restoration guidelines.

Monitoring

Habitat restoration

Restoration of habitat should be monitored for one year following implementation. Monitoring reports documenting the restoration effort should be submitted to the Service: (1) upon completion of the restoration implementation; and (2) one year from restoration implementation. Monitoring reports should include photo documentation, when restoration was completed, what materials were used, plantings (if specified) and justification of any substitutions to the Service recommended guidelines. Monitoring reports should also include recommendations for remedial actions and approval from the Service, if necessary, and justification from release of any further monitoring, if requested.

Creation of replacement habitat

Replacement habitat should be monitored for five years following implementation. Hydrology should be monitored for the first two years after creation of wetlands. The monitoring effort should continue for three additional years to ensure success criteria are met. Monitoring reports documenting implementation of conservation measures should be submitted to the Service: (1) upon completion of wetland creation; (2) yearly for the first two years of monitoring; and (3) five years from implementation. Monitoring reports should include photo documentation, when restoration was completed, what materials were used, plantings (if specified) and justification of any substitutions to the Service recommended guidelines. Monitoring reports should also include recommendations for remedial actions and approval from the Service, if necessary, and justification from release of any further monitoring, if requested.

Success criteria for replacement habitat:

1. At completion of monitoring, the cover measured on the habitat area should be 90 percent of cover measured on the reference site.

2. At completion of monitoring, the species composition measured on the habitat area should be 90 percent of that measured on the reference site.

3. At completion of monitoring, wetlands created on the site should meet Corps jurisdictional criteria.

Maintenance and management of replacement giant garter snake habitat

1. A final management plan of replacement habitat must be approved by the Service.

2. All maintenance activities should follow the Service's Standard Avoidance and Minimization Measures During Construction Activities in Giant Garter Snake Habitat.

3. Additional guidance includes:

    a. Canal Maintenance - Hand clearing of canals is preferred for removal of excessive vegetation or debris. Any equipment should be operated from the bank top. Excavate from only one side of the canal during a given year. Avoid excavating the banks above the high water level. Preferably, one side of the canal should be left undisturbed indefinitely (the preferred side would be the west or north side) so that emergent vegetation and bank side cover is left in place.

    b. Place the spoils from canal clearing in a designated location, rather than along bank tops. This will prevent burying or crushing snakes basking on the banks, or trapping snakes taking cover in burrows or bank-top soil crevices.

    c. Vegetation control - Uplands should not be disced. Leave vegetation on levees and canal sides wherever possible. Mowing to control vegetation should take place July through September and mower blades should be raised to leave at least six inches of grassy cover to avoid injuring snakes.

    d. Traffic - Control vehicle access to avoid vehicular mortality of giant garter snakes.

4. Use a water maintenance regime that will keep some open water channels adjacent to vegetated edges for giant garter snake foraging.

5. Eradicate/control non-natives and invasive exotics.

Compatible uses of giant garter snake replacement habitat:

Rice farming is a compatible land use for adjacent properties.

Uses of giant garter snake replacement habitat that are incompatible with the habitat of giant garter snakes, or represent threats to giant garter snakes include row cropping on uplands, orchards on uplands, OHV (off-highway vehicle) use, and combining with riparian habitat creation which requires dense cover or SRA habitat.

Appendix C: Standard Avoidance and Minimization Measures During Construction Activities in Giant Garter Snake (*Thamnophis gigas*) Habitat

Standard Avoidance and Minimization Measures During Construction Activities in Giant Garter Snake (*Thamnophis gigas*) Habitat

HABITAT TYPE:

The giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, irrigation and drainage canals, and rice fields. Giant garter snakes require permanent aquatic habitat, or habitat seasonally flooded during its active period (early-spring through mid-fall), with herbaceous wetland vegetation, such as cattails and bulrushes, grassy banks (often salt grass), and uplands for cover and retreat sites during its active season and for refuge from flood waters during the dormant season (winter). Giant garter snakes are typically absent from larger rivers and from wetlands with sand, gravel, or rock substrates because of lack of suitable habitat. Some riparian woodlands may not provide suitable habitat because of excessive shade, lack of basking sites, and absence of giant garter snake prey.

AVOIDANCE AND MINIMIZATION MEASURES:

1. Avoid construction activities within 200 feet from the banks of giant garter snake aquatic habitat. Confine movement of heavy equipment to existing roadways to minimize habitat disturbance.

2. Construction activity within habitat should be conducted between May 1 and October 1. This is the active period for giant garter snakes and direct mortality is lessened because snakes are expected to actively move and avoid danger. Between October 2 and April 30 contact the Service's Sacramento Fish and Wildlife Office to determine if additional measures are necessary to minimize and avoid take.

3. Confine clearing to the minimal area necessary to facilitate construction activities. Flag and designate avoided giant garter snake habitat within or adjacent to the project area as Environmentally Sensitive Areas. These areas should be avoided by all construction personnel.

4. Construction personnel should receive Service-approved worker environmental awareness training. This training instructs workers to recognize giant garter snakes and their habitat(s).

5. 24-hours prior to construction activities, the project area should be surveyed for giant garter snakes. The survey of the project area should be repeated if a lapse in construction activity of two weeks or greater has occurred. If a snake is encountered during construction, activities shall cease until appropriate corrective

measures have been completed or it has been determined that the snake will not be harmed. Report any sightings and any incidental take to the Service immediately by telephone at (916) 414-6620.

6. Any dewatered habitat should remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat.

7. After completion of construction activities, remove any temporary fill and construction debris and, wherever feasible, restore disturbed areas to pre-project conditions. Restoration work may include such activities as replanting species removed from banks or replanting emergent vegetation in the active channel.

8. Follow the conservation measures in Table 1 to minimize the effects of loss and disturbance of habitat on giant garter snakes. Replacement ratios are based on the acreage and on the duration of disturbance.

TABLE 1 - SUMMARY OF GIANT GARTER SNAKE CONSERVATION MEASURES

	IMPACTS: DURATION	**IMPACTS:** ACRES	**CONSERVATION MEASURE:** COMPENSATION
LEVEL 1	1 season	Less than 20 and temporary	Restoration
LEVEL 2	2 seasons	Less than 20 and temporary	Restoration plus 1:1 replacement
LEVEL 3	More than 2 seasons and temporary	Less than 20 and temporary	3:1 Replacement (or restoration plus 2:1 replacement)
	Permanent loss	Less than 3 acres total giant garter snake habitat AND Less than 1 acre aquatic habitat; OR Less than 218 linear feet bank habitat	3:1 Replacement

Giant garter snake habitat includes 2.0 acres of surrounding upland habitat for every 1.0 acre of aquatic habitat. The 2.0 acres of upland habitat also may be defined as 218 linear feet of bank side habitat which incorporates adjacent uplands to a width of 200 feet from the edge of each bank. Each acre of created aquatic habitat should be supported by two acres of surrounding upland habitat. Compensation may include creating upland refuges and over-wintering sites for the giant garter snake that are above the 100-year flood plain.

A season is defined as the calendar year period between May 1 and October 1: the active period for giant garter snakes, when mortality is less likely to occur.