UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

In response refer to:
2008/01096: MTM

DEC 29 2008

Richard J. Woodley
Regional Resource Manager
Bureau of Reclamation, Mid-Pacific Region
2800 Cottage Way
Sacramento, California 95825-1898

Dear Ms. Woodley:

This letter transmits NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Enclosure 1) based on our review of the American Basin Fish Screen and Habitat Improvement project (ABFS) in Sutter and Sacramento counties, California, and its effects on Federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), and their designated critical habitat, as well as the threatened southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris*) in accordance with section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). Your initial request for formal section 7 consultation on this project was received on February 27, 2008. A response was sent by NMFS on March 12, 2008 stating that all information necessary to initiate formal consultation had been received by NMFS' Sacramento Area Office.

The information provided includes the Action Specific Implementation Plan (ASIP) and Environmental Impact Statement/Report for the ABFS, fish screen design, and vegetation plans, and detailed construction activities. A complete administrative record of this consultation is on file at the Sacramento Area Office of NMFS.

Based on the best available scientific and commercial information, the biological opinion concludes that the ABFS project, as presented by the U.S. Bureau of Reclamation, California Department of Fish and Game, and the applicant, Natomas Central Mutual Water Company, is not likely to jeopardize the continued existence of the listed species or destroy or adversely modify designated critical habitat. NMFS also has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed salmonids associated with the project. While the terms and conditions also address take of North American green sturgeon, the section 9 prohibitions against taking of listed species and the terms and conditions of this biological opinion will not apply to North American green sturgeon until the final section 4(d) ruling under the ESA has been published in the Federal Register.

This letter also transmits NMFS' Essential Fish Habitat (EFH) conservation recommendations for Pacific salmon *(O. tshawytscha)* as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 *et seq.*; Enclosure 2). The document concludes that the ABFS project will adversely affect the EFH of Pacific salmon in the action area and adopts certain terms and conditions of the incidental take statement and the ESA conservation recommendations of the biological opinion as the EFH conservation recommendations.

Reclamation has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed response in writing to NMFS within 30 days of receipt of these conservation recommendations that includes a description of the measures proposed for avoiding, mitigating, or offsetting the impact of the activity on EFH (50 CFR 600.920 (j)). If unable to complete a final response within 30 days, the Corps should provide an interim written response within 30 days before submitting its final response.

Please contact Ms. Madelyn Martinez in our Sacramento Area Office at (916) 930-3605 or via e-mail at Madelyn.Martinez@noaa.gov, if you have any questions regarding this document or require additional information.

Sincerely,

for Rodney R. McInnis
Regional Administrator

Enclosures (2)

cc: Copy to file – ARN# 151422SWR2004SA9112
NMFS-PRD, Long Beach, CA
Brad Hubbard, Natural Resources Specialists, BOR, Mid-Pacific Regional Office, 2800 Cottage Way, Sacramento, CA 95825-1898
Nancy Haley, U.S. Army Corps of Engineers, Regulatory Division, 1325 J Street, Rm 1480, Sacramento, CA 95814
Dan Meir and Jana Milliken, USFWS, 2800 Cottage Way, Sacramento, CA 95825
James Navicky and Todd Gardner, CDFG, North Central Region, 1701 Nimbus Road, Rancho Cordova, CA 95670
Dee E. Swearingen, General Manager, Natomas Central Mutual Water Company, 2601 W. Elkhorn Blvd., Rio Linda, CA 95673

Agency: U.S. Bureau of Reclamation

Activity: American Basin Fish Screen and Habitat Improvement Project

CONSULTATION CONDUCTED BY: National Marine Fisheries Service, Southwest Region

FILE NUMBER: F/SWR/2008/01096

DATE ISSUED: DEC 29 2008

I. CONSULTATION HISTORY

The American Basin Fish Screen and Habitat Improvement (ABFS) Proposed Action was included in the National Marine Fisheries Service (NMFS) programmatic biological opinion for the California-Federal Bay Delta Program (CALFED). Over the last four years, the lead agencies have held numerous meetings with U.S. Fish and Wildlife Service (USFWS) and NMFS throughout the development of the ABFS Proposed Action and the Action-Specific Implementation Plan (ASIP). At these meetings, issues pertaining to development of the ASIP and other Endangered Species Act (ESA) compliance issues were discussed. These meetings included representatives from U.S. Bureau of Reclamation (Reclamation), CALFED, USFWS, NMFS, and California Department of Fish and Game (CDFG). The history of ongoing discussions between Natomas Central Mutual Water Company's (Natomas Mutual) and the aforementioned agencies for the ABFS Proposed Action is summarized in Table 1.

Table 1. Summary of Consultation, Pre-Consultation, and Coordination to Date

Period	Activities
Q1* 2001	Natomas Mutual distributes Biological Resources Report to resource agencies.
Q1 2004	Natomas Mutual discusses with NMFS the appropriateness of preparing an ASIP versus a biological assessment. Coordination meeting held with Natomas Mutual and resource agencies to discuss the contents of the ASIP. Natomas Mutual distributes an annotated outline of the ASIP, and requests comments from resource agencies. Natomas Mutual receives comments from Reclamation. **On March 12, 2004 Natomas Mutual distributes the first administrative draft ASIP to Reclamation, CDFG, USFWS, and NMFS**
Q2 2004	Reclamation and NMFS provide comments on the administrative draft ASIP.

Period	Activities
Q2 2005	**On June 7, 2006, second administrative draft ASIP is provided to Reclamation, CDFG, USFWS, and NMFS.** NMFS stated they had no comments on the impact analysis presented in Chapter 4 of the ASIP. NMFS requested that a long-term operations and maintenance plan be developed and that the Fish Rescue Plan include a reporting requirement.
Q3 2005	Natomas Mutual meets with Reclamation, USFWS, and NMFS Fisheries to discuss the status of project schedule, mitigation, and funding. Natomas Mutual provides updated ASIP Comment Log to CDFG, Reclamation, USFWS, and NMFS.
Q1 2007	Telephone discussions held between Natomas Mutual and NMFS to discuss updating fisheries sections based on the recent critical habitat designations for Central Valley steelhead and Central Valley spring-run Chinook salmon and the recent listing of the Southern Distinct Population Segment (DPS) of green sturgeon as a threatened species.
Q2 2007	Natomas Mutual submits Administrative Draft of the ASIP to resource agencies. NMFS and USFWS provide comments on the ASIP.
Q3 2007	Natomas Mutual meets with NMFS to discuss its comments on the ASIP. Natomas Mutual addresses NMFS' comments on the ASIP.
Q4 2007	Natomas Mutual distributes revised ASIP and EIS/EIR to regulatory agencies for review.

*Q1 = Quarter 1 from January to March, Q2 = Quarter 2 from April to June, Q3 = Quarter 3 from July to September, Q4 = Quarter 4 from October to December

On February 27, 2008, NMFS received a letter from Reclamation requesting initiation of formal section 7 consultation under the Endangered Species Act (ESA).

On March 12, 2008, NMFS initiated consultation.

II. DESCRIPTION OF THE PROPOSED ACTION

The purpose of the ABFS Proposed Action is to improve passage conditions for migratory fish species in segments of the lower Sacramento River and Natomas Cross Canal (NCC) adjacent to the American Basin, to improve aquatic and riparian habitat conditions in the project area, and to prevent entrainment of resident and migratory fish species in unscreened water diversions. The Natomas Mutual's water diversion and distribution facilities supply water for agricultural use, habitat preservation, and habitat maintenance, including the seasonal flooding of rice fields for rice straw decomposition that also provides important wetland habitat for resident and migratory waterfowl. The habitat created through the operation of Natomas Mutual irrigation facilities provides important habitat for at-risk species such as the state and federally-listed giant garter snake and the state-listed Swainson's hawk, as well as many other species. Natomas Mutual also provides surface water to mitigation lands managed by The Natomas Basin Conservancy (TNBC) and some untreated raw water from its delivery system to shareholders for landscape irrigation purposes within its service area. Natomas Mutual does not own or operate a water treatment system for domestic supply.

Since the ABFS Proposed Action would not result in any changes in the magnitude, timing, or duration of diversions from the Sacramento River or NCC and no changes in river flows would result from the long term operation of the diversion, the components addressed in this biological opinion would be the construction of the new diversions and dismantling of old diversions along the Sacramento River and NCC.

The ABFS is located in the Natomas Basin, part of the larger American Basin, and adjacent reaches of the Sacramento River and NCC within the Sacramento Valley of California, in southern Sutter County and northwestern Sacramento County (Figure 1). The ABFS Proposed Action consists of three phases (Figure 2).

Phase I of the ABFS Proposed Action consists of constructing one new diversion (434 cfs, 420 cfs for Natomas Mutual, and 14 cfs for a private diverter), equipped with a state-of-the-art fish screen, on the Sacramento River; decommissioning and removing the existing Verona Diversion Dam and Lift Pumps and Natomas Mutual diversions at the Northern and Bennett pumping plants, and the small privately-owned pump for the Bolen Ranch property. Thus, the total existing diversion capacity of 630 cfs would be maintained with the new Sankey Diversion and the existing diversions at Elkhorn, Prichard, and Riverside, which would continue to operate without fish screens until implementation of Phases II and III.

Phase II of the ABFS Proposed Action consists of constructing a second new diversion (210 cfs capacity), equipped with a state-of-the-art fish screen, on the Sacramento River. The new Elkhorn Diversion would be located between Elkhorn and Elverta roads (adjacent to and just downstream of the existing Elkhorn Pumping Plant (Figure 3)). Also under Phase II, the two existing Natomas Mutual diversions at the Prichard and Elkhorn pumping plants would be decommissioned and removed. The new Elkhorn Diversion capacity would match the combined capacity of the old Elkhorn and Prichard pumping plants. Thus, the total existing diversion capacity of 630 cfs would be maintained, with the only remaining unscreened diversion being the Riverside Diversion.

Phase III of the ABFS Proposed Action consists of decommissioning and removal of the existing Riverside Pumping Plant and re-grading the Riverside Main Canal along with other associated improvements to the internal conveyance system (Figure 3). The Sankey Diversion would commence pumping at full capacity (434 cfs) to make up for the lost capacity from removal of the Riverside Pumping Plant. Following Phase III, no unscreened diversions owned by Natomas Mutual would remain operational within the ABFS Action Area.

The fish screen design was reviewed and would meet NMFS, USFWS, and CDFG fish screen criteria for federally listed aquatic species. The unscreened and screened diversions for each phase are summarized in Table 2.

Table 2. Natomas Mutual Operating Screened and Unscreened Diversions by ABFS Proposed Action Phase

	Unscreened Diversions					Screened Diversions		
	Northern	Bennett	Prichard	Elkhorn	Riverside	Bolen	Sankey	Elkhorn
Existing	250 cfs	125 cfs	150 cfs	60 cfs	45 cfs	14 cfs		
Following Phase I			150 cfs	60 cfs	45 cfs		389 cfs[a]	
Following Phase II					45 cfs		389 cfs[a]	210 cfs
Following Phase III							434 cfs[b]	210 cfs

a Includes 375 cfs for Natomas Mutual and 14 cfs for Bolen Ranch. This diversion facility will be built with a capacity of 434 cfs, but will be operated at 384 cfs until the Riverside Diversion is decommissioned under Phase III.

b 420 cfs for Natomas Mutual and 14 cfs for Bolen Ranch.

A. Construction Activities

The construction activities would generally be performed in the fall and spring, preceding the beginning of facility construction. Work on irrigation facilities would be performed after the last irrigations in early September and before the first irrigations in late April. In-stream work activities would be limited to the period between July 1 and November 30.

1. Construction of the New Screened Diversions

The activities for the constructions of the new screened Sankey and Elkhorn Diversions would occur in the Sacramento River and its associated banks. Construction activities entail the removal of the Verona Dam and its diversion pumps, site preparation by clearing and grubbing the vegetation within the area along the levee slopes, the removal and replacement of riprap, installation and removal of a cofferdam, the construction of transitions and intake structures, and the installation of the fish screens.

Site preparation for the Sankey Diversion would remove 0.22 acres of riparian forest and 0.13 acres of shaded riverine aquatic (SRA) habitat. The construction footprint of the proposed Sankey Diversion includes 600 linear feet of mature riparian vegetation and SRA habitat that extends from the water's edge to the top of the slope (a distance of approximately 60 feet) and outward from the top of the bank for approximately 10 feet (Table 3).

SRA habitat in the construction footprint of the proposed Elkhorn Diversion (Phase II) is discontinuous. A total of 1.07 acres of riparian forest, 0.13 acre of SRA habitat, and 0.1 acre of riparian scrub habitat would be permanently removed to facilitate construction of the Elkhorn Diversion. The new Elkhorn facility would be constructed just downstream of the existing pumping plant and would result in the permanent disruption of approximately 160 linear feet (lf) of shoreline, while an additional 50 feet may be temporarily disturbed by construction activities.

The construction of facilities and the placement of riprap at both diversion facilities (Phases I and II) may require the removal of instream woody material (IWM) present in the near-shore, shallow water (i.e., <10 feet) areas adjacent to the east bank of the Sacramento River. The specific amount of presently inundated IWM at this location has not been estimated.

A vibratory hammer and pile driver would be used to place cofferdam sheet piles and H-Piles. Pile driving and other noise/vibratory operations associated with the ABFS Proposed Action would be conducted as follows:

(1) They would occur during daylight hours only, limited to between 6 a.m. and 8 p.m. on weekdays, and 7 a.m. to 8 p.m. on weekends; the time limits are established by Sacramento County noise policies. Additionally, in-river construction work on the cofferdams would not begin prior to July 1 and would extend up to November 30.

(2) Sheet pilings for the cofferdam would be vibrated into place.

(3) Guides or soldier piles would likely be impact driven, prior to cofferdam dewatering (used as support guides for driving cofferdam sheet piles).

(4) Impact driving would commence at low energy levels and slowly build to impact force.

(5) A Pile Driving Plan would be reviewed and approved by NMFS.

Typically, sheetpile placement for cofferdams would occur sequentially starting from the upstream end to the downstream end of the in-river footprint area to be enclosed by the cofferdam. The typical production rate for driving sheetpiles is 500 to 1000 square feet per 8-hour day. The Sankey cofferdam would be approximately 55 feet by 160 feet. The construction of the Sankey cofferdam would take approximately 30-45 days. Driving the sheetpile transitions is estimated to take an additional 30 to 35 days, totaling 90 days of sheetpile driving. The Elkhorn cofferdam would be approximately 60 feet by 100 feet. The construction of the Elkhorn cofferdam would take approximately 14 to 20 days. Driving sheetpile transitions would take another 7 to 10 days, totaling 30 days of sheetpile driving.

Prior to dewatering the cofferdam, stranded fish would be rescued by seining and released back into the Sacramento River by a qualified biologist. Then, a pile driver would be used to drive H-Piles for the construction of the foundation and intake structure. After dewatering of the cofferdam, excavation of the streambed would occur in preparation for the installation of the foundation and intake pipes. The installation of the H-Piles for the transitions is expected to take approximately 15 to 20 days while the installation of the H-Piles for the intake is expected to take approximately 15 to 23 days for the Sankey Diversion. The Elkhorn Diversion would have no

H-Piles for the transitions but would have H-Piles installed for the intake, which would take approximately 10 to 16 days.

The fish screen would be installed after the transitions and intake structure are constructed. The Sankey Diversion screen would be vertically oriented with a length of approximately 160 feet. The Elkhorn Diversion screen would be inclined on a slope of 1.5 horizontal to 1 vertical, due to low river depth, and would be approximately 80 feet in length. Neither screen would be equipped with a bypass, thereby keeping fish in the river. Screen material would be stainless steel wedge wire with 1.75 mm (0.0689 inch) wide openings, in compliance with CDFG criteria for steelhead fry, and with a minimum open area of 40 percent. Screen area would be sized for a maximum approach velocity of 0.33 fps, and an adjustable porosity control system would be included behind the screen face to provide for uniform flow distribution. Screened facilities would be equipped with automatic cleaning and sediment control systems to prevent accumulation of debris and sediment that could impede the screen's flow area, and affect the screen system hydraulics. The screen face would be aligned with the bank, parallel to stream flow. Tangential or sweeping velocity would be provided by the natural river current, and would be maximized by setting the screen face out from the bank in an area of relatively strong currents. The screen face would be flush with the face of the structure to allow for unimpeded fish movement parallel to the screen face.

Once construction is complete, the cofferdam would be removed and the disturbed area would be regraded and replanted. Riprap size of 18-inch minus would be replaced on the levee slope and regraded around the Sankey Diversion and 4-inch minus gravel would be used to backfill and grade the streambed. Using the same type of materials, the levee slope around the Elkhorn Diversion would be replaced and contoured. The streambed would be backfilled and graded.

Table 3. Summary of Permanent and Temporary Habitat Disturbances by Acreage[a]

	Permanent (Acres)									Temporary (Acres)							
Proposed Project	**Isolated Trees[b]**	**Oak Woodland**	**Agricultural Fields (non-rice crops)**	**Rice lands**	**SRA[c]**	**Riparian Forest**	**Riparian Scrub**	**Irrigation Canal[d]**	**Aquatic[e]**	**Annual Grassland/ Ruderal**	**Agricultural Fields (non-rice crops)**	**Rice lands**	**Riparian Scrub**	**Irrigation Canal[d]**	**Open Water[f]**	**Aquatic[e]**
Sankey Canal and Drain				29.84						36.37		4.59		4.69		
Sankey Staging Area												2.00				
Sankey Diversion				2.42	0.13	0.22			0.37	3.46		0.70		0.07		0.30
Phase I - Sankey Diversion subtotal				***32.26***	***0.13***	***0.22***			***0.37***	***39.83***		***7.29***		***4.76***		***0.30***
Elkhorn Main Canal	12	0.43	3.72							14.58	3.08			3.10		
Elkhorn Staging Area										0.75	1.00					
Elkhorn Diversion		0.05			0.13	1.07	0.10	0.04	0.13	1.47			0.03		0.44	0.18
Phase II - Elkhorn Diversion subtotal	***12***	***0.48***	***3.72***		***0.13***	***1.07***	***0.10***	***0.04***	***0.13***	***16.80***	***4.08***		***0.03***	***3.10***	***0.44***	***0.18***
Riverside Main Canal	1	0.05	5.78	0.11			0.05			2.64	1.38	0.14		0.78		
Riverside Staging Area											0.80					
Phase III - Internal Conveyance Upgrades subtotal	***1***	***0.05***	***5.78***	***0.11***			***0.05***			***2.64***	***2.18***	***0.14***		***0.78***		
ABFS Proposed Action Total	**13**	**0.53**	**9.50**	**32.37**	**0.26**	**1.29**	**0.15**	**0.04**	**0.50**	**59.27**	**6.26**	**7.43**	**0.03**	**8.64**	**0.44**	**0.48**

[a] *The acreages were calculated using the proposed project plan set. Areas were scaled off of the plans within the proposed project footprint and temporary construction easement. Habitat types were determined using aerial photographs and site visits.*

[b] *Represents actual number of trees.*

[c] *SRA acreage was calculated based on a 20-foot-wide strip along the bank. Bank within the disturbed area is 276 LF at Elkhorn and 518 LF at Sankey. Only areas of vegetated bank at the Sankey Diversion are included in the SRA calculation (281 LF).*

[d] *Irrigation canal refers to temporary open water aquatic habitat that is found in canals, interior ditches, and drains that are used to convey agricultural water for irrigation, and where standing or slow moving water is typically less than five feet deep.*

[e] *Aquatic habitat includes the portion of the Sacramento River in which work would be conducted.*

[f] *Open water habitat includes the sediment retention basin across from the existing Elkhorn Diversion.*

2. <u>Decommissioning Existing Pumping Facilities</u>

As part of the proposed project, the five unscreened diversions (Northern, Bennett, Prichard, Elkhorn, and Riverside) would be sequentially decommissioned as the new screened Sankey and Elkhorn Diversions are being constructed and operated (Table 2). The five pumping plants would be dismantled and the equipment and materials would be salvaged. The diversion pipes in the Sacramento River and NCC would be abandoned or cut, capped, and sealed.

B. Operations and Maintenance

The objective of the proposed project is to decommission five small diversions and construct two new large diversions with fish screens while maintaining the existing water supplies for agricultural use, habitat preservation, and habitat maintenance, including the seasonal flooding of rice fields for rice straw decomposition that also provides important wetland habitat for resident and migratory waterfowl. The fish screen design would meet NMFS and CDFG Fish Screen Criteria Guidelines for listed salmonids. The operation and maintenance of the new diversions and fish screens would occur year round and would comply with the NMFS-approved fish screen operations and maintenance plan (O&M). As listed and described in Attachment 3 of the ASIP, O&M would include preventive and corrective maintenance procedures; inspections and reporting requirements; maintenance logs; particularly with respect to debris, screen cleaning, and sedimentation issues; periodic visual inspections; and reporting.

C. Conservation Measures

The following conservation measures have been incorporated into the project design to avoid or minimize potential adverse effects of the proposed project on special status fish species and their habitats. These include water quality and construction-related measures.

- Site-specific construction and maintenance plans designed to minimize the potential for sediment input into the aquatic system, and to comply with all SWRCB, Central Valley Regional Water Quality Control Board (CVRWQCB) and CDFG requirements, will developed and implemented.

- Construction and maintenance activities will be conducted according to site-specific plans to minimize the potential for contaminants to enter water courses and drainage, and to effectively respond to accidental spills.

- Work or equipment operation in flowing water will be minimized by constructing cofferdams to isolate major construction activities from flowing water.

- In-river construction activities associated with the ABFS Proposed Action will be limited to the period from July 1 through November 30.

- Continue to examine USFWS beach seining data from established survey sites within, and adjacent to the ABFS Proposed Action Area (i.e., Discovery Park, Elkhorn, Verona, Sand Cove, and Knights Landing), to evaluate whether the fish screen operation is affecting the migration.

- The disruption of the streambed at, and adjacent to the construction site will be minimized by limiting the areas to be cleared, graded and recontoured.

- Water pumped from within the cofferdams will be properly disposed of. If necessary, water from within the cofferdams would be pumped into desilting basins to allow sediment to settle out and returned to the Sacramento River (at a rate slow enough to minimize the potential for disturbing sediment in the rivers, and inadvertently increasing turbidity), downstream of the intake structures.

- Sheet pilings for the cofferdam would be vibrated into place.

- Pile driving would occur during daylight hours only and would commence at low energy levels and slowly build to impact force.

- As described in Attachment 4 of the ASIP, a Fish Rescue Plan has been developed to minimize potential impacts resulting from placement of the cofferdam, and to safely evacuate fish within the cofferdam before dewatering.

- As described in Attachment 3 of the ASIP, Natomas Mutual will prepare a Post Construction Evaluation and Assessment Plan for review and approval by USFWS, NMFS, and CDFG. A draft Fish Screen Operations Procedure Plan (Operations and Maintenance Plan) has been prepared for review and approval by USFWS, NMFS, and CDFG; it is included as an attachment to the ASIP. The Operations and Maintenance Plan includes procedures for:

  (1) Operating the fish screens and the intake facilities under a variety of environmental conditions and diversion needs.

  (2) Periodic maintenance procedures required to ensure the effectiveness of the screens over the design life of the facilities.

- The Fish Rescue Plan will be implemented prior to cofferdam closure. The cofferdam will be constructed via sequential placement of sheet piles from the upstream to the downstream end. Prior to closure of the cofferdam, biologists representing Reclamation, NMFS, USFWS, and Natomas Mutual will snorkel the cofferdam area to conduct a visual count of anadromous salmonids and other Species of Primary Management Concern present to obtain an estimate of the number and type of fish within the cofferdam area. The visual estimate will be conducted from the upstream to the downstream end of the cofferdam. The biologists conducting the snorkeling procedure will horizontally space themselves to provide complete visual coverage of the survey area. Each biologist will carry and use a counting device. As they observe a fish, they will note whether it is a steelhead, a Chinook salmon, an unidentified salmonid, a green sturgeon, or another fish species. The procedure will be performed twice. Repetition of the procedure would provide a first measure of the variation of the visual count. If there is a wide variation between the two estimates, a third visual count will be conducted to obtain a relatively accurate estimate of the number of fish within the cofferdam.

(1) After the visual counts are completed, a "crowding net" will be placed at the upstream end of the cofferdam. The crowding net will be constructed of 0.25-inch knotless nylon mesh, 20-feet deep, of sufficient length to span the extension of the cofferdam, with float and lead lines. While the substrate bottom inside the cofferdam would be of variable elevation, the 20-foot depth of the net is sufficient to reach the deepest areas. Individuals on each side of the cofferdam will hold the crowding net tight at the top and will proceed slowly from the upstream to the downstream end of the cofferdam. Commercial divers will be inside the cofferdam, guiding the bottom of the net, and removing the net from snags, as needed. This procedure will ensure a smooth transition of the net from the upstream to the downstream end of the cofferdam.

(2) At the downstream end of the cofferdam, one sheet pile panel, approximately 4 feet wide, will remain open. With assistance of the individuals at the top of the cofferdam and the commercial divers inside the cofferdam, the net will be brought to the downstream end, and collapsed such that it is flush against the surface of the open panel. The net will remain in place at this location, and manipulated such that the last panel can then be driven into place, with the net serving as a barrier, preventing fish from reentering the cofferdam. Once the cofferdam is fully closed, the biologists will repeat the snorkeling procedure described above to determine whether fish still remain in the cofferdam, and if so, how many. If less than 10 juvenile or adult fish Species of Primary Management Concern are estimated to remain in the cofferdam after its closure, then the fish removal process would be considered complete. Conversely, if 10 or more juvenile or adult fish Species of Primary Management Concern remain within the cofferdam, then the netting procedure would be repeated. After the netting procedure is repeated, the net will be collapsed, and with assistance of commercial divers, the bottom of the lead line will be brought up against the face of the cofferdam. The outside edges of the net will be clasped and pulled up, effectively forming a purse. The fish net will be brought up to the surface, and captured fish will be immediately returned to the river, implementing NMFS' standard protocols for handling anadromous salmonids that are listed under the ESA.

(3) No later than one month following implementation of the Fish Rescue and Salvage Plan, a Draft Fish Salvage Operation Report will be prepared and submitted to NMFS (Southwest Region, Protected Resources Division, Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814-4706). The Draft Fish Salvage Operations Report will document the fish rescue and salvage operations, including: (1) the number of fish salvaged; (2) identification and fork length of each species salvaged; and (3) identification and length of each sensitive species salvaged, if possible (these three elements would be estimated as most fish would not actually be handled by the rescuers). The Draft Fish Salvage Operations Report will be reviewed by a designated NMFS biologist, and comments, if any, will be submitted to Reclamation, CDFG, USFWS, and Natomas Mutual. Once the comments have been satisfactorily addressed, a Final Fish Salvage Operations Report will be issued to comply with reporting requirements associated with the ABFS Proposed Action.

In order to minimize the impacts on water quality during the construction activities, the following plans and agreements will be developed and implemented to control erosion and prevent sedimentation and degradation of water quality:

- Stormwater Pollution Prevention Plan in compliance with the NPDES permit.
- Construction Erosion and Sedimentation Control Plan.
- Spill Prevention and Countermeasure Plan developed and completed prior to the initiating construction.
- Erosion and Sedimentation Control Best Management Practices.
- CDFG Streambed Alteration Agreement conditions and measures.

D. Action Area

The action area is defined as all areas to be affected directly or indirectly by the proposed action and not merely the immediate area involved in the action (50 CFR § 402.02). The action area, for the purposes of this biological opinion, is located between Sacramento River mile (RM) 80, the confluence of NCC and the Sacramento River at Verona, and RM 61 (Figure 2).

Specifically, the proposed new screened Sankey and Elkhorn Diversions would be located at Sacramento River RM 78.3 and RM 73.3, respectively. The action area extends approximately 200 feet from the top of the levee slope to the middle of the river and 350 feet upstream and downstream from the proposed new screened diversions. This area encompasses the width of the expected construction area and the upstream and downstream extent of anticipated acoustic effects of the pile drivers (used during in-channel construction activities) on fish movements/behavior

The unscreened Northern and Bennet diversions are located in the Natomas Cross Canal, and the Prichard, Elkhorn, and Riverside diversions are located in the Sacramento River at RM 73.6, RM 73.3, and RM 65.0 respectively. The action area for the dismantling of the existing unscreened diversions extends approximately 100 feet out from the bank, 100 feet upstream, and 300 feet downstream from the existing locations of the pumps. This area encompasses the levee slopes and the expected extent of sedimentation effects from the dismantling and decommissioning of the old diversion pumps within the Natomas Cross Canal and the Sacramento River.

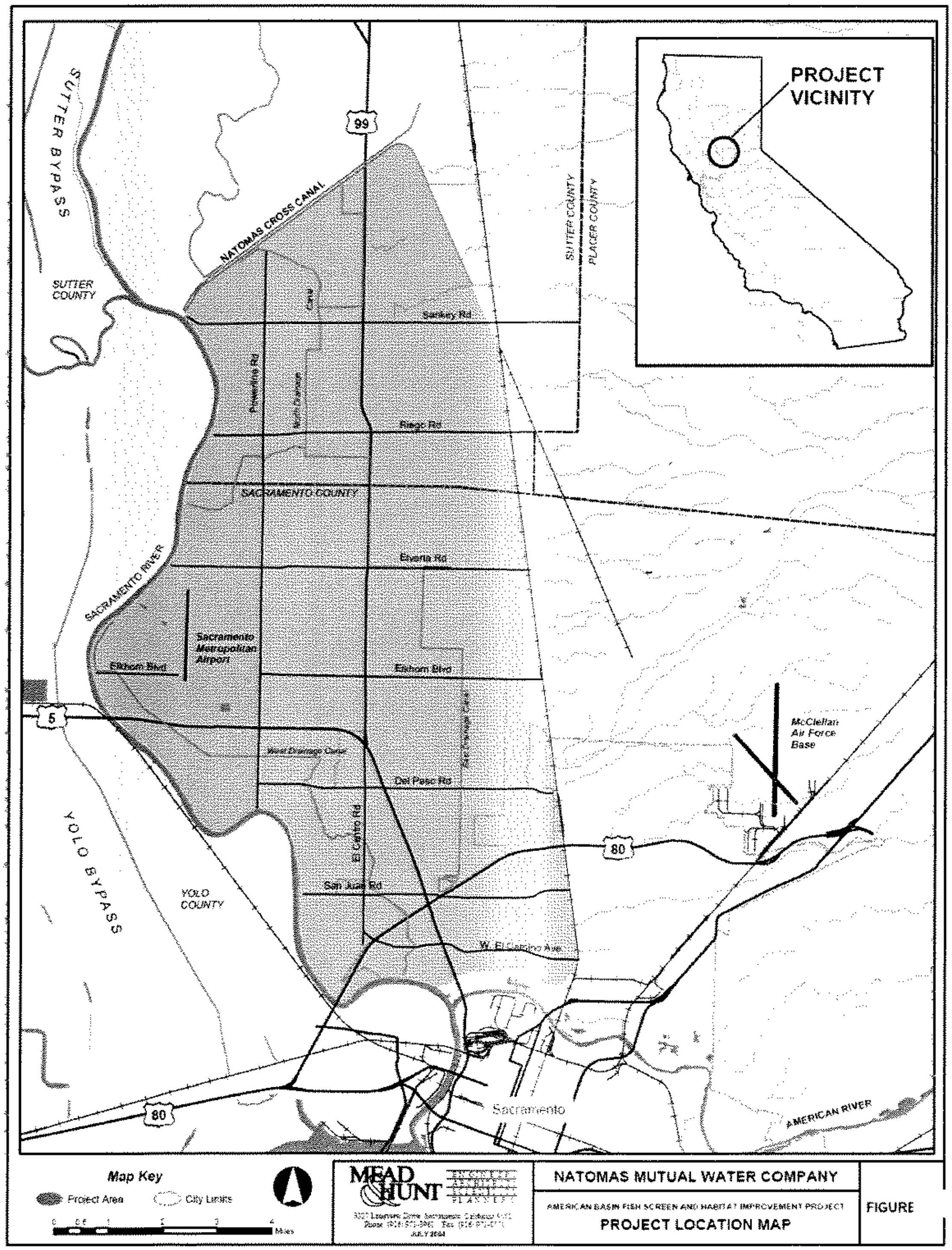

Figure 1. American Basin Fish Screen and Habitat Improvement Project location map

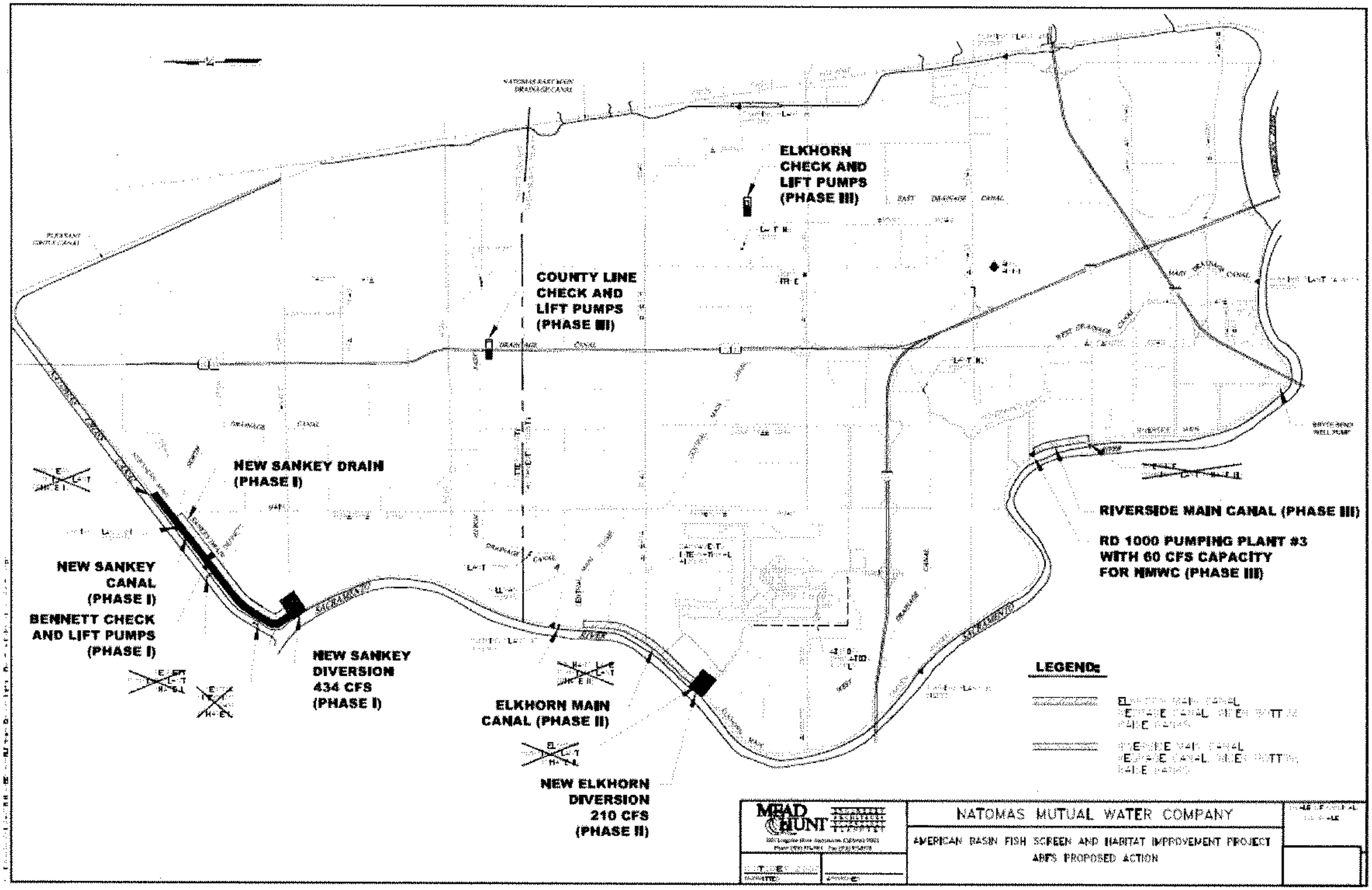

Figure 2. Location of Proposed Action Area

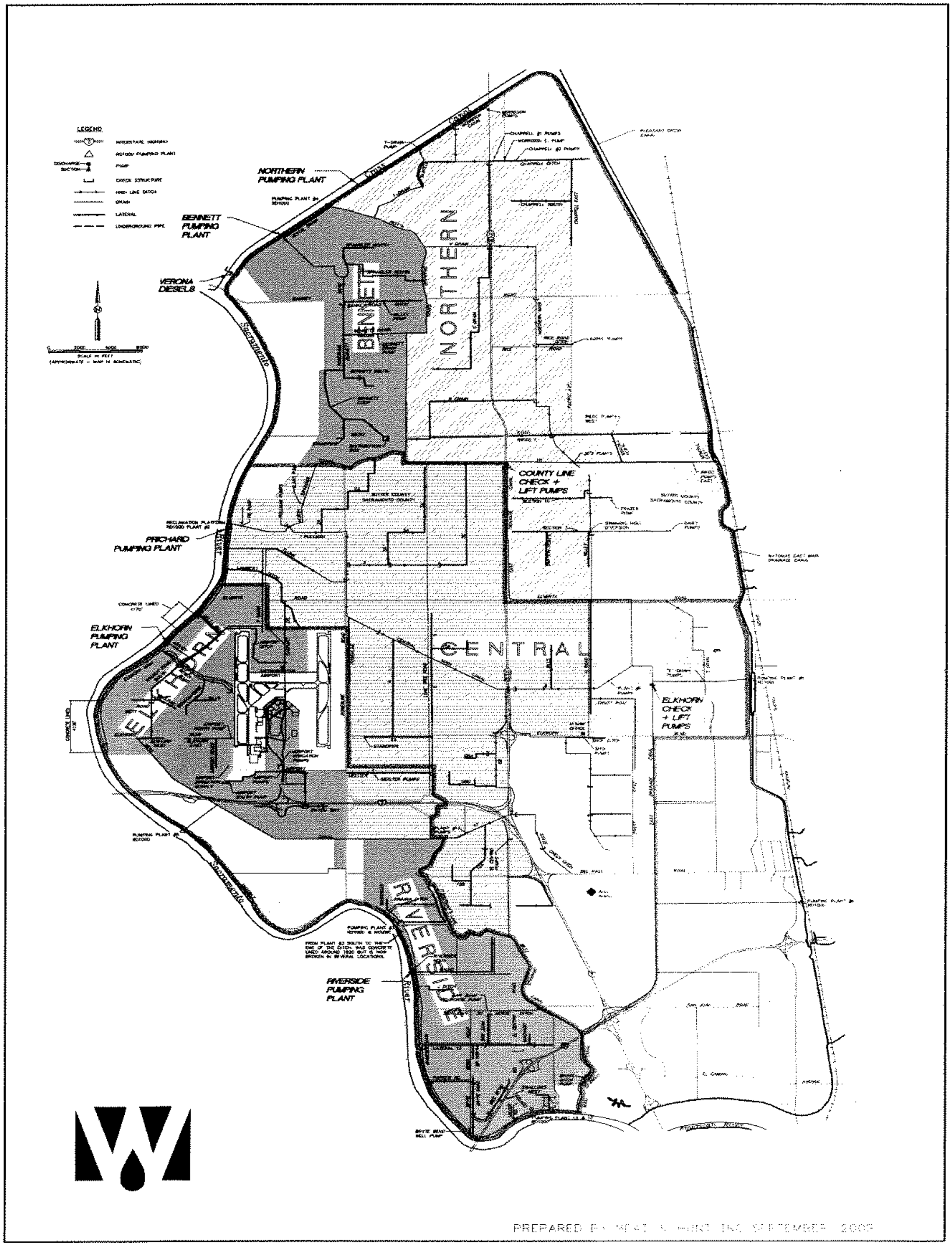

Figure 3. Existing Natomas Mutual Facilities

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally listed species evolutionary significant units (ESU) or distinct population segments (DPS) and designated critical habitat occur in the action area and may be affected by the proposed project:

> **Sacramento River winter-run Chinook salmon ESU** (*Oncorhynchus tshawytscha*)
> endangered (June 28, 2005, 70 FR 37160)
> **Sacramento River winter-run Chinook salmon designated critical habitat**
> (June 16, 1993, 58 FR 33212)
> **Central Valley spring-run Chinook salmon ESU** (*Oncorhynchus tshawytscha*)
> threatened (June 28, 2005, 70 FR 37160)
> **Central Valley spring-run Chinook salmon designated critical habitat**
> (September 2, 2005, 70 FR 52488)
> **Central Valley steelhead DPS** (*Oncorhynchus mykiss*)
> threatened (December 22, 2005)
> **Central Valley steelhead designated critical habitat**
> (September 2, 2005, 70 FR 52488)
> **Southern DPS of North American green sturgeon** (*Acipenser medirostris*)
> threatened (April 7, 2006, 70 FR 17386)
> **Southern DPS of North American green sturgeon proposed critical habitat**
> (September 8, 2008, 73 FR 52084)

A. Species Life History, Population Dynamics, and Likelihood of Survival and Recovery

1. Chinook Salmon

Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). "Stream-type" Chinook salmon, enter freshwater months before spawning and reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon spawn soon after entering freshwater and migrate to the ocean as fry or parr within their first year. Spring-run Chinook salmon exhibit a stream-type life history. Adults enter freshwater in the spring, hold over summer, spawn in fall, and the juveniles typically spend a year or more in freshwater before emigrating. Winter-run Chinook salmon are somewhat anomalous in that they have characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in winter or early spring, and delay spawning until spring or early summer (stream-type). However, juvenile winter-run Chinook salmon migrate to sea after only 4 to 7 months of river life (ocean-type). Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over-summering by adults and/or juveniles.

Chinook salmon typically mature between 2 and 6 years of age (Myers *et al.* 1998). Freshwater entry and spawning timing generally are thought to be related to local water temperature and flow regimes. Runs are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

Information on the migration rates of adult Chinook salmon in freshwater is scant and primarily comes from the Columbia River basin where information regarding migration behavior is needed to assess the effects of dams on travel times and passage (Matter *et al.* 2003). Keefer *et al.* (2004) found migration rates of Chinook salmon ranging from approximately 10 kilometers (km) per day to greater than 35 km per day and to be primarily correlated with date, and secondarily with discharge, year, and reach, in the Columbia River basin. Matter *et al.* (2003) documented migration rates of adult Chinook salmon ranging from 29 to 32 km per day in the Snake River. Adult Chinook salmon inserted with sonic tags and tracked throughout the Delta and lower Sacramento and San Joaquin rivers were observed exhibiting substantial upstream and downstream movement in a random fashion while on their upstream migration (California Bay-Delta Authority (CALFED) 2001). Adult salmonids migrating upstream are assumed to make greater use of pool and mid-channel habitat than channel margins (Stillwater Sciences 2004), particularly larger salmon such as Chinook, as described by Hughes (2004). Adults are thought to exhibit crepuscular behavior during their upstream migrations; meaning that they primarily are active during twilight hours. Recent hydroacoustic monitoring conducted by LGL Environmental Research Associates showed peak upstream movement of adult Central Valley spring-run Chinook salmon in lower Mill Creek, a tributary to the Sacramento River, occurring in the four hour period before sunrise and again after sunset.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools (USFWS 1995). Upon emergence, fry swim or are displaced downstream (Healey 1991). Similar to adult movement, juvenile salmonid downstream movement is primarily crepuscular. Martin *et al.* (2001) found that the daily migration of juveniles passing Red Bluff Diversion Dam (RBDD) is highest in the four hour period prior to sunrise. Once started downstream, fry may continue downstream to the estuary and rear, or may take up residence in the stream for a period of time from weeks to a year (Healey 1991).

Migrating and rearing fry seek nearshore habitats containing beneficial aspects such as riparian vegetation and associated substrates important for providing aquatic and terrestrial invertebrates, predator avoidance, and slower velocities for resting (NMFS 1996). The benefits of shallow water habitats for salmonid rearing also have recently been realized as shallow water habitat has been found to be more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey 1980). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, MacFarlane and Norton 2001, Sommer *et al.* 2001).

As juvenile Chinook salmon grow they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures (Healey 1991). Catches of juvenile Chinook salmon in the Sacramento River near West Sacramento by the USFWS (1997) exhibited larger juvenile captures in the main channel and smaller sized fry along the margins. When the channel of the river is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1980). Stream flow and/or turbidity increases in the upper Sacramento River basin are thought to stimulate emigration (Kjelson *et al.* 1982, Brandes and McLain, 2001).

Juvenile Chinook salmon migration rates vary considerably presumably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al.* (1982) found fry Chinook salmon to travel as fast as 30 kilometers (km) per day in the Sacramento River and Sommer *et al.* (2001) found rates ranging from approximately 0.5 miles up to more than 6 miles per day in the Yolo Bypass. As Chinook salmon begin the smoltification stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healey 1980, Levy and Northcote 1981).

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1981, Healey 1991). Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Juvenile Chinook salmon were found to spend about 40 days migrating through the Sacramento-San Joaquin Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallon Islands (MacFarlane and Norton 2001). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon) MacFarlane and Norton (2001) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry.

a. *Sacramento River Winter-run Chinook Salmon*

Sacramento River winter-run Chinook salmon originally were listed as threatened in August 1989, under emergency provisions of the Endangered Species Act (ESA), and formally listed as threatened in November 1990 (55 FR 46515). The ESU consists of only one population that is confined to the upper Sacramento River in California's Central Valley. The ESU was reclassified as endangered on January 4, 1994 (59 FR 440), due to increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and a 99 percent decline between 1966 and 1991. NMFS reaffirmed the listing of Sacramento River winter-run Chinook salmon as endangered on June 28, 2005 (70 FR 37160). The Livingston Stone National Fish Hatchery population has been included in the listed Sacramento River winter-run Chinook salmon population as of June 28, 2005 (70 FR 37160). NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212).

Sacramento River winter-run Chinook salmon adults enter the Sacramento River basin between December and July; the peak occurring in March (Table 4; Yoshiyama *et al.* 1998, Moyle 2002). Spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick Dam and RBDD (Vogel and Marine 1991). The majority of Sacramento River winter-run Chinook salmon spawners are 3 years old.

Sacramento River winter-run Chinook salmon fry begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994), with emergence generally occurring at night. Post-emergent fry disperse to the margins of the river, seeking out shallow waters with slower currents, finer sediments, and bank cover such as overhanging and submerged vegetation, root wads, and fallen woody debris, and begin feeding on small insects and crustaceans.

Emigration of juvenile Sacramento River winter-run Chinook salmon past RBDD may begin as early as mid July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991, NMFS 1997). From 1995 to 1999, all Sacramento River winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). Juvenile Sacramento River winter-run Chinook salmon occur in the Delta primarily from November through early May based on data collected from trawls in the Sacramento River at West Sacramento (RM 57) (USFWS 2001). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Winter-run Chinook salmon juveniles remain in the Delta until they reach a fork length of approximately 118 millimeters (mm) and are from 5 to 10 months of age, and then begin emigrating to the ocean as early as November and continuing through May (Fisher 1994, Myers *et al.* 1998).

Historical Sacramento River winter-run Chinook salmon population estimates, which included males and females, reached approximately 100,000 fish in the 1960s, but declined to under 200 fish in the 1990s (Good *et al.* 2005). Population estimates in 2003 (8,218), 2004 (7,701), and 2005 (15,730), and 2006 (17,334) (CDFG 2008) show a recent increase in the population size and a 4-year average of 12,315. The 2006 run was the highest since the listing. However, the preliminary adult population estimate of winter-run Chinook salmon in 2007 was only 2,542 (CDFG 2008). The saltwater life history traits and habitat requirements of winter-run Chinook salmon and fall-run Chinook salmon are similar. Therefore, the unusually poor ocean conditions that are suspected to have contributed to the drastic decline in returning fall run Chinook salmon populations coast wide in 2007 (Varanasi and Bartoo 2008) are likely to have also contributed to the observed decrease in the winter-run Chinook salmon spawning population in 2007.

Two current methods are utilized to estimate the juvenile production of Sacramento River winter-run Chinook salmon: the Juvenile Production Estimate (JPE) method, and the Juvenile Production Index (JPI) method (Gaines and Poytress 2004). Gaines and Poytress (2004) estimated the juvenile population of Sacramento River winter-run Chinook salmon exiting the upper Sacramento River at RBDD to be 3,707,916 juveniles per year using the JPI method between the years 1995 and 2003 (excluding 2000 and 2001). Using the JPE method, they estimated an average of 3,857,036 juveniles exiting the upper Sacramento River at RBDD between the years of 1996 and 2003 (Gaines and Poytress 2004). Averaging these 2 estimates yields an estimated population size of 3,782,476.

Based on the RBDD counts, the population has been growing rapidly since the 1990s with positive short-term trends. An age-structured density-independent model of spawning escapement by Botsford and Brittnacker in 1998 (as referenced in Good *et al.* 2005) assessing the viability of Sacramento River winter-run Chinook salmon found the species was certain to fall below the quasi-extinction threshold of 3 consecutive spawning runs with fewer than 50 females (Good *et al.* 2005). Lindley *et al.* (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures found a biologically significant expected quasi-extinction probability of 28 percent. Although the status of the Sacramento River winter-run Chinook salmon population appears to be improving, there is only one population, and it depends on cold-water releases from Shasta Dam, which could be vulnerable to a prolonged drought (Good *et al.* 2005).

This population remains below the draft recovery goals established for the run (NMFS 1997, 1998) and the naturally-spawned component of the ESU is dependent on one extant population in the Sacramento River. In general, the draft recovery criteria for Sacramento River winter-run Chinook salmon include a mean annual spawning abundance over any 13 consecutive years of at least 10,000 females with a concurrent geometric mean of the cohort replacement rate greater than 1.0 (NMFS 1997). Recent trends in Sacramento River winter-run Chinook salmon abundance and cohort replacement remain positive, indicating some recovery since the listing. However, the population remains well below the recovery goals of the draft recovery plan, and is particularly susceptible to extinction because of the reduction of the genetic pool to one population.

(1) Viable Salmonid Population Summary for Sacramento River Winter-run Chinook Salmon

Abundance. Redd and carcass surveys, and fish counts, suggest that the abundance of winter-run Chinook salmon has been increasing. The depressed 2007 abundance estimate is an exception to this trend and may represent a new cycle of poor ocean productivity. Population growth is estimated to be positive in the short-term trend at 0.26; however, the long-term trend is negative, averaging -0.14. Recent winter-run Chinook salmon abundance represents only 3 percent of the maximum post-1967, 5-year geometric mean, and is not yet well established (Good *et al.* 2005).

Productivity. ESU productivity has been positive over the short term, and adult escapement and juvenile production have been increasing annually (Good *et al.* 2005). The long-term trend for the ESU remains negative, however, as it consists of only one population that is subject to possible impacts from environmental and artificial conditions. The most recent Cohort Replacement Rate (CRR) estimate suggests a reduction in productivity for the 1998-2001 cohorts.

Spatial Structure. The greatest risk factor for winter-run Chinook salmon lies with their spatial structure (Good *et al.* 2005). The remnant population cannot access historical winter-run habitat and must be artificially maintained in the Sacramento River by a regulated, finite cold water pool from Shasta Dam. Winter-run Chinook salmon require cold water temperatures in summer that simulate their upper basin habitat, and they are more likely to be exposed to the impacts of drought in a lower basin environment. Battle Creek remains the most feasible opportunity for the ESU to expand its spatial structure, which currently is limited to the upper 25-mile reach of the mainstem Sacramento River below Keswick Dam.

Diversity. The second highest risk factor for the Sacramento River winter-run Chinook salmon ESU has been the detrimental effects on its diversity. The present winter-run population has resulted from the introgression of several stocks that occurred when Shasta Dam blocked access to the upper watershed. A second genetic bottleneck occurred with the construction of Keswick Dam; there may have been several others within the recent past (Good *et al.* 2005).

Current water operations and habitat management protocols also limit the ability of winter-run Chinook salmon to express behavioral diversity within the ESU. The tightly controlled and managed habitat conditions within the limited spawning habitat for this ESU does not allow for plasticity in traits such as spawn timing, spawning location or migration timing. Any fish that try to spawn or migrate at a time or in an area outside of that which is being tightly managed for are unlikely to succeed. This confinement of suitable habitat conditions to specifically managed times and places further limits the diversity of the Sacramento River winter-run Chinook salmon ESU.

b. *Central Valley Spring-run Chinook Salmon*

NMFS listed the Central Valley spring-run Chinook salmon (CV spring-run Chinook salmon) ESU as threatened on September 16, 1999 (64 FR 50394). On June 28, 2005, after reviewing the best available, up-dated scientific and commercial information, NMFS issued a final decision to retain the status of CV spring-run Chinook salmon as threatened (70 FR 37160). This decision was based on the recognition that although CV spring-run Chinook salmon productivity trends are positive, the ESU continues to face risks from having a limited number of remaining populations (*i.e.*, 3 existing populations from an estimated 17 historical populations), a limited geographic distribution, and potential hybridization with Feather River Hatchery (FRH) spring-run Chinook salmon, which until recently were not included in the ESU and are genetically divergent from other populations in Mill, Deer, and Butte Creeks. The June 28, 2005, decision also included the FRH spring-run Chinook salmon population as part of the CV spring-run Chinook salmon ESU. Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005 (70 FR 52488).

Adult CV spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River between March and September, primarily in May and June (Table 5; Yoshiyama *et al.* 1998, Moyle 2002). Lindley *et al.* (2006a) indicates adult CV spring-run Chinook salmon enter native tributaries from the Sacramento River primarily between mid April and mid June. Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al.* 1998).

Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year (YOY) or as juveniles or yearlings. The modal size of fry migrants at approximately 40 mm between December and April in Mill, Butte, and Deer Creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al.* 2006a). Studies in Butte Creek (Ward *et al.* 2002, 2003, McReynolds *et al.* 2005) found the majority of spring-run Chinook salmon out-migrants to be fry occurring primarily during December, January and February; and that these movements appeared to be influenced by flow. Small numbers of CV spring-run Chinook salmon remained in Butte Creek to rear and migrated as yearlings. Juvenile emigration patterns in Mill and Deer Creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer Creek juveniles typically exhibit a later young-of-the-year (YOY) migration and an earlier yearling migration (Lindley *et al.* 2006a).

Once juveniles emerge from the gravel they initially seek areas of shallow water and low velocities while they finish absorbing the yolk sac (Moyle 2002). Many also will disperse downstream during high-flow events. As is the case in other salmonids, there is a shift in microhabitat use by juveniles to deeper faster water as they grow. Microhabitat use can be influenced by the presence of predators which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002). Peak movement of juvenile CV spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the FRH. In 2002, the FRH reported 4,189 returning spring-run Chinook salmon, which is 22 percent below the 10-year average of 4,727 fish. However, coded-wire tag (CWT) information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to hatchery practices. Because Chinook salmon are not temporally separated in the hatchery, spring-run and fall-run Chinook salmon have been spawned together, thus, compromising the genetic integrity of the spring-run Chinook salmon stock. The number of naturally-spawning spring-run Chinook salmon in the Feather River has been estimated only periodically since the 1960s, with estimates ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of this population is questionable because of the significant temporal and spatial overlap between spawning populations of spring-run and fall-run Chinook salmon (Good *et al.* 2005). For the reasons discussed above, the Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance.

The CV spring-run Chinook salmon ESU has displayed broad fluctuations in adult abundance, ranging from 1,403 in 1993 to 25,890 in 1982. The average abundance for the ESU was 12,590 for the period of 1969 to 1979, 13,334 for the period of 1980 to 1990, 6,554 from 1991 to 2001, and 16,349 between 2002 and 2005 (for the purposes of this biological opinion, the average adult population is assumed to be 16,349 until new information is available) (DFG 2008). Sacramento River tributary populations in Mill, Deer, and Butte Creeks are probably the best trend indicators for the Central Valley spring-run Chinook ESU as a whole because these streams contain the primary independent populations with the ESU. Generally, these streams have shown a positive escapement trend since 1991. Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 fish since 1995. During this same period, adult returns on Mill Creek have averaged 778 fish, and 1,463 fish on Deer Creek. Although recent trends are positive, annual abundance estimates display a high level of fluctuation, and the overall number of CV spring-run Chinook salmon remains well below estimates of historic abundance. Additionally, in 2003, high water temperatures, high fish densities, and an outbreak of Columnaris Disease (*Flexibacter Columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiis*) contributed to the pre-spawning mortality of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek.

Several actions have been taken to improve habitat conditions for CV spring-run Chinook salmon, including: improved management of Central Valley water (*i.e.*, through use of CALFED Environmental Water Account (EWA) and the Central Valley Project Improvement Act (CVPIA) (b)(2) water accounts); implementing new and improved screen and ladder designs at major water diversions along the mainstem Sacramento River and tributaries; and, changes in ocean and inland fishing regulations to minimize harvest. Although protective measures likely have contributed to recent increases in spring-run Chinook salmon abundance, the ESU is still below levels observed from the 1960s through 1990. Threats from hatchery production (*i.e.*, competition for food between naturally spawned and hatchery fish, run hybridization and genomic homogenization), climatic variation, high temperatures, predation, and water diversions still persist.

There have been significant habitat improvements (including the removal of several small dams and increases in summer flows) in CV spring-run Chinook salmon watersheds, as well as reduced ocean fisheries and a favorable terrestrial and marine climate. It appears that the three independent spring-run Chinook salmon populations in the Central Valley are growing (Good *et al.* 2005). All three spring-run Chinook salmon populations show signs of positive long- and short-term mean annual population growth rates. Although CV spring-run Chinook salmon have some of the highest population growth rates in the Central Valley, other than Butte Creek and the hatchery-influenced Feather River, population sizes are relatively small compared to fall-run

Chinook salmon populations (Good *et al.* 2005). Because the CV spring-run Chinook salmon ESU is spatially confined to relatively few remaining streams, continues to display broad fluctuations in abundance, and a large proportion of the population (*i.e.*, in Butte Creek) faces the risk of high mortality rates, the population remains at a moderate to high risk of extinction.

(1) Viable Salmonid Population Summary for CV Spring-run Chinook Salmon

Abundance. The CV spring-run Chinook salmon ESU has experienced a trend of increasing abundance in some natural populations, most dramatically in the Butte Creek population (Good *et al.* 2005). There has been more opportunistic utilization of migration-dependent streams overall. The FRH spring-run stock has been included in the ESU based on its genetic linkage to the natural population and the potential development of a conservation strategy for the hatchery program.

Productivity. The 5-year geometric mean for the extant Butte, Deer, and Mill Creek spring-run populations ranges from 491 to 4,513 fish (Good *et al.* 2005), indicating increasing productivity over the short-term and projected as likely to continue (Good *et al.* 2005). The productivity of the Feather River and Yuba River populations and contribution to the Central Valley spring-run ESU currently is unknown.

Spatial Structure. Spring-run Chinook salmon presence has been reported more frequently in several upper Central Valley creeks, but the sustainability of these runs is unknown. Butte Creek spring-run cohorts have recently utilized all available habitat in the creek; the population cannot expand further and it is unknown if individuals have opportunistically migrated to other systems. The spatial structure of the spring-run ESU has been reduced with the extirpation of all San Joaquin River basin spring-run populations.

Diversity. The Central Valley spring-run ESU is comprised of two genetic complexes. Analysis of natural and hatchery spring-run Chinook salmon stocks in the Central Valley indicates that the southern Cascades spring-run population complex (Mill, Deer, and Butte creeks) retains genetic integrity. The genetic integrity of the Sierra Nevada spring-run population complex has been somewhat compromised. The Feather River spring-run have introgressed with the fall-run, and it appears that the Yuba River population may have been impacted by FRH fish straying into the Yuba River. Additionally, the diversity of the spring-run ESU has been further reduced with the loss of the San Joaquin River basin spring-run populations.

2. Central Valley Steelhead

Central Valley steelhead was originally listed as threatened on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento and San Joaquin River basins in California's Central Valley. In June 2004, NMFS proposed that Central Valley spring-run Chinook salmon remain listed as threatened (69 FR 33102). On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of Central Valley steelhead as threatened (70 FR 37160). This decision also included the

Coleman National Fish Hatchery and FRH steelhead populations. These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for Central Valley steelhead on September 2, 2005 (70 FR 52488).

Steelhead can be divided into two life history types, summer-run steelhead and winter-run steelhead, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Only winter steelhead currently are found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento river system prior to the commencement of large-scale dam construction in the 1940s (Interagency Ecological Program (IEP) Steelhead Project Work Team 1999). At present, summer steelhead are found only in North Coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

Central Valley steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April with peaks from January though March in small streams and tributaries where cool, well oxygenated water is available year-round (Hallock *et al.* 1961, McEwan and Jackson 1996) (Table 6). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapolov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams.

Spawning occurs during winter and spring months. The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of steelhead eggs in hatcheries takes about 30 days at 51 °F. Fry emerge from the gravel usually about four to six weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Newly emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools, although young-of-the-year also are abundant in glides and riffles. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small woody debris. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating Central Valley steelhead use the lower reaches of the Sacramento River and the

Delta for rearing and as a migration corridor to the ocean. Juvenile Central Valley steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002). Some may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall. Nobriga and Cadrett (2003) also have verified these temporal findings based on analysis of captures at Chipps Island, Suisun Bay.

Historic Central Valley steelhead run sizes are difficult to estimate given the paucity of data, but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River. Steelhead counts at the RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Recent estimates from trawling data in the Delta indicate that approximately 100,000 to 300,000 (mean 200,000) smolts emigrate to the ocean per year representing approximately 3,600 female Central Valley steelhead spawners in the Central Valley basin (Good *et al.* 2005). This can be compared with McEwan's (2001) estimate of one million to two million spawners before 1850, and 40,000 spawners in the 1960s.

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). Recent snorkel surveys (1999 to 2002) indicate that steelhead are present in Clear Creek (J. Newton, USFWS, pers. comm. 2002, as reported in Good *et al.* 2005). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Until recently, Central Valley steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000, 2001).

It is possible that naturally-spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread, throughout accessible streams and rivers in the Central Valley (Good *et al.* 2005). CDFG staff has prepared juvenile migrant Central Valley steelhead catch summaries on the San Joaquin River near Mossdale representing migrants from the Stanislaus, Tuolumne, and Merced Rivers. Based on trawl recoveries at Mossdale between 1988 and 2002, as well as rotary screw trap efforts in all three tributaries, CDFG staff stated that it is "clear from this data that rainbow trout do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River" (Letter from Dean Marston, CDFG, to Madelyn Martinez, NMFS, January 9, 2003). The documented returns on the order of single fish in these tributaries suggest that existing populations of Central Valley steelhead on the Tuolumne, Merced, and lower San Joaquin Rivers are severely depressed.

Lindley *et al.* (2006b) indicated that prior population census estimates completed in the 1990s found the Central Valley steelhead spawning population above RBDD had a fairly strong negative population growth rate and small population size. Good *et al.* (2005) indicated the decline was continuing as evidenced by new information (Chipps Island trawl data). Central Valley steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates.

(1) Viable Salmonid Population Summary for CV Steelhead

Abundance. All indications are that natural Central Valley steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good *et al.* 2005); the long-term trend remains negative. There has been little steelhead population monitoring despite 100 percent marking of hatchery steelhead since 1998. Hatchery production and returns are dominant over natural fish and include significant numbers of non-DPS-origin Eel River steelhead stock.

Productivity. An estimated 100,000 to 300,000 natural juvenile steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good *et al.* 2005). Concurrently, one million in-DPS hatchery steelhead smolts and another half million out-of-DPS hatchery steelhead smolts are released annually in the Central Valley. The estimated ratio of nonclipped to clipped steelhead has decreased from 0.3 percent to less than 0.1 percent, with a net decrease to one-third of wild female spawners from 1998 to 2000 (Good *et al.* 2005).

Spatial Structure. Steelheads appear to be well-distributed where found throughout the Central Valley (Good *et al.* 2005). Until recently, there was very little documented evidence of steelhead due to the lack of monitoring efforts. Since 2000, steelhead have been confirmed in the Stanislaus and Calaveras rivers.

Diversity. Analysis of natural and hatchery steelhead stocks in the Central Valley reveal genetic structure remaining in the DPS (Nielsen *et al.* 2003). There appears to be a great amount of gene flow among upper Sacramento River basin stocks, due to the post-dam, lower basin distribution of steelhead and management of stocks. Recent reductions in natural population sizes have created genetic bottlenecks in several Central Valley steelhead stocks (Good *et al.* 2005; Nielsen *et al.* 2003). The out-of-basin steelhead stocks of the Nimbus and Mokelumne River hatcheries are not included in the Central Valley steelhead DPS.

3. Southern DPS of North American Green Sturgeon

The southern DPS of North American green sturgeon was listed as threatened on April 7, 2006, (70 FR 17386) and includes the North American green sturgeon population spawning in the Sacramento River and utilizing the Sacramento River, the Delta, and the San Francisco Estuary.

North American green sturgeon are widely distributed along the Pacific Coast and have been documented offshore from Ensenada Mexico to the Bering Sea and found in rivers from British Columbia to the Sacramento River (Moyle 2002). As is the case for most sturgeon, North American green sturgeon is anadromous; however, they are the most marine-oriented of the sturgeon species (Moyle 2002). In North America, spawning populations of the anadromous green sturgeon currently are found in only three river systems, the Sacramento and Klamath Rivers in California and the Rogue River in southern Oregon.

Two green sturgeon DPSs were identified based on evidence of spawning site fidelity (indicating multiple DPS tendencies), and on the preliminary genetic evidence that indicates differences at least between the Klamath River and San Pablo Bay samples (Adams *et al.* 2002). The Northern DPS includes all green sturgeon populations starting with the Eel River and extending northward. The southern DPS would include all green sturgeon populations south of the Eel River with the only known spawning population being in the Sacramento River.

The southern DPS of North American green sturgeon life cycle can be broken into four distinct phases based on developmental stage and habitat use: (1) adult females greater than or equal to 13 years of age and males greater than or equal to 9 years of age, (2) larvae and post-larvae less than 10 months of age, (3) juveniles less than or equal to 3 years of age, and (4) coastal migrant females between 3 and 13, and males between 3 and 9 years of age (Nakamoto *et al.* 1995, Jeff McLain, NMFS, pers. comm., 2006).

New information regarding the migration and habitat use of the southern DPS of North American green sturgeon has emerged. Lindley (2006c) presents preliminary results of large-scale green sturgeon migration studies. Lindley's analysis verified past population structure delineations based on genetic work and found frequent large-scale migrations of green sturgeon along the Pacific Coast. It appears North American green sturgeon migrate considerable distances up the Pacific Coast into several bays and estuaries, particularly the Columbia River estuary. This information also agrees with the results of green sturgeon tagging studies completed by CDFG where they tagged a total of 233 green sturgeons in the San Pablo Estuary between 1954 and 2001. A total of 17 tagged fish were recovered: 3 in the Sacramento-San Joaquin Estuary, 2 in the

Pacific Ocean off of California, and 12 from commercial fisheries off of Oregon and Washington. Eight of the 12 recoveries were in the Columbia Estuary (CDFG 2002).

Kelley *et al.* (2006) indicated that green sturgeon enter the San Francisco Estuary during the spring and remain until autumn. The authors studied the movement of adults in the San Francisco Estuary and found them to make significant long-distance movements with distinct directionality. The movements were not found to be related to salinity, current, or temperature and the authors surmised they are related to resource availability (Kelley *et al.* 2006). The majority of green sturgeon in the Rogue River emigrated from freshwater habitat in December after water temperatures dropped (Erickson *et al.* 2002). Green sturgeon were most often found at depths greater than 5 meters with low or no current during summer and autumn months (Erickson *et al.* 2002). The authors surmised that this holding in deep pools was to conserve energy and utilize abundant food resources. Based on captures of adult green sturgeon in holding pools on the Sacramento River above the GCID diversion (RM 205) and the documented presence of adults in the Sacramento River during the spring and summer months and the presence of larval green sturgeon in late summer in the lower Sacramento River indicating spawning ocurrence, it appears adult green sturgeon could possibly utilize a variety of freshwater and brackish habitats for up to nine months of the year (Ray Beamesderfer, S.P. Cramer & Associates, Inc., pers. comm. 2006).

Adult green sturgeon are believed to feed primarily upon benthic invertebrates such as clams, mysid and grass shrimp, and amphipods (Radtke 1966, Adams *et al.* 2002, Jeffrey Stuart, NMFS, pers. comm. 2006). Adult sturgeon caught in Washington State waters were found to have fed on Pacific sand lance (*Ammodytes hexapterus*) and callianassid shrimp (Moyle *et al.* 1992).

Based on the distribution of sturgeon eggs, larva, and juveniles in the Sacramento River, CDFG (2002) indicated that southern DPS of green sturgeon spawn in late spring and early summer above Hamilton City possibly to Keswick Dam. Adult green sturgeon are believed to spawn every 3 to 5 years and reach sexual maturity only after several years of growth (*i.e.*, 10 to 15 years based on sympatric white sturgeon sexual maturity (CDFG 2002). Adult female green sturgeon produce between 60,000 and 140,000 eggs each reproductive cycle, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al.* 2001). Southern DPS Green sturgeon adults begin their upstream spawning migrations into the San Francisco Bay in March, reach Knights Landing during April, and spawn between March and July (Heublein *et al.* 2006). Peak spawning is believed to occur between April and June (Table 7) and thought to occur in deep turbulent pools (Adams *et al.* 2002). Substrate is likely large cobble but can range from clean sand to bedrock (USFWS 2002). Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length. According to Heublein (2006) all adults leave the Sacramento River prior to September 1 of each year.

After approximately 10 days, larvae begin feeding, growing rapidly, and young green sturgeon appear to rear for the first 1 to 2 months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging from 24 to 31 mm fork length (CDFG 2002, USFWS

2002). The mean yearly total length of post-larval green sturgeon captured in rotary screw traps at the RBDD ranged from 26 mm to 34 mm between 1995 and 2000 indicating they are approximately 2 weeks old. The mean yearly total length of post-larval green sturgeon captured in the GCID rotary screw trap, approximatley 30 miles downstream of RBDD ranged from 33 mm to 44 mm between 1997 and 2005 (CDFG, unpublished data) indicating they are approximately 3 weeks old (Van Eenennaam *et al.* 2001).

Green sturgeon larvae do not exhibit the initial pelagic swim-up behavior characteristic of other *Acipenseridae.* They are strongly oriented to the bottom and exhibit nocturnal activity patterns. Under laboratory conditions, green sturgeon larvae cling to the bottom during the day, and move into the water column at night (Van Eenennaam *et al.* 2001). After six days, the larvae exhibit nocturnal swim-up activity (Deng *et al.* 2002) and nocturnal downstream migrational movements (Kynard *et al.* 2005). Juvenile green sturgeon continue to exhibit nocturnal behavioral beyond the metamorphosis from larvae to juvenile stages. Kynard *et al.*'s (2005) laboratory studies indicated that juvenile fish continued to migrate downstream at night for the first six months of life. When ambient water temperatures reached 46 °F, downstream migrational behavior diminished and holding behavior increased. This data suggests that 9-to 10-month-old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds. Juvenile green sturgeon have been salvaged at the Harvey O. Banks Pumping Plant and the John E. Skinner Fish Facility (Fish Facilities) in the South Delta, and captured in trawling studies by the CDFG during all months of the year (CDFG 2002). The majority of these fish were between 200 and 500 mm indicating they were from 2 to 3 years of age based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates juvenile southern DPS North American green sturgeon likely hold in the mainstem Sacramento River as suggested by Kyndard *et al.* (2005).

Population abundance information concerning the southern DPS green sturgeon is described in the NMFS status reviews (Adams *et al.* 2002, NMFS 2005a). Limited population abundance information comes from incidental captures of North American green sturgeon from the white sturgeon monitoring program by the CDFG sturgeon tagging program (CDFG 2002). By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult North American green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG does not consider these estimates reliable. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile North American green sturgeon per year (Adams *et al.* 2002). The only existing information regarding changes in the abundance of the southern DPS of green sturgeon includes changes in abundance at the John E. Skinner Fish Facility between 1968 and 2001. The average number of North American green sturgeon taken per year at the State Facility prior to 1986 was 732; from 1986 on, the average per year was 47 (70 FR 17386). For the Harvey O. Banks Pumping Plant, the average number prior to 1986 was 889; from 1986 to 2001 the average was 32 (70 FR 17386). In light of the increased exports, particularly during the previous 10 years, it is clear that the abundance of the southern DPS of North American green sturgeon is dropping. Additional analysis of North American green and white sturgeon taken at the Fish Facilities indicates that take of both North American green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s (70 FR 17386). Catches of sub-adult and adult North American green sturgeon by the IEP between 1996 and 2004 ranged from 1 to 212 green sturgeon per year (212 occurred in 2001); however, the portion of the southern DPS of North American green sturgeon is unknown as these captures were primarily located in San Pablo Bay which is known to consist of a mixture of Northern and southern DPS North American green sturgeon. Recent spawning population estimates using sibling based genetics by Israel (2006) indicates a maximum spawning population of 32 spawners in 2002, 64 in 2003, 44 in 2004, 92 in 2005, and 124 in 2006 above RBDD (with an average of 71). Based on the length and estimated age of post-larvae captured at RBDD (approximately two weeks of age) and GCID (downstream; approximately three weeks of age), it appears the majority of southern DPS North American green sturgeon are spawning above RBDD. Note, there are many assumptions with this interpretation (*i.e.*, equal sampling efficiency and distribution of post-larvae across channels) and this information should be considered cautiously.

There are at least two records of confirmed adult sturgeon observation in the Feather River (Beamesderfer *et al.* 2004); however, there are no observations of juvenile or larval sturgeon even prior to the 1960s when Oroville Dam was built (NMFS 2005a). There are also unconfirmed reports that green sturgeon may spawn in the Feather River during high flow years (CDFG 2002).

Spawning in the San Joaquin River system has not been recorded, but alterations of the San Joaquin River tributaries (Stanislaus, Tuolumne, and Merced Rivers) and its mainstem occurred early in the European settlement of the region. During the later half of the 1800s impassable barriers were built on these tributaries where the water courses left the foothills and entered the valley floor. Therefore, these low elevation dams have blocked potentially suitable spawning habitats located further upstream for over a century. Additional destruction of riparian and stream channel habitat by industrialized gold dredging further disturbed any valley floor habitat that was still available for sturgeon spawning. It is likely that both white and green sturgeon utilized the San Joaquin River basin for spawning prior to the onset of European influence, based on past use of the region by populations of Central Valley spring-run Chinook salmon and Central Valley steelhead. These two populations of salmonids have either been extirpated or greatly diminished in their use of the San Joaquin River basin over the past two centuries.

The freshwater habitat of North American green sturgeon in the Sacramento-San Joaquin drainage varies in function, depending on location. Spawning areas currently are limited to accessible upstream reaches of the Sacramento River. Preferred spawning habitats are thought to contain large cobble in deep cool pools with turbulent water (CDFG 2002, Moyle 2002).

Migratory corridors are downstream of the spawning areas and include the mainstem Sacramento River and the Delta. These corridors allow the upstream passage of adults and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers which can include dams, unscreened or poorly screened diversions, and degraded water quality. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their 1 to 3 year residence in freshwater. Rearing habitat condition and function may be affected by variation in annual and seasonal flow and temperature characteristics.

Table 4. The temporal occurrence of adult (a) and juvenile (b) Sacramento River winter-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

a) Adult

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sac. River basin[1]												
Sac. River[2]												

b) Juvenile

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sac. River @ Red Bluff[3]												
Sac. River @ Red Bluff[2]												
Sac. River @ Knights L.[4]												
Lower Sac. River (seine)[5]												
West Sac. River (trawl)[5]												

Source: [1]Yoshiyama *et al.* 1998; Moyle 2002; [2]Myers *et al.* 1998; [3]Martin *et al.* 2001; [4]Snider and Titus 2000; [5]USFWS 2001

Relative Abundance: = High = Medium = Low

Table 5. The temporal occurrence of adult (a) and juvenile (b) Central Valley spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

(a) Adult

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,2]Sac.River basin			M, M	M, M	H, H	H, H	M, M	M, M	M, M			
[3]Sac. River			M, M	M, M	M, M	M, M	M, M					
[4]Mill Creek			L, L	M, H	H, H	H, M	M, L	L, –				
[4]Deer Creek			L, L	M, H	H, H	H, M	M, –					
[4]Butte Creek		M, M	M, M	M, M	M, M	M, M	M, M					

(b) Juvenile

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[5]Sac. River Tribs	M, M	M, M	M, M							M, M	H, H	H, H
[6]Upper Butte Creek	H, H	H, H	M, M	M, M	M, M	L, L				L, L	L, L	H, H
[4]Mill, Deer, Butte Creeks	H, H	H, H	M, M	M, M	M, M	L, L				L, L	L, L	L, L
[3]Sac. River at RBDD	H, H	L, L	L, L	L, L							H, H	H, H
[7]Sac. River at Knights Landing (KL)	M, M	M, M	H, H	H, H	M, M						M, M	H, H

Source: [1]Yoshiyama *et al.* 1998; [2]Moyle 2002; [3]Myers *et al.* 1998; [4]Lindley *et al.* 2006a; [5]CDFG 1998; [6]McReynolds *et al.* 2005; Ward *et al.* 2002, 2003; [7]Snider and Titus 2000

Relative Abundance: ■ = High ■ = Medium ■ = Low

Table 6. The temporal occurrence of adult (a) and juvenile (b) Central Valley steelhead in the Central Valley. Darker shades indicate months of greatest relative abundance.

(a) Adult

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,3]Sac. River												
[2,3]Sac R at Red Bluff												
[4]Mill, Deer Creeks												
[6]Sac R. at Fremont Weir												
[6]Sac R. at Fremont Weir												
[7]San Joaquin River												

(b) Juvenile

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,2]Sacramento River												
[2,8]Sac. R at Knights Land												
[9]Sac. River @ KL												
[10]Chipps Island (wild)												
[8]Mossdale												
[11]Woodbridge Dam												
[12]Stan R. at Caswell												
[13]Sac R. at Hood												

Source: [1]Hallock 1961; [2]McEwan 2001; [3]USFWS unpublished data; [4]CDFG 1995; [5]Hallock *et al.* 1957; [6]Bailey 1954; [7]CDFG Steelhead Report Card Data 1995; [8]CDFG unpublished data; [9]Snider and Titus 2000; [10]Nobriga and Cadrett 2003; [11]Jones & Stokes Associates, Inc., 2002; [12]S.P. Cramer and Associates, Inc. 2000 and 2001; [13]Schaffter 1980

Relative Abundance: = High = Medium = Low

Table 7. The temporal occurrence of adult (a) larval and post-larval (b) juvenile (c) and coastal migrant (d) southern DPS of North American green sturgeon. Locations emphasize the Central Valley of California. Darker shades indicate months of greatest relative abundance.

(a) Adult (≥13 years old for females and ≥9 years old for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,2,3]Upper Sac. River			Medium	Medium/High	High	High/Medium	Medium	Medium	Medium	Medium	Medium	
[4,8]SF Bay Estuary			Medium	Medium	Medium	Medium	Medium	Medium	Medium			

(b) Larval and post-larval (≤10 months old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[5]RBDD, Sac River					Medium	High	High	Medium				
[5]GCID, Sac River					Medium	High	High	Medium	Low	Low		

(c) Juvenile (> 10 months old and ≤3 years old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[6]South Delta*	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
[6]Sac-SJ Delta	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
[5]Sac-SJ Delta				Medium	Medium	Medium	Medium	Medium	Medium	Medium		
[5]Suisun Bay	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

(d) Coastal migrant (3-13 years old for females and 3-9 years old for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[3,7]Pacific Coast	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

Source: [1]USFWS 2002; [2]Moyle *et al.* 1992; [3]Adams *et al.* 2002 and NMFS 2005a; [4]Kelley *et al.* 2006; [5]CDFG 2002; [6]Interagency Ecological Program Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [7]Nakamoto *et al.* 1995; [8]Heublein *et al.* 2006

* Fish Facility salvage operations

Relative Abundance: ■ = High ▒ = Medium □ = Low

B. Critical Habitat Condition and Primary Constituent Elements

1. Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley Steelhead

The designated critical habitat for Sacramento River winter-run Chinook salmon includes the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta; all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Estuary to the Golden Gate Bridge north of the San Francisco/Oakland Bay Bridge. In the Sacramento River, critical habitat includes the river water column, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. In the areas westward of Chipps Island, critical habitat includes the estuarine water column and essential foraging habitat and food resources used by Sacramento River winter-run Chinook salmon as part of their juvenile emigration or adult spawning migration.

Critical habitat for Central Valley spring-run Chinook salmon includes stream reaches such as those of the Feather and Yuba Rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear Creeks, and the Sacramento River and Delta. Critical Habitat for Central Valley steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope Creeks in the Sacramento River basin; and, the San Joaquin River its tributaries, and the Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (70 FR 52488). The bankfull elevation is defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series (MacDonald *et* al. 1991, Rosgen 1996). Critical habitat for Central Valley spring-run Chinook salmon and steelhead is defined as specific areas that contain the primary constituent elements (PCE) and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for Central Valley spring-run Chinook salmon and Central Valley steelhead, and as physical habitat elements for Sacramento River winter-run Chinook salmon.

a. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for Chinook salmon and steelhead is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for Sacramento River winter-run Chinook salmon is restricted to the Sacramento River primarily between RBDD and Keswick Dam. Central Valley spring-run Chinook salmon also spawn on the mainstem Sacramento River between RBDD and Keswick Dam and in tributaries such as Mill, Deer, and Butte Creeks. Spawning habitat for Central Valley steelhead is similar in nature to the requirements of Chinook salmon, primarily occurring in reaches directly below dams (*i.e.*, above RBDD on the Sacramento River) throughout the Central Valley. Natural spawning habitats (those not downstream from large dams) require adequate water temperatures, stream flows, and gravel conditions to support successful reproduction. Some areas below dams, especially for steelhead are degraded by fluctuating flow conditions related to water storage and flood management, that scour or strand redds. Spawning habitat is considered a primary constituent element of critical habitat because its condition and function directly affect the spawning success and reproductive potential of listed salmonids.

b. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and presence of predators of juvenile salmonids. Some complex, productive habitats with functional floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with set-back levees (*i.e.*, primarily located upstream of the City of Colusa)). However, the channeled, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat is considered a primary constituent element of critical habitat because the juvenile life stages of salmonids are dependant on the condition and function of this habitat for successful survival and recruitment. Thus, although much of the rearing habitat is in poor condition, it remains extremely important to the species.

c. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of obstruction with adequate water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility, survival and food supply. Migratory corridors are downstream of the spawning area and include the lower Sacramento River and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams, unscreened or poorly- screened diversions, and degraded water quality. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta can be impaired by physical barriers such as the Suisun Marsh Salinity Control Structure and the Sacramento Deep Water Ship Channel locks, and by other factors such as high water temperatures and low dissolved oxygen. Passage problems at diversion dams and hydroelectric facilities also exist on many tributary streams, and at the RBDD. For juveniles, unscreened or inadequately screened water diversions throughout their migration corridors and a scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations, and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to be highly important to the species.

d. Estuarine Areas

Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover such as submerged and overhanging large wood, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are highly important to anadromous species because they function as a transition area between fresh water and the ocean environment.

2. North American Green Sturgeon

The proposed critical habitat the Southern DPS of the North American green sturgeon is the coastal U.S. marine waters out to 110 meters (depth), starting at Monterey Bay (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; the lower Columbia River estuary; and certain coastal bays and estuaries in California (Humbolt Bay), Oregon (Coos Bay, Winchester Bay, and Yaquina Bay), and Washington Bay and Grays Harbor). The areas proposed for designation comprise approximately 325 miles (524 kilometers) of freshwater river habitat, 1058 square miles (2,739 square kilometers) of estuarine habitat, 11,927 square miles (30,890 square kilometers) of marine habitat, and 136 square miles (352) of habitat within the Yolo and Sutter bypasses (Sacramento River, CA).

a. Freshwater Riverine Systems

(1) Food Resources. This PCE includes an appropriate quantity and quality of available food items for larval, juvenile subadult, and adult life stages. Although the Critical Habitat Review Team (CHRT) lacked specific data on food resources for green sturgeon within freshwater riverine systems, juvenile green sturgeon most likely feed on aquatic insect larvae (based on nutritional studies on the closely-related white sturgeon (J.Suart, NMFS, *pers comm.*, 2008). These food resources are important for juvenile foraging, growth, and development during their downstream migration to the Delta and bays. In addition, subadult and adult green sturgeon may forage during their downstream post-spawning migration, while holding within deep pools (Erickson *et al.*, 2002), or on non-spawning migrations within freshwater rivers. Subadult and adult green sturgeon in freshwater rivers most likely feed on benthic prey species similar to those fed on in bays and estuaries, including shrimp, clams, and benthic fish (Molye *et al.*, 1995: Erickon *et al.*, 2002:

Moser and Lindley, 2007; Dumbauld *et al.*, 2008).

(2) Substrate Type or Size. (*i.e.*, structural features of substrates). This PCE includes substrates suitable for egg deposition and development (*e.g.*, bedrock sills and shelves, cobble and gravel, or hard clean sand, with interstices or irregular surfaces to "collect" eggs and provide protection from predators), free from excessive silt and debris that could smother eggs during incubation. Substrates must also be suitable for larval development (*e.g.*, substrates with interstices or voids providing refuge from predators and from high flow velocities), and subadults and adults (*e.g.*, substrates for holding and spawning). For example, spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett et al., 1991; Moyle et al., 1995). Eggs likely adhere to substrates, or settle into crevices between substrates (Deng, 2000; Van Eenennaam *et al.*, 2001; Deng *et al.*, 2002). Both embryos and larvae exhibit a strong affinity for benthic structure during laboratory studies (Van Eenennaam *et al.*, 2001; Deng *et al.*, 2002; Kynard *et al.*, 2005), and may seek refuge within crevices, but prefer flat-surfaced substrates for foraging (Nguyen and Crocker, 2007).

(3) Water Flow. This PCE includes an appropriate flow regime (*i.e.*, the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11 - 19°C) (Cech *et al.*, 2000, cited in COSEWIC, 2004; Mayfield and Cech, 2004; Van Eenennaam *et al.*, 2005; Allen *et al.*, 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs (Deng *et al.*, 2002; Parsley *et al.*, 2002), and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in (and potentially suffocating the eggs (Deng *et al.*, 2002)) and to maintain surfaces for feeding (Nguyen and Crocker, 2007). Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning success is most certainly associated with water flow and water temperature. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 400 m^3/s (average daily water flow during spawning months: 198 - 306 m^3/s; Brown, 2007). Post-spawning downstream migrations are triggered by increased flows, ranging from 174 - 417 m^3/s in the late summer (Vogel, 2005) and greater than 100 m^3/s in the winter (Erickson *et al.*, 2002; Benson *et al.*, 2007).

(4) Water Quality. This PCE includes suitable water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth, and viability of all life stages of green sturgeon. Suitable water temperatures would include: stable water temperatures within spawning reaches (wide fluctuations could increase egg mortality or deformities in developing embryos); temperatures within 11 - 17°C (optimal range = 14 - 16°C) in spawning reaches for egg incubation (March-August) (Van Eenennaam *et al.*, 2005); temperatures below 20°C for larval development (Werner *et al.*, 2007); and temperatures below 24°C for juveniles (Mayfield and Cech, 2004; Allen *et al.*, 2006). Suitable salinity levels range from fresh water (< 3 parts per thousand or 3‰) for larvae and early juveniles (about 100 dph) to brackish water (10‰) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech, 2007). Adequate levels of dissolved oxygen are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1} for juveniles) (Allen and Cech, 2007). Suitable water quality also includes water with acceptably low levels of contaminants (*i.e.*, pesticides, organochlorines, elevated levels of heavy metals, etc.) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Waters free of elevated levels of such contaminants protect green sturgeon from adverse impacts on growth, reproductive development, and reproductive success (*e.g.*, reduced egg size and abnormal gonadal development) likely to result from exposure to contaminants (Fairey *et al.*, 1997; Foster *et al.*, 2001a; Foster *et al.*, 2001b; Kruse and Scarnecchia, 2002; Feist *et al.*, 2005; Greenfield *et al.*, 2005).

(5) Migratory Corridor. An unobstructed migratory pathway is necessary for the safe and timely passage of green sturgeon within riverine habitats and between riverine and estuarine habitats (*e.g.*, an unobstructed river or dammed river that still allows for free passage). Safe and timely passage means that human-induced impediments, either physical, chemical, or biological, do not alter the migratory behavior of the fish such that its survival or the overall viability of the species is compromised (*e.g.*, an impediment that compromises the ability of fish to reach their spawning habitat in time to encounter con-specifics and to reproduce). Unimpeded migratory corridors are necessary for adult green sturgeon to migrate downstream from spawning/rearing habitats within freshwater rivers to rearing habitat within the estuaries. For example, unimpeded passage throughout the Sacramento River up to Keswick Dam (rkm 486) is important, because barriers to passage (*i.e.*, the Red Bluff Diversion Dam , or RBDD, located at rkm 391) could reduce the total spawning area available to green sturgeon, increasing competition for the remaining habitat.

(6) Water Depth. Deep (≥ 5 m) holding pools for both upstream and downstream holding of adult or subadult fish, with adequate water quality and flow is necessary to maintain the physiological needs of the holding adult or subadult fish. Deep pools of ≥ 5 m depth with high associated turbulence and upwelling are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from high water temperatures (Erickson *et al.*, 2002; Benson *et al.*, 2007).

(7) Sediment Quality. Sediment quality (*i.e.*, chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of elevated levels of contaminants (*e.g.*, elevated levels of selenium, polyaromatic hydrocarbons (PAHs), and organochlorine pesticides) that can result in adverse effects on any life stages of green sturgeon. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may adversely affect the growth, reproductive development, and reproductive success of green sturgeon.

b. Estuarine Areas

(1) Food Resources. Abundant food items within estuarine habitats and substrates are necessary for juvenile, subadult, and adult life stages. As described previously, prey species for juvenile, subadult, and adult green sturgeon within bays and estuaries primarily consist of benthic invertebrates and fish, including crangonid shrimp, burrowing thalassinidean shrimp, amphipods, isopods, clams, annelid worms, crabs, sand lances, and anchovies. These prey species are critical for the rearing, foraging, growth, and development of juvenile, subadult, and adult green sturgeon within the bays and estuaries.

(2) Water Flow. Within bays and estuaries adjacent to the Sacramento River (*i.e.*, the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds. Sufficient flows are needed to attract adult green sturgeon to the Sacramento River to initiate the upstream spawning migration (Kohlhorst *et al.*, 1991, cited in CDFG, 2002; Kohlhorst *et al.*, 1991, cited in CDFG, 2002; J.Suart, NMFS, *pers comm.*, 2008).

(3) Water Quality. Suitable water quality, including temperature, salinity, oxygen content, and other chemical characteristics, are necessary for normal behavior, growth, and viability of all life stages. Suitable water temperatures for juvenile green sturgeon should be below 24°C. At temperatures above 24°C, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and Cech, 2004) and increased cellular stress (Allen *et al.*, 2006). Suitable salinities range from brackish water (10‰) to salt water (33‰). Juveniles transitioning from brackish to salt water can tolerate prolonged exposure to salt water salinities, but may exhibit decreased growth and activity levels (Allen and Cech, 2007), whereas subadults and adults tolerate a wide range of salinities (Kelly *et al.*, 2007). Subadult and adult green sturgeon occupy a wide range of dissolved oxygen levels, but may need a minimum dissolved oxygen level of at least 6.54 mg 0_2/l (Kelly *et al.*, 2007; Moser and Lindley, 2007). As described above, adequate levels of dissolved oxygen are also required to support oxygen consumption by juveniles (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1}) (Allen and Cech, 2007). Suitable water quality also includes waters with acceptably low levels of contaminants (e.g., pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal development of juvenile life stages, or the growth, survival, or reproduction of subadult or adult stages.

(4) Migratory Corridor. An unobstructed migratory pathway is necessary for the safe and timely passage of green sturgeon within estuarine habitats. Safe and timely passage means that human-induced impediments, either physical, chemical, or biological, do not alter the migratory behavior of the fish such that its survival or the overall viability of the species is compromised (*e.g.*, an impediment that compromises the ability of fish to reach their spawning habitat in time to encounter con-specifics and to reproduce). Within the bays and estuaries adjacent to the Sacramento River, unobstructed passage is needed for juvenile green sturgeon to migrate from the river to the bays and estuaries and eventually out into the ocean. Passage within the bays and the Delta is also critical for adults and subadults for feeding and summer holding, as well as to access the Sacramento River for their upstream spawning migrations and to make their outmigration back into the ocean. For bays and estuaries outside of the Delta and the Suisun, San Pablo, and San

Francisco bays, unobstructed passage is necessary for adult and subadult green sturgeon to access feeding areas, holding areas, and thermal refugia, and to ensure passage back out into the ocean.

(5) ***Water Depth.*** This PCE includes a diversity of depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Subadult and adult green sturgeon occupy a diversity of depths within bays and estuaries for feeding and migration. Tagged adults and subadults within the San Francisco Bay estuary primarily occupied waters over shallow depths of less than 10 m, either swimming near the surface or foraging along the bottom (Kelly *et al.*, 2007). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 1 – 3 meters deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke, 1966). Thus, a diversity of depths is important to support different life stages and habitat uses for green sturgeon within estuarine areas.

(6) ***Sediment Quality.*** This PCE includes sediment quality (*i.e.*, chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of elevated levels of contaminants (*e.g.*, elevated levels of selenium, PAHs, and organochlorine pesticides) that can cause adverse effects on all life stages of green sturgeon (see description of *Sediment quality* for riverine habitats above).

c. Coastal Marine Areas

(1) ***Migratory Corridor.*** Unobstructed passage within coastal marine waters is critical for subadult and adult green sturgeon to access oversummering habitats within coastal bays and estuaries and overwintering habitat within coastal waters between Vancouver Island, BC, and southeast Alaska. Passage is also necessary for subadults and adults to migrate back to San Francisco Bay and to the Sacramento River for spawning.

(2) ***Water Quality.*** This PCE includes coastal marine waters with adequate dissolved oxygen levels and with acceptably low levels of contaminants (such as pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon. Based on studies of tagged subadult and adult green sturgeon in the San Francisco Bay estuary, CA, and Willapa Bay, WA, subadults and adults may need a minimum dissolved oxygen level of at least 6.54 mg 0_2/l (Kelly *et al.*, 2007; Moser and Lindley, 2007). As described above, exposure to, and bioaccumulation of contaminants may adversely affect the growth, reproductive development, and reproductive success of subadult and adult green sturgeon. Thus, waters free of elevated levels of such contaminants are required for the normal development of green sturgeon for optimal survival and spawning success.

(3) ***Food Resources.*** This PCE includes abundant food items for subadults and adults, which likely include benthic invertebrates and fish. Green sturgeon spend most of their lives in marine and estuarine waters along the coast. Abundant food resources are important to support subadults and adults over long-distance migrations, and may be one of the factors attracting green sturgeon to habitats far to the north (off the coast of Vancouver Island and Alaska) and to the south

(Monterey Bay, CA, and off the coast of southern California) of their natal habitat. Although data on prey species in coastal marine waters is lacking, prey species likely include benthic invertebrates and fish species similar to those fed upon by green sturgeon in bays and estuaries (e.g., shrimp, clams, crabs, anchovies, sand lances).

C. Factors Affecting the Species and Critical Habitat

1. Sacramento River Winter-run Chinook Salmon, Central Valley Steelhead, and Spring-run Chinook Salmon

A number of documents reviewed by NMFS for this biological opinion address the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley. For example, NMFS prepared range-wide status reviews for west coast Chinook salmon (Myers *et al.* 1998) and steelhead (Busby *et al.* 1996). Also, the NMFS Biological Review Team (BRT) published a draft updated status review for west coast Chinook salmon and steelhead in November 2003 (NMFS 2003b), and an additional updated and final draft in 2005 (Good *et al.* 2005). NMFS also assessed the factors for Chinook salmon and steelhead decline in supplemental documents (NMFS 1996, 1998). Information also is available in Federal Register notices announcing ESA listing proposals and determinations for some of these species and their critical habitat (*e.g.*, 58 FR 33212; 59 FR 440; 62 FR 24588; 62 FR 43937; 63 FR 13347; 64 FR 24049; 64 FR 50394; 65 FR 7764). The Final Programmatic Environmental Impact Statement/Report (EIS/EIR) for the CALFED Program (CALFED 2000), and the Final Programmatic EIS for the CVPIA provide a summary of historical and recent environmental conditions for salmon and steelhead in the Central Valley. The following general description of the factors affecting Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, and their critical habitat is based on a summarization of these documents.

In general, the human activities that have affected listed anadromous salmonids and the PCEs of their critical habitats consist of: (1) the destruction, modification, or curtailment of habitat or range; (2) over-utilization; (3) disease and predation; (4) the inadequacy of existing regulatory mechanisms; and (5) other natural and manmade factors, including habitat and ecosystem restoration, and global climate change. All of these factors have contributed to the ESA-listing of these fish and deterioration of their critical habitat. However, it is widely recognized in numerous species accounts in the peer-reviewed literature that the modification and curtailment of habitat and range have had the most substantial impacts on the abundance, distribution, population growth, and diversity of salmonid ESUs. Although habitat and ecoystem restoration has contributed to population stability and increases in abundance throughout the ESUs, global climate change remains a looming threat.

a. Modification and Curtailment of Habitat and Range

Modification and curtailment of habitat and range from hydropower, flood control, and consumptive water use have permanently blocked or hindered salmonid access to historical spawning and rearing grounds resulting in the complete loss of substantial portions of spawning, rearing, and migration PCEs. Clark (1929) estimated that originally there were 6,000 linear miles of salmon habitat in the Central Valley system and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 linear miles of salmon habitat actually was available before dam construction and mining, and concluded that 82 percent is not accessible today. Yoshiyama *et al.* (1996) surmised that steelhead habitat loss was even greater than salmon loss, as steelhead migrated farther into drainages. In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and the Delta block salmon and steelhead access to the upper portions of their respective watersheds. The loss of upstream habitat has required Chinook salmon and steelhead to use less hospitable reaches below dams. The loss of substabtial habitat above dams also has resulted in decreased juvenile and adult salmonid survival during migration, and in many cases, has resulted in the dewatering and loss of important spawning and rearing habitats.

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted stream flows and altered the natural cycles by which juvenile and adult salmonids have evolved. Changes in stream flows and diversions of water affect spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and IWM. More uniform flows year-round have resulted in diminished natural channel formation, altered food web processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bedload movement, caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat below dams.

Water withdrawals, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al.* 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). High water temperatures in the Sacramento River have limited the survival of young salmon.

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of channels and diversions to increase channel elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects that have diminished conditions for adult and juvenile migration and survival.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization, and riprapping, include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features (Stillwater Sciences 2006). These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling *et al.* 2001, Garland *et al.* 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

Large quantities of downed trees are a functionally important component of many streams (NMFS 1996). Large woody debris influences channel morphology by affecting longitudinal profile, pool formation, channel pattern and position, and channel geometry. Downstream transport rates of sediment and organic matter are controlled in part by capture of this material within and behind large wood. Large wood affects the formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (NMFS 1996). Wood enters streams inhabited by salmonids either directly from adjacent riparian zones or from riparian zones in adjacent non-fish bearing tributaries. Removal of riparian vegetation and instream woody material (IWM) from the streambank results in the loss of a primary source of overhead and instream cover for juvenile salmonids. The removal of riparian vegetation and IWM and the replacement of natural bank substrates with rock revetment can adversely affect important ecosystem functions. Living space and food for terrestrial and aquatic invertebrates is lost, eliminating an important food source for juvenile salmonids. Loss of riparian vegetation and soft substrates reduces inputs of organic material to the stream ecosystem in the form of leaves, detritus, and woody debris, which can affect biological production at all trophic levels. The magnitude of these effects depends on the degree to which riparian vegetation and natural substrates are preserved or recovered during the life of the project.

In addition, the armoring and revetment of stream banks tends to narrow rivers, reducing the amount of habitat per unit channel length (Sweeney *et al.* 2004). As a result of river narrowing, benthic habitat decreases and the number of macroinvertebrates, such as stoneflies and mayflies, per unit channel length decreases affecting salmonid food supply.

b. *Ecosystem Restoration*

The CVPIA, enacted in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the Central Valley Project. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screening Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward doubling the natural populations of select anadromous fish species residing in the Central Valley.

Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines Federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the Department of Interior's ability to meet regulatory water quality requirements. Water acquisition has been used successfully to improve fish habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

Two programs included under CALFED; the Ecosystem Restoration Program (ERP) and the EWA, were created to improve conditions for fish, including listed salmonids, in the Central Valley. Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids and emphasis has been placed in tributary drainages with high potential for Central Valley steelhead and Central Valley spring-run Chinook salmon production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat restoration initiatives sponsored and funded primarily by the CALFED-ERP have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids.

The California Department of Water Resources' (CDWR) Four Pumps Agreement Program has provided approximately $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreements inception in 1986. Four Pumps projects that benefit Central Valley spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer Creeks; enhanced law enforcement efforts from San Francisco Estuary upstream to the Sacramento and San Joaquin Rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and, screening of diversions in Suisun Marsh and San Joaquin tributaries. Predator habitat isolation and removal, and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead.

c. *Climate Change*

The world is about 1.3 °F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (Intergovernmental Panel on Climate Change [IPCC] 2001). Much of that increase will likely occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data Huang and Liu (2000) estimated a warming of about 0.9 °F per century in the Northern Pacific

Ocean.

An alarming prediction is that Sierra snow packs are expected to decrease with global warming and that the majority of runoff in California will be from rainfall in the winter rather than from melting snow pack in the mountains (CDWR 2006). This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt dominated system to a winter rain dominated system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This should truncate the period of time that suitable cold-water conditions exist below existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold-water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures below reservoirs, such as Lake Shasta, potentially could rise above thermal tolerances for juvenile and adult salmonids (*i.e.* Sacramento River winter-run Chinook salmon and Central Valley steelhead) that must hold below the dam over the summer and fall periods.

2. Critical Habitat for Salmonids

According the NMFS CHART report (2005b) the major categories of habitat-related factors affecting Central Valley salmonids include: (1) irrigation impoundments and withdrawals (2) channel modifications and levee maintenance, (4) the presence and operation of hydroelectric dams, (5) flood control and streambank stabilization, and (6) exotic and invasive species introductions and management. All of these factors affect PCEs via their alteration of one or more of the following: stream hydrology, flow and water-level modification, fish passage, geomorphology and sediment transport, temperature, DO levels, nearshore and aquatic vegetation, soils and nutrients, physical habitat structure and complexity, forage, and predation (Spence *et al.* 1996). According to the NMFS CHART report (2005b), the condition of critical habitat varies throughout the range of the species. The condition of existing spawning habitat ranges from moderate to high quality, with the primary threats including changes to water quality, and spawning gravel composition from rural, suburban, and urban development, forestry, and road construction and maintenance. Downstream, river and estuarine migration and rearing corridors range in condition from poor to high quality depending on location. Tributary migratory and rearing corridors tended to rate as moderate quality due to threats to adult and juvenile life stages from irrigation diversion, small dams, and water quality. Delta (*i.e.*, estuarine) and mainstem Sacramento and San Joaquin river reaches tended to range from poor to moderately-high quality, depending on location. In the alluvial reach of the Sacramento River between Red Bluff and Colusa, the PCEs of rearing and migration habitat are in better conditions than the lower river because, despite the influence of upstream dams, this reach retains natural, and functional channel processes that maintain and develop anadromous fish habitat. The river reach downstream from Colusa and including the Delta is poor in quality due to impaired hydrologic conditions from dam operations, water quality from agriculture, degraded nearshore and riparian habitat from levee construction and maintenance, and habitat loss and fragmentation.

Although there are degraded habitat conditions within the action area, NMFS considers the value of this area for the conservation of the species to be high because its entire length is used for migration and rearing during extended periods of time by a large proportion of all Federally listed anadromous fish species in the Central Valley. NMFS considers an area to be of high value, regardless of its current conservation condition, where the area's habitat PCEs are highly valuable to the ESUs that depend on that area.

3. Southern Distinct Population Segment of North American Green Sturgeon

The principal factors for the decline in the southern DPS of North American green sturgeon are reviewed in the proposed listing notice (70 FR 17386) and status reviews (Adams *et al.* 2002, NMFS 2005a), and primarily consist of: (1) the destruction, modification, or curtailment of habitat or range; (2) poor water quality; (3) over-utilization; (4) increased water temperatures; (5) non-native species, and (6), other natural and manmade factors, including habitat and ecosystem restoration, and global climate change.

NMFS (2005a) concluded that the principle threat to green sturgeon is impassible barriers, primarily Keswick and Shasta Dams on the Sacramento River and Oroville Dam on the Feather River that likely block and prevent access to historic spawning habitat (NMFS 2005a). Spawning habitat may have extended up into the three major branches of the Sacramento River; the Little Sacramento River, the Pit River system, and the McCloud River (NMFS 2005a). In contrast, recent modeling evaluations by Mora (2006) indicate little or no habitat in the little Sacramento River or the Pit River exists above Shasta dam; however, a considerable amount of habitat exists above Shasta on the mainstem Sacramento River. Green and white sturgeon adults have been observed periodically in the Feather and Yuba River (USFWS 1995, Beamesderfer *et al.* 2004, Jeff McLain, NMFS, pers. comm., 2006) and habitat modeling my Mora (2006) suggests there is appropriate habitat above Oroville Dam. There are no records of larval or juvenile white or green sturgeon being captured on the Feather River; however, there are reports that green sturgeon may reproduce in the Feather River during high flow years (CDFG 2002), but these are unconfirmed.

No green sturgeon have been documented in the San Joaquin River; however, the presence of white sturgeon has been documented (USFWS 1995, Beamesderfer *et al.* 2004) making the historical presence of green sturgeon likely as the two species require similar habitat and their ranges overlap in the Sacramento River. Habitat modeling by Mora (2006) also suggests sufficient conditions are present in the San Joaquin River to Friant Dam, and in the Stanislaus, Tuolumne, and Merced Rivers to the dams. In addition, the San Joaquin River had the largest spring-run Chinook salmon population in the Central Valley prior to the construction of Friant Dam (Yoshiyama *et al.* 2001) with escapements approaching 500,000 fish. Thus it is very possible, based on prior spring-run Chinook salmon distribution and habitat use of the San Joaquin River, that green sturgeon were extirpated from the San Joaquin basin in a similar manner to spring-run Chinook salmon. The loss of potential green sturgeon spawning habitat on the San Joaquin River also may have contributed to the overall decline of the southern DPS of North American green sturgeon.

The potential effects of climate change were discussed in the Chinook Salmon and Central Valley Steelhead sections and primarily consist of altered ocean temperatures and stream flow patterns in the Central Valley. Changes in Pacific Ocean temperatures can alter predator prey relationships and affect migratory habitat of the southern DPS of North American green sturgeon. Increases in rainfall and decreases in snow pack in the Sierra Nevada range will affect cold-water pool storage in reservoirs affecting river temperatures. As a result, the quantity and quality of water that may be available to maintain habitat for the southern DPS of North American green sturgeon will likely significantly decrease.

4. Critical Habitat for Southern Distinct Population Segment of North American Green Sturgeon

According the to NMFS CHRT report for green sturgeon (2008) the major categories of habitat-related impacts affecting southern DPS of North American Green sturgeon include: (1) Concentration of spawning for the entire DPS into, a single river reach increasing the risk of catastrophic extinction; (2) loss of spawning habitat in the upper Sacramento and Feather rivers due to migration barriers; (3) a general lack of population data, but suspected small population size; (4) entrainment by water project operations; (5) potentially limiting or lethal water temperatures; (6) commercial and recreational fisheries harvest; and (7) toxins and exotic species. All of these issues affect PCEs via their alteration of one or more of the following: fish passage, temperature, nutrients, physical habitat structure and complexity, forage, and predation (Biological Review Team (BRT) 2005). The condition of critical habitat varies throughout the range of the species (NMFS CHRT report 2008). The condition of existing spawning habitat ranges from moderate to high quality with the primary threats including passage barriers and poor water quality. Downstream, river and estuarine migration and rearing corridors range in condition from ultra low to high quality, depending on location. Tributary migratory and rearing corridors tended to rate as moderate quality due to the current conditions and efforts to improve habitat by on-going restoration projects. The mainstem Sacramento and San Joaquin delta was identified as an important area for juvenile feeding, rearing, and growth prior to ocean migration, and as an important transition zone between the freshwater and ocean environments.

Although there are degraded habitat conditions within the action area, NMFS considers the importance of this area for the conservation of the species to be medium and possibly high because its entire length is used for migration and off-channel rearing/feeding during high flow events.

IV. ENVIRONMENTAL BASELINE

The environmental baseline "includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR §402.02).

A. Status of the Listed Species within the Action Area

1. Status of the Species within the Action Area

The action area functions as a migratory corridor for adult Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, and provides migration and rearing habitat for juveniles of these species. The action area also functions as a migratory and holding corridor for adult North American green sturgeon and as rearing and migratory habitat for juvenile North American green sturgeon. Because the general status is provided in detail in the preceding section, this section has been condensed, and will concentrate primarily on which populations are expected to utilize the action area and the timing of that expected utilization.

a. *Sacramento River Winter-run Chinook Salmon*

The entire in-river population of winter-run Chinook salmon (both adults and juveniles) is expected to pass through the action area due to its location downstream of the only remaining spawning area for this ESU. Adult Sacramento River winter-run Chinook salmon are expected to be present in the Sacramento River between November and June (Myers *et al.* 1998, Good *et al.* 2005) as they migrate to spawning grounds. Winter-run Chinook salmon primarily spawn in the mainstem Sacramento River between Keswick Dam (RM 302) and RBDD (RM 243) from late-April to mid-August. Winter-run Chinook salmon fry and juvenile emigration past RBDD occurs from July through March (Reclamation 1992). Juvenile emigration past Knights Landing reportedly occurs between November and March, peaking in December with some emigration continuing through May in some years (Snider and Titus 2000). Juvenile winter-run Chinook salmon may exhibit a sustained residence in the middle or lower Sacramento River or upper Delta prior to seaward migration. The location and extent of this rearing area is related to the magnitude of river flows during the rearing period (Stevens 1989). It is probable that winter-run Chinook salmon juveniles rear within that portion of the Sacramento River covered by the ABFS Proposed Action.

The USFWS conducted seining surveys in the vicinity of the project area at several locations in the Sacramento River (*i.e.*, Verona at RM 80, Elkhorn at RM 71, Discovery Park at RM 60, Sand Cove at 62, and Knights Landing RM 89.5). USFWS seining surveys did not distinguish between specific Chinook salmon runs. However, the results of the USFWS (2002a) seining surveys suggested that the greatest abundance of juvenile Chinook salmon occurs at the Elkhorn site during the months of February and March. Peaks in abundance at the Verona and Discovery Park sites also occurred during these months. A relatively short residence period for the juveniles in the ABFS Action Area is apparent, with over 95 percent of the peak at the three sites from which the majority of the data were obtained (Verona, Elkhorn, and Discovery Park) occurring between

January and April. In the 2006 and 2007 USFWS seining surveys, juvenile Chinook salmon were caught at Discovery Park, Sand Cove, Elkhorn and Verona. The highest number of juvenile Chinook salmon caught among the four sites occurred at Discovery Park in 2006 and at Verona and Elkhorn in 2007 (data available at http://bdat.ca.gov).

b. *Central Valley Spring-run Chinook Salmon*

Spring-run Chinook salmon immigration through the lower Sacramento River reportedly occurs from March through July (Deas *et al.* 1997). Spring-run Chinook salmon spawn in the upper portions of the Sacramento River and its tributaries from mid-August through early October (CDFG 1990). Spring-run Chinook salmon may emigrate as post-emergent fry (i.e., individuals less than 45 millimeters [mm] [1.77 inches] length), or rear in the upper Sacramento River and tributaries during the winter and spring, and emigrate as juveniles (i.e., individuals greater than 45 mm in length, but not having undergone smoltification) or smolts (silvery-colored fingerlings having undergone the smoltification process in preparation for ocean entry). The timing of juvenile emigration from the spawning and rearing grounds varies among the tributaries of origin, and can occur during the period extending from November to early May (CDFG 1998, NMFS 2004).

As previously discussed, the results of the USFWS (2002a) seining surveys suggest that the greatest abundance of juvenile Chinook salmon occurs at the Elkhorn site during the months of February and March. Peaks in abundance at the Verona and Discovery Park sites also occurred during these months. A relatively short residence period for the juveniles in the ABFS Action Area is apparent, with over 95 percent of the peak at the three sites from which the majority of the data were obtained (Verona, Elkhorn, and Discovery Park) occurring between January and April. In the 2006 and 2007 USFWS seining surveys, juvenile Chinook salmon were caught at Discovery Park, Sand Cove, Elkhorn and Verona. The highest number of juvenile Chinook salmon caught among the four sites occurred at Discovery Park in 2006 and at Verona and Elkhorn in 2007 (data available at http://bdat.ca.gov).

c. *Central Valley Steelhead*

Hallock *et al.* (1961) found that adult steelhead migrate into the upper Sacramento River during most months of the year. They begin moving through the mainstem of the Sacramento River in July, peak near the end of September, and continue migrating through February or March (Bailey 1954, Hallock *et al.* 1961). RBDD counts from 1969 through 1982 follow this same temporal distribution, although some fish were counted during April and May (Hallock 1989). McEwan (2001) reported that the period of steelhead adult immigration in the Central Valley extends from September through March. Central Valley steelhead spawn mainly from January through March, but spawning can begin as early as the latter part of December, and can extend through April (Hallock *et al.* 1961). Juvenile steelhead rear in their natal streams for one to two years prior to emigration, then migrate to the ocean in spring and early summer, with peak migration through the Delta in March and April (Reynolds *et al.* 1993).

The lower Sacramento River serves primarily as a migration corridor for steelhead. CDFG has conducted rotary screw trap (RST) and trawl emigration surveys of juvenile anadromous salmonids in the lower Sacramento River at Knights Landing (RM 89.5) since the fall of 1995. In the three years of reported emigration data (i.e., 1995-1996, 1996-1997, and 1997-1998), four different life stages or age groups of steelhead have been captured at Knights Landing (i.e., adult, young-of-the-year, yearlings, and two-year-old smolts). In each year, less than one percent were captured in December, 10 to 61 percent in January, 5 to 41 percent in February, 3 to 70 percent in March, 3 to 22 percent in April, and 3 to 10 percent in May. Young steelheads were not typically found after May (CDFG 1998b).

Juvenile rainbow trout/steelhead[1] were captured in each of the USFWS seine survey between 1995 and 2004. Captures of non-hatchery origin fish occurred exclusively between January and April. Most rainbow trout/steelhead were captured at Verona, although counts at Elkhorn were similar but lower. Few rainbow trout/steelhead were captured at Discovery Park and Sand Cove. USFWS surveys in 2006 captured no rainbow trout or steelhead at Discovery Park, Sand Cove, Elkhorn or Verona. In 2007 two rainbow trout/steelhead were caught at Discovery Park in April, while none were caught at Sand Cove, Elkhorn or Verona (data available at http://bdat.ca.gov).

2. Status of Critical Habitat Within the Action Area

The action area is within designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead and is proposed critical habitat for southern DPS North American green sturgeon. Habitat requirements for these species are similar. The PCEs of salmonid habitat within the action area include: freshwater rearing habitat and freshwater migration corridors containing adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions. Habitat within the action area is primarily used for juvenile and smolt freshwater rearing and migration and for adult freshwater migration. The condition and function of this habitat has been severely impaired through several factors such as constriction of the river through a levee system for flood control, loss of riparian vegetation and SRA habitat due to armoring of the banks, depletion of river flows through diversions and human consumption, and degraded water quality from agricultural practices and increased urban development. The result has been the reduction in quantity and quality of several essential elements of migration and rearing habitat required by juvenile anadromous fish to grow and survive.

Specifically, there is a total of 1.29 acres of thin, semi-continuous strip of riparian vegetation and 0.26 acre of SRA habitat on the east side of the Sacramento River within the ABFS Action Area. The steeply sloped banks in the ABFS Action Area create little shallow water habitat, decreasing the suitability of the area for rearing juvenile salmonids. Additionally there is very little instream woody debris present within the ABFS Action Area. A survey conducted within the ABFS Action

[1] USFWS surveys did not differentiate between rainbow trout and steelhead, therefore the number of rainbow trout captured and the number of steelhead captured were combined into one number.

Area (at RM 74.6) in 2003 found that the shoreline was devoid of IWM, and the banks sloped steeply towards the Sacramento River. At this location large trees (i.e., >24 inch diameter at breast height) and other overhanging woody vegetation along the river bank provide shade near the water's edge. The survey indicated that the existing overhead riparian canopy extends above a narrow open water area of the river, shading approximately 90 percent of littoral habitat within five to 10 feet of the shoreline, and can extend shading in sections of the river channel up to approximately 20 feet. In spite of the degraded condition of this habitat, the conservation value of the action area is high because its entire length could be used for extended periods of time for adult refugia during migration.

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted streamflows and altered the natural cycles by which juvenile and adult salmonids have evolved. Changes in streamflows and diversions of water affect freshwater rearing habitat and freshwater migration corridor PCEs in the action area. Various land-use activities in the action area such as urbanization and agricultural encroachment have resulted in habitat simplification. Runoff from upstream residential and industrial areas also contributes to water quality degradation (California RWQCB1998). Urban stormwater runoff contains pesticides, oil, grease, heavy metals, polynuclear aromatic hydrocarbons, other organics and nutrients (California RWQCB 1998) that contaminate drainage waters and destroy aquatic life necessary for salmonid survival (NMFS 1996). In addition, juvenile salmonids are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges in the action area.

3. <u>Status of Southern DPS of North American Green Sturgeon in the Action Area</u>

Little information is available, on the life stage-specific environmental requirements of this species in the Sacramento River, probably due to its low abundance, limited spawning range, and low commercial and sport fishing value. Nevertheless, spawning populations have been identified in the Sacramento River (Beak Consultants 1993), and most spawning is believed to occur in the upper Sacramento River up to Keswick Dam. It is further believed that the life history periodicity of green sturgeon in the Sacramento River is similar to that of green sturgeon in the Klamath River system (USFWS 1994a *in* EDAW and SWRI 1999).

USFWS seining surveys between 1995 and 2004 for locations in and around the ABFS Action Area did not record green sturgeon (California Environmental Data Exchange Network [CEDEN] 2005). Furthermore, green sturgeon were not recorded during USFWS beach seining surveys conducted from 1976 to 2004 at one or more sites (i.e., Elkhorn, Discovery Park, Sand Cove, Verona, and Knights Landing) in, and around, the ABFS Action Area.

B. Factors affecting species and critical habitat within the action area

1. <u>Altered Flows and Temperatures</u>

The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs affecting listed salmonids in the action area. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks. Consequently, the mainstream of the river often remains too high and turbid to provide quality rearing habitat.

2. Levies and Bank Stabilization

The reach of the Sacramento River downstream of Verona (RM 80-0) is the most ecologically degraded of the three reaches (RM 80-0, RM 143-80 and RM 185-143) that have been altered by bank protection and riprapping activities (USFWS 2000). The use of riprap in streams has been shown to affect natural river processes and functions by:

- Reducing recruitment of spawning gravels for salmonids;
- Halting new accretion of point bars and other deposition areas where riparian vegetation can colonize (CDWR 1994);
- Preventing meander migration (CDWR 1994), which over time, reduces habitat renewal, diversity, and complexity (National Research Council 1996);
- Incising the thalweg of the river adjacent to the riprap lined area (CDWR 1994);
- Filling in sloughs, tributary channels, and oxbow lake areas, causing loss of nearby wetland habitat and diversity;
- Limiting lateral mobility of the channel (National Research Council 1996), potentially reducing habitat complexity, including small backwaters and eddies (Bisson *et al.* 1987; Gregory *et al.* 1991);
- Decreasing near-shore roughness, causing stream velocity to increase at a high rate with increasing discharge (Sedell *et al.* 1990), potentially causing accelerated erosion of earthen banks downstream;
- Reducing the contribution of allochthonous material (rock material from upstream) to the stream by inhibiting plant growth adjacent to the stream; and
- Reducing recruitment of IWM to the stream system (Hicks *et al.* 1991), potentially resulting in a range of negative effects (USFWS 2000).

This reach is also narrowly constrained by levees (USFWS 2000), which prevents the river from overflowing its banks and creating productive floodplain habitat. The reach has undergone large losses of riparian and wetland habitat. The existing condition of the berm continues to degrade and erode. (USFWS 2000).

The portion of the Sacramento River within the ABFS Action Area is located just downstream of Verona (RM 80). The east and west banks of the action area, where construction activities have occurred and are scheduled to occur upstream and downstream of the proposed diversions, have been levied and artificially stabilized, and have lost the natural riverine morphology found on the opposite bank. Bank protection and levies can cause adverse effects to anadromous fish and their habitat. The effects of bank protection projects on anadromous fish have been thoroughly studied (USFWS 2000, Schmetterling *et al.* 2001, Garland *et al.* 2002), and modeled (Corps 2004, Stillwater Sciences 2006). Bank protection projects affect salmonid habitat availability and the processes that develop and maintain preferred habitat by reducing floodplain connectivity, changing riverbank substrate size, and decreasing riparian habitat and SRA habitat. Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes reduce habitat quality along the shoreline by eliminating the shallow, slow-velocity river margins preferred by juvenile fish as refuge and escape from fast currents, deep water, and predators.

Presently, the Natomas Levee Improvement Project and the Sacramento River Bank Protection Project are being developed and reviewed. The planning for these two projects has involved the development of alternative levee repair designs and conservation measures to minimize the loss of SRA habitat as well as other impacts of the projects resulting from the utilization of riprap as a means for levee repairs and flood control.

3. Water Contaminants and Pollution

The Sacramento River at the proposed Sankey (RM 78.3) and Elkhorn (RM 73.3) diversion sites is bordered by agricultural lands. The southern end of the Natomas basin supports a growing community of housing and business development, which are sources of point source and non-nonpoint pollution discharge. Point source and non-point source pollution resulting from agricultural discharge and urban and industrial development has impacts and effects that are discussed in detail in the *Status of the Species and Habitat* section. Environmental stresses resulting from poor water quality can lower reproductive success and may account for low productivity rates of salmonids and green sturgeon (Klimley 2002). Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high trace element concentrations may deleteriously affect early life-stage survival of fish in the Sacramento River (USFWS 1995).

The existing unscreened diversions in the action area on the Sacramento River pose a potential threat to the listed salmonids and green sturgeon. Until the diversions are decommissioned and the new diversions with fish screens are constructed, NMFS assumes listed fish species will continue to be susceptable to entrainment from these diversion facilities drawing water from the bottom and top of the water column.

C. Likelihood of species survival and recovery in the action area

Because the action area does not provide spawning habitat for any particular population of the listed ESUs/DPSs, but instead acts as rearing and migrational habitat for the majority of the fish that make up these ESUs/DPSs, the likelihood of survival and recovery of these fish in the action area is directly linked to the likelihood of survival and recovery of the overall ESUs/DPSs in the Sacramento River watershed. In their recent evaluation of the viability of Central Valley salmonids, Lindley et al. (2007) found that the remaining population of Sacramento River winter-run Chinook salmon and three populations of Central Valley spring-run Chinook salmon appear to be fairly viable. These populations meet several viability criteria including population size, growth, and risk from hatchery strays. However, the viability of the ESUs to which these populations belong appears low to moderate, as the ESUs remain vulnerable to extirpation due to their limited spatial distribution, low diversity, and potential for being affected by a significant catastrophic event.

Lindley et al. (2007) were not able to determine the viability of existing steelhead populations, but believe that the DPS has a moderate to high risk of extinction since most of the historic habitat is inaccessible due to dams, the remaining accessible habitat has been severely degraded by human activities, and the anadromous life-history strategy is being replaced by residency.

Recent population estimates for the southern DPS of North American green sturgeon indicate that there are few fish relative to historic conditions, and that loss of habitat has affected population size and distribution. However, the southern DPS of North American green sturgeon remain widely distributed along the Pacific coast from California to Washington, and recent findings of fish in the Feather and the Yuba River indicate that their distribution in the Central Valley may be more broad than previously thought. This suggests that the DPS probably meets several viable species population criteria for distribution and diversity, and indicates that the southern DPS of North American green sturgeon faces a low to moderate risk of extinction.

V. EFFECTS OF THE ACTION

A. Approach to the Assessment

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species. This biological opinion assesses the effects of the proposed action on endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, their designated critical habitat, and threatened southern DPS of North American green sturgeon.

In the *Description of the Proposed Action* section of this biological opinion, NMFS provided an overview of the action. In the *Status of the Species* and *Environmental Baseline* sections of this biological opinion, NMFS provided an overview of the threatened and endangered species and critical habitat that are likely to be adversely affected by the activity under consultation.

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if Federal actions would destroy or adversely modify the conservation value of critical habitat (16 U.S.C. §1536).

NMFS generally approaches "jeopardy" analyses in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of proposed actions on individual members of listed species or aspects of the species' environment These effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment (*i.e.,* reducing a species' prey base, enhancing populations of predators, altering its spawning substrate, altering its ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or a sound). Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (*i.e.,* by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

To evaluate the effects of the proposed action, NMFS examined the proposed construction activities, O&M activities, habitat loss, and conservation measures, to identify likely impacts to listed anadromous salmonids and sturgeon within the action area based on the best available information.

The information used in this assessment includes fishery information previously described in the *Status of the Species* and *Environmental Baseline* sections of this biological opinion; studies and accounts of the impacts of construction and operation activities involving unscreened and screened diversion on anadromous fish; and documents prepared in support of the proposed action, including the February 2008 draft ASIP for the proposed project (Reclamation 2008) and the draft EIR/EIS (Reclamation 2007).

In the absence of definitive data or conclusive evidence, NMFS will make a logical series of assumptions to overcome the limits of the available information. These assumptions will be made using sound, scientific reasoning that can be logically derived from the available information. The progression of the reasoning will be stated for each assumption, and supporting evidence cited.

B. Assessment

The effects of the ABFS project fall into two categories: short-term construction related effects and persistent long-term effects of the two screened diversion operations. Construction effects will primarily be related to the acoustic impacts of the installation of the coffer dam for the two new screened diversion construction and associated fish rescue to remove fish from the coffer dam. The long-term operation of the two screened diversions is expected to decrease the entrainment of listed species during the operation of the diversion pumps.

The assessment will consider the nature, duration, and extent of the effects of the proposed action relative to the migration timing, behavior, and habitat requirements of Federally listed Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon and the magnitude, timing, frequency, and duration of project impacts to these listed species. Specifically, this assessment will consider the potential impacts related to construction (short-term) and operation (long-term) activities.

The project is downstream from the spawning habitat of Chinook salmon, steelhead, and the Southern DPS of North American green sturgeon. Therefore, no short- or long-term effects on spawning habitat are expected.

1. <u>Construction Effects</u>

The proposed in-water activities and construction activities continuing behind the cofferdam are expected to be conducted between July 1 and November 30. The construction site is in an area where salmon, steelhead, and green sturgeon are likely to be present during the construction period. The effects would be short-term and temporary to listed species and their habitat. The in-water construction activities particularly the installation and removal of the coffer dam with a vibratory hammer could result in direct effects to juvenile salmon and adult and juvenile green sturgeon as described below.

The primary migration period of juvenile winter-run Chinook salmon through the action area occurs between December and April, with the highest concentrations in the action area during the months of February and March, though a small number may be present in November, at the tail end of the construction period (CEDEN 2005). Green sturgeon larvae and post-larvae may be present in the action area throughout the construction period, but are most abundant during June and July (CDFG 2002), and would therefore be most heavily affected by activities occurring during the first month of construction (July). Although the proposed instream construction period avoids the primary emigration periods for juvenile spring-run Chinook salmon and steelhead, a small proportion of emigrating and rearing juveniles of these species may linger in the action area throughout the summer, and there remains the potential for very small numbers of these fish to be present in the action area during the construction period. Adult winter- and spring-run Chinook salmon are not expected to be present in the action area during the instream construction activities. However, adult green sturgeon primarily migrate through the action area between March and July (USFWS 2002), and adult steelhead migrate into spawning streams as early as September, and could therefore be present in the action area during construction of the proposed project.

a. *Coffer Dam*

The installation and removal of the coffer dam would result in localized, temporary disturbance of habitat conditions that may alter natural behavior patterns of adult and juvenile fish and cause the injury or death of individuals. These effects may include displacement, or impairment of feeding, migration, or other essential behaviors by juvenile salmon and green sturgeon from noise, suspended sediment, turbidity, and sediment deposition generated during in-water construction activities. Some of these effects could occur in areas downstream of the project sites, because noise and sediment may be propagated downstream. Additionally, the closure of the cofferdam would block a portion of the migratory passage and may entrain and strand fish within the enclosed dam. Having a fish rescue prior to dewatering would also have a direct effect on fish. Depending on the methodology of the fish rescue, capturing and releasing the fish could result in injury, harm, or mortality. The prolong presence of the cofferdam may provide habitat for predator species which could lead to injury or death of individuals.

(1) Acoustic Effects. In-river construction work associated with the cofferdams and the intake facilities would involve equipment and activities that will produce pressure waves, and create underwater noise and vibration, thereby temporarily altering in-river conditions under the ABFS Proposed Action. Of particular concern is the noise associated with impact pile driving. Vibratory pile drivers use counter-rotating eccentric weights to vertically vibrate the pile and cause the soil surrounding the pile to loosen, allowing the pile to sink under its own weight. Impact pile drivers contain a heavy weight that descends upon the pile (through the use of hydraulics, steam or diesel) to force it into the ground.

Excessive noise levels caused by in-river and shoreline disturbance activities could affect fish behavior by disrupting or startling fish to the point of causing non-volitional movement out of preferred habitat, a response that can increase the risk of predation. NMFS has found that noise levels less than 150 decibels are not likely to result in temporary abnormal behavior indicative of stress or cause a startle response, nor will it result in permanent harm or injury (NMFS 2007).

Major construction equipment noise sources associated with construction of the proposed intake structures include heavy diesel equipment (e.g., backhoes, graders, pavers) and other earth-moving equipment as well as stationary sources (e.g., compressors and generators), which also will temporarily increase underwater and ambient noise levels under the ABFS Proposed Action, compared to the Environmental Baseline. Typical noise levels associated with the common construction practices of ground clearing, excavation, and foundation laying range from 84 to 89 decibels (EPA 1971). Therefore, with the exception of pile driving, construction equipment noise sources such as heavy diesel equipment (e.g., backhoes, graders, pavers) and other earth-moving equipment as well as stationary sources (e.g., compressors and generators) are not expected to produce sound pressure waves of sufficient magnitude to harm listed species.

Hydrostatic pressure waves and vibration generated by pile driving activities may potentially affect all life stages of fish (Washington *et al.* 1992). Studies (Fitch and Young 1948, Teleki and Chamberlain 1978, Yeleverton *et al.* 1975) suggest that effects on fish resulting from hydrostatic pressure waves and vibration primarily are a function of species morphology and species physiology. Hydrostatic pressure waves of sufficient magnitude could rupture the swim bladders and other internal organs of all life stages of fish in the immediate construction area (Bonneville Power Administration 2002, Jones & Stokes Associates 2001, Washington *et al.* 1992). However, juvenile fish are more susceptible than adults to adverse effects caused by pile driving. Additionally, noise and vibration generated by pile driving activities could potentially have sublethal effects on individual fish by causing movement into lower quality habitats (Bonneville Power Administration 2002). Although understanding of effects from pile driving activities on fish is evolving, it remains problematic. There is evidence that lethal effects can occur from pile driving, but accurately analyzing and addressing these impacts, as well as sublethal impacts (e.g., injury, temporary hearing threshold shifts, stress, and behavioral disturbance) is complicated by several factors. Sound levels and particle motion produced from pile driving can vary depending on pile type, pile size, substrate composition, and type of equipment used (NMFS 2007)

Currently, NMFS is supporting dual criteria as thresholds for assessing the onset of physical injury to fish from pile driving (NMFS 2007). These criteria were proposed in a white paper produced for the Fisheries Hydroacoustic Working Group (FHWG) (Popper *et al.* 2006) and are: (1) an accumulated sound exposure level (SEL) of 187 dB (re: 1μPa^2/sec); and (2) a peak pressure of 208 dB (re: 1 μPa2).

As sound waves move through a uniform medium (e.g., water), the loudness decreases as energy is spread out over a larger and larger volume. For a sound wave spreading out equally in all directions, the loudness decreases rapidly as given by the formula $S_1 = S_0 - 20 \log (d)$ where: S_1 = loudness in dB at point measured, S_0 = loudness in dB at source and d = distance from source (Colorado College 2001). Woodbury and Stadler (2007) gave an example of the sound generated from a single strike to a H-pile of 182 dB as measured at 10 m. In order to produce a 182 dB at 10 m, the source must come from 202 dB (Woodbury and Stadler 2007). An illustration of sound decay as a function of distance is presented in Figure 4 using 202 dB as a starting point.

Utilizing the interim criteria described above, no single H-pile strike exceeds the NMFS peak pressure criterion of 208 dB (re: 1 μPa); therefore, fish are not likely to be harmed by a single

2 μPa = micropascal

H-pile driver strike. However, the accumulated criterion of SEL exceeding 187 dB (re: 1μPa²/sec) will be exceeded in a specific region surrounding the pile driving activity. Accumulated SEL is computed by the formula SEL_a = SEL 10 log (#strikes) where SEL is the noise produced by a single strike at a specified distance, SEL_a is the accumulated SEL, and #strikes is the number of strikes of the pile driver on the sheet pile to which fish would be exposed (Woodbury and Stadler 2007). Most pile drivers operate at a frequency of 0.75 to 1.25 strikes per second; therefore, # strikes can be converted to a time period. Because the in-river sheet pile driving activity is occurring in a migratory corridor, fish would be exposed to sound pressure generated by the pile driving as they pass through the ABFS Action Area. For example, assuming a pile driving strike frequency of 1 strike/sec., utilizing the above formulas, the time required to accumulate an SEL of 187 dB can be computed. Figure 5 depicts the time required to accumulate an SEL of 187 dB as a function of distance from a source SEL of 202 dB. Additionally, Woodbury and Sadler (2007) through the use of a Practical Spreading Loss Model, suggest that the maximum potential injury radius for fish would be 100 m.

Sheet pilings for the cofferdams would be driven into place using vibration. Pile driving activities generating an accumulated SEL greater than 187 dB would likely be harmful to fish. However, based on similar activities conducted for the City of Sacramento's Fish Screen Replacement Project pile driving operations associated with construction of the intake structure can be expected to produce sound pressure levels of up to 95 to 120 dB, which is within the frequency range of salmonid hearing (Feist 1992). These sound pressure levels would be well under the 187 dB level. Because sheet pilings would be vibrated into place during construction of the cofferdam, resultant sound pressure waves would remain below the levels which would result in mortality or physical injury to fish species. Since impact pile driving will likely be necessary to install guides or soldier piles to properly install the sheetpiles, sound levels within a portion of the Sacramento River adjacent to the construction site during H-pile driving operations has the potential to exceed the peak pressure criterion. However, based on Woodbury and Stadler (2007) example of the sound generated from a single strike to a sheet pile of 182 dB, measured at 10 m from the source. The peak pressure criterion of 208 dB resulting from a single strike is not expected to be exceeded and, therefore, is not expected to impact fish species.

The second criterion, an accumulated sound exposure level (SEL) of 187 dB (re: 1μPa²/sec), considers exposure level, and duration of exposure. Exposure level considers the "loudness" of a single strike, and the attenuation of sound pressure waves with distance from source. Pile driving strike frequency and the speed of river flow are used to calculate the duration of exposure (the time a fish is exposed to an accumulated number of strikes). A brief summary of the methods and assumptions used to calculate the size and shape of the region of potential impact for accumulated SEL is presented below.

- The sound generated from a single strike to a pile is estimated as 202 dB (Woodbury and Stadler 2007).

- The rate of sound decay through a uniform medium (e.g., water) as a function of distance used in this analysis is presented in Figure 4.

- A distance of approximately 15 m between the Sacramento River bank and pile driving locations was estimated.

- A pile driver strike frequency of 1 strike/sec. was used.

- A downstream migratory rate of 0.82 m/sec. for the Sankey facility (Phase I) and 0.70 m/sec for the Elkhorn facility (Phase II) was used. A passive migration at a speed of minimum river current velocity during summer flow conditions was assumed. Under summer flow conditions, the calculated average monthly flow velocity in the Sacramento River is 2.7 feet per second near the Sankey facility and 2.3 feet per second near the Elkhorn facility.

- Data regarding the time required to accumulate an SEL of 187 dB as a function of distance from a source, as presented in Figure 5 were used.

Application of the above considerations and assumptions led to the result that the accumulated SEL of 187 dB (re: $1\mu Pa^2/sec$) will be exceeded in a specific region surrounding the pile driving activity. Figure 6 illustrates the estimated region of the river that has the potential to be harmful to fish during downstream migration while impact pile driving operations are occurring. The region of potential harm extends for a distance of approximately 200 m along the east bank of the river and extends outward to approximately mid-river as shown in Figure 6. Since most anadromous salmonid downstream migration occurs at night (Moyle 2002, Vogel and Marine 1991) and approximately 14 percent of Chinook salmon outmigration occurs during daylight hours (Triton Environmental Consultants, Ltd. 2004), NMFS expects a small portion of migrating juvenile salmon and green sturgeon would be harmed, injured, or killed during the pile driving.

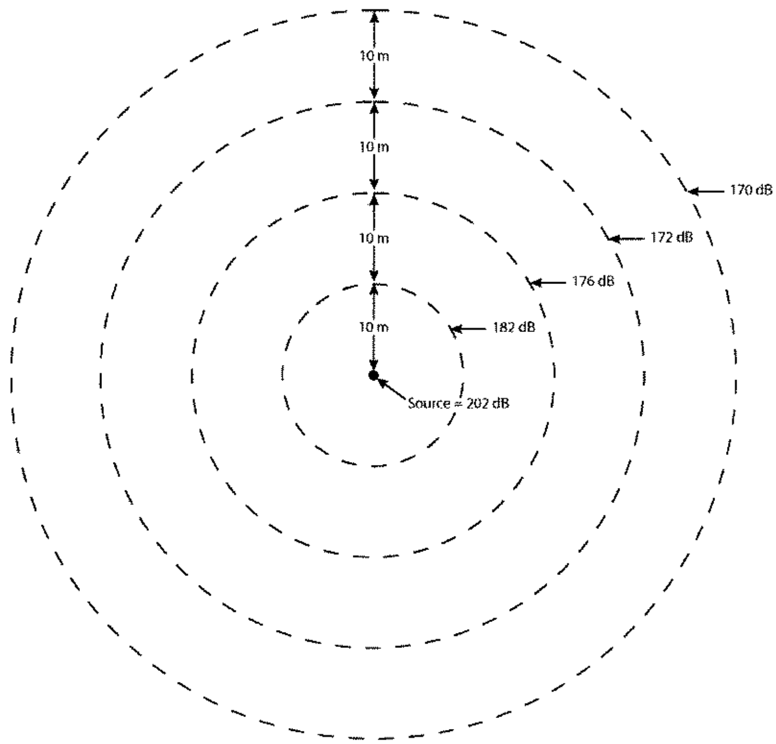

Figure 4. Perceived Loudness as a Function of Distance from Source.

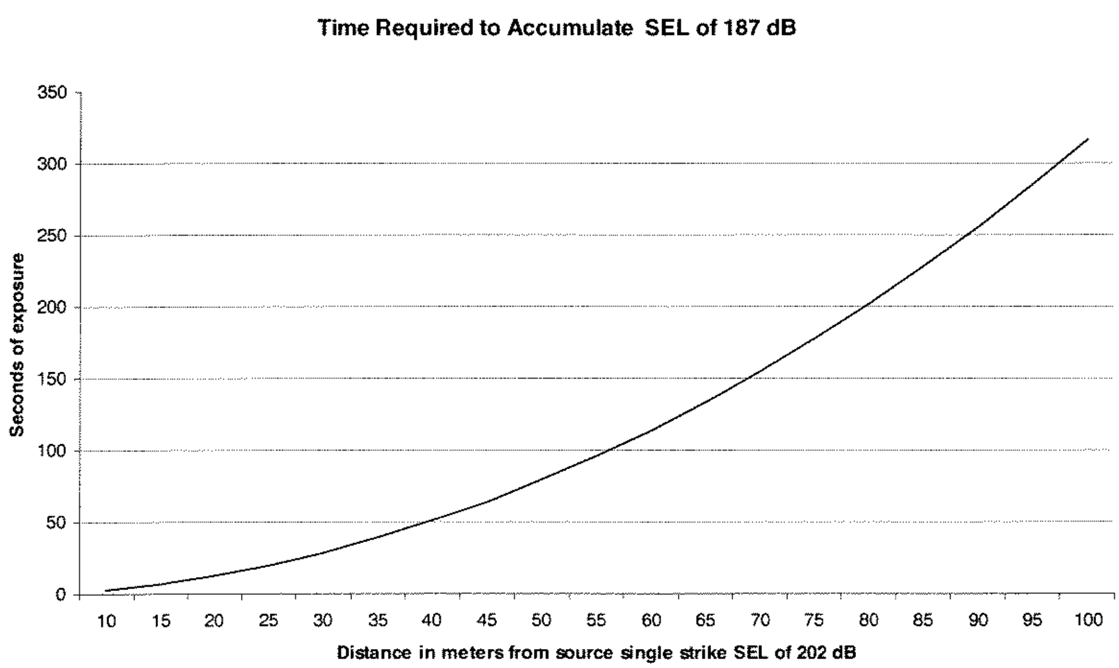

Figure 5. Duration of Exposure to Accumulate SEL of 187 dB as a Function of Distance.

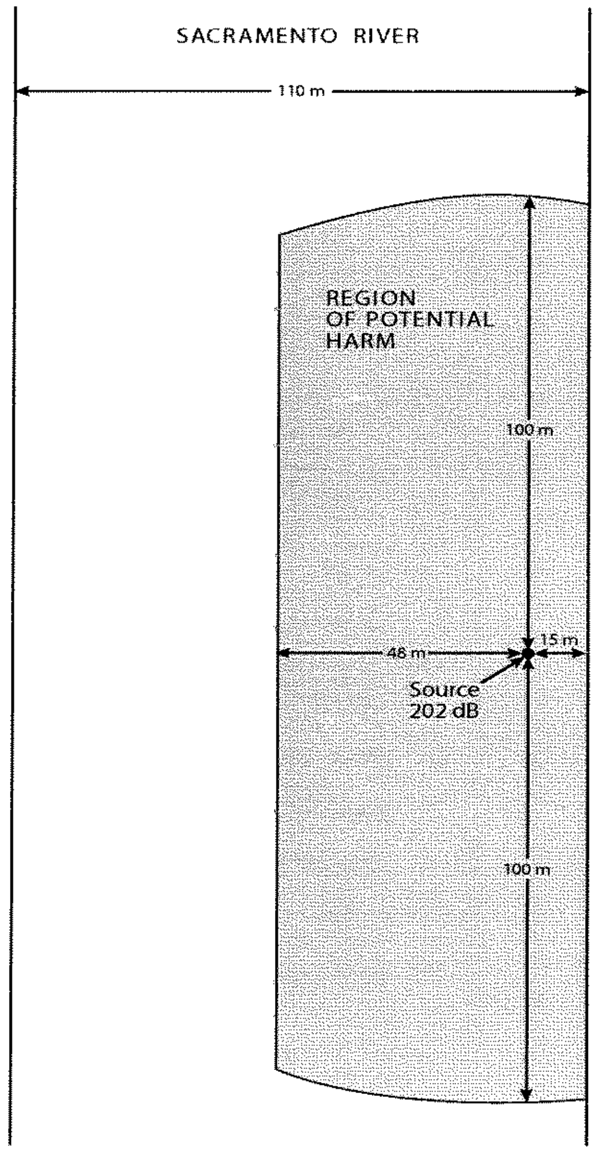

Figure 6. The Region of the Sacramento River Within the ABFS Action Area That Would be Potentially Harmful to Fish During Impact Pile Driving Operations.

(2) ***Water Quality.*** Based on in-water construction projects conducted by USFWS, CDWR, and the Corps, located upstream and downstream of the action area, construction activities are expected to result in periodic turbidity levels that exceed 25 to 75 Nephelometric Turbidity Units

(NTUs). These levels are capable of affecting normal feeding and sheltering behavior. Based on observations during the construction activities in the Sacramento River, turbidity plumes are not expected to extend across the Sacramento River, but rather the plume is expected to extend downstream from the site along the side of the channel. Turbidity plumes will occur during daylight hours during in-water construction. At a maximum, these plumes are expected to be as wide as 100 feet, and extend downstream for up to 1,000 feet. Most plumes extend into the channel approximately 10 to 15 feet, and downstream less than 200 feet. In contrast, the channel of the Sacramento River is several hundred feet wide. Once construction stops, water quality is expected to return to background levels within hours. Adherence to erosion control measures and BMPs such as use of silt fences, straw bales and straw wattles will minimize the amount of project-related sedimentation and minimize the potential for post-construction turbidity changes. Since project-related turbidity plumes will be limited to shoreline construction areas, and the Sacramento River is much wider than any plume that could be generated, NMFS expects that individual fish will mostly avoid the turbid areas of the river and use alternate migration corridors or rearing habitat. For those fish that do not avoid the turbid water, exposure is expected to be brief (*i.e.*, minutes to hours) and not likely to cause injury or death from reduced growth, or physiological stress. This expectation is based on the general avoidance behaviors of salmon and the BMPs to suspend construction when turbidity exceeds Regional Board standards.

There is a potential for juveniles that are exposed suddenly to turbidity plumes to be injured or killed by predator fish that take advantage of disrupted or abnormal behavior. The installation and removal of the sheet piles of the cofferdam will disrupt the river flow and disturb the water column; resulting in increased turbulence and turbidity. Migrating juveniles react to this situation by suddenly dispersing in random directions (Carlson *et al.* 2001). This displacement can lead them into predator habitat where they can be targeted, and injured and killed by opportunistic predators taking advantage of juvenile behavioral changes. Carlson *et al.* (2001) observed this behavior occurring in response to routine channel maintenance activities in the Columbia River. Some of the fish that did not immediately recover from the disorientation of turbidity and noise from channel dredges and pile driving swam directly into the point of contact with predators. Once fish migrate past the turbid water, normal feeding and migration behaviors are expected to resume.

Biological studies conducted at GCID also support that predation may be higher in areas where juveniles are disoriented by turbulent flows or are involuntarily routed into high-quality predator habitat or past areas with higher predator densities (Vogel 2006). Behavioural observations of predator and salmon interactions at GCID also surmised that predators responded quickly to the release of fish during the biological tests and preyed on fish soon after they were released into the water, even when the release locations were periodically changed (David Vogel, Natural Resource Scientists, pers. comm. 2006). Some of the predator species were found between the corrugated sheetpiles waiting for juvenile salmon to pass (Howard Brown, NMFS, 2008). This is a strong indication that predators quickly adapt and respond to changes in natural juvenile salmonid behavioural responses to disturbance.

Short-term increases in turbidity and suspended sediment may disrupt feeding and migratory behavior of juvenile and adult of green sturgeon. The installation and removal of the cofferdam and the construction activities within the coffer dam could result in localized displacement and likely behavioral modifications to individual green sturgeon that do not readily move away from the channel or nearshore areas directly affected by the project. Turbidity and sedimentation events are not expected to affect visual feeding success of green sturgeon, as they are not believed to rely heavily on visual cues (Sillman *et al.* 2005); however, olfaction appears to be a key feeding mechanism and could be affected by such events. In addition, green sturgeons are known to immediately stop swimming and drift toward the substrate upon changes in light conditions (Sillman *et al.* 2005). Thus, the effects of sedimentation on light levels could elicit green sturgeon behavioral changes. Construction activities also may increase sediment, silt, and pollutants that could adversely affect the production of food sources, such as aquatic invertebrates, necessary for juvenile green sturgeon and salmonid survival.

The toxic substances used at construction sites, including gasoline, lubricants, and other petroleum-based products could enter the Sacramento River as a result of spills or leakage from machinery or storage containers and injure or kill listed species. These substances can kill aquatic organisms through exposure to lethal concentrations or exposure to non-lethal levels that cause physiological stress and increased susceptibility to other sources of mortality. Petroleum products also tend to form oily films on the water surface that can reduce DO levels available to aquatic organisms. NMFS expects that adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway because the prevention and contingency measures will require frequent equipment checks to prevent leaks, will keep stockpiled materials away from the water, and will require that absorbent booms are kept on-site to prevent petroleum products from entering the river in the event of a spill or leak. NMFS does not expect the project to result in water contamination that will injure or kill individual fish.

(3) Strand and Rescue. The closure of the cofferdam has the potential to entrain juvenile and adult green sturgeon and juvenile salmon. Stranded fish would likely be subjected to low water quality when enclosed within the coffer dam, direct mortality upon water removal from the area enclosed by the cofferdam, or various levels of impacts associated with capture of the fish rescued from the enclosure. Juvenile salmonids and sturgeon would be most prone to stranding as their ability to escape from such a situation is lower than adult salmonids or sturgeon that has greater swimming ability. Although the vibrations and sediment re-suspension that would occur during installation of the cofferdam would be expected to cause most juvenile fish residing in/passing through the area to relocate and, therefore, avoid stranding behind the cofferdam, some fish may become stranded. It is likely that the cofferdam will be completed during the first three months of in-water construction (July-September). The July through September period is a key migration period for larval and post-larval southern DPS of North American green sturgeon. However, scheduling construction of the coffer dam at this time minimizes the collective potential for stranding juvenile salmonid outmigrants. Additionally, installation of the cofferdam is a relatively slow process (*i.e.*, occurs over days), and because juvenile salmonids and green sturgeon are transitory, and because the area to be enclosed by cofferdams is small relative to the action area and the river as a whole, any losses of juvenile anadromous salmonids and sturgeon associated with cofferdam placement is expected to be very small relative to the total number of outmigrants.

Once the cofferdam is in place, larval, post-larval, and juvenile salmonids and green sturgeon trapped within the cofferdam risk injury or death due to stranding and or removal by fish rescue efforts (*i.e.*, seining or electrofishing). However, NMFS believes, based on the analysis of previous cofferdam-related projects, that the entrainment risk to juvenile salmonids and sturgeon is low. On August 18, 2005, a fish rescue was performed by Hanson Environmental Inc. for the Sutter Mutual Water Company at the Tisdale Positive Barrier Fish Screen construction project site. The fish rescue was performed to remove fish from a construction zone within the Sacramento River that had been isolated from the river by use of coffer dams. A comprehensive fish rescue effort yielded no salmonids or other listed species, with the only species of note captured being a single Sacramento splittail. Hanson Environmental Inc. also sampled behind a coffer dam at the Reclamation District 108 Wilkins Slough Pumping Plant on October 4, 1997 (Hanson Environmental Inc. 1997). A total of five fish were collected behind the coffer dam: four tule perch, and one lamprey amnocete. Additionally, three separate passes with a seine net were completed behind a partially dewatered section of Wilkins Slough, bordered by an earthen dam, resulting in a total of 687 fish. No Chinook salmon, steelhead, or sturgeons were captured.

*(3) **Migratory Delay/blockage.*** The presence of the cofferdam at the two sites (New Sankey and New Elkhorn Diversion) will obstruct passage of approximately 25 and 32 percent of the river channel's cross-sectional width for a linear (downstream) distance of approximately 55 and 60 feet respectively. River flow in the constricted portion (*i.e.*, remaining 75 and 68 percent of cross-section) of the channel would have somewhat higher current velocities than conditions without the cofferdam in place, due to the channel restriction. According to a study conducted for the Chico Wastewater Treatment plant diffuser project (Flow Science 2004 and Robertson-Bryan, Inc. 2005), the average river velocities are estimated to range from 1.5 feet per second (ft/s) at 2,800 cubic feet per second (cfs) to 2.2 ft/s at 7,500 cfs in the project area. A 20 percent channel width blocked from the cofferdam would produce velocities to not exceed a range of 2.0 to 4.0 ft/s, which is similar to the velocities within a natural riffle in the Sacramento River (Robertson-Bryan, Inc. 2005). Because 25 and 32 percent of the channel width would be blocked from the cofferdam, velocities are expected to be between 2.5 and 6.4 ft/s, which is 25 to 60 percent increased in velocities, which is considered to be higher velocities than a natural riffle. Therefore, Chinook salmon, steelhead, and green sturgeon upstream migration could be disrupted due to placement of the cofferdam and associated increased current velocities in the remainder of the river cross-section. Emigrating fish that may encounter the cofferdam when traveling along the east bank of the river would be delayed only long enough for them to find their way around the cofferdam.

Since 64 to 75 percent of the river cross-section at the cofferdam site will remain unobstructed, outmigration of juvenile salmonids and sturgeon is not expected to be impeded while the cofferdam is in place. Juveniles that encounter the cofferdam when traveling along the east bank of the river would be forced to leave the protection of the shallow, near-shore habitat and travel out into deep water to get around the cofferdam, where they would be more exposed and susceptible to predation. While a significant proportion of a single year class of out-migrating juvenile green sturgeon are likely to be exposed to these impacts, a relatively small proportion of juvenile outmigrating salmonids would be affected because the cofferdam will not be in place during their peak emigration period.

b. *Degradation of Habitat*

Approximately 0.020 acres (8,800 square feet at the New Sankey Diversion) and 0.06 acres (2,500 square feet at the New Elkhorn Diversion) of benthic substrate will be removed and subsequently replaced with gravel and clean fill to cover disturbed streambed. This new substrate will be devoid of benthic invertebrates which may be used as food by listed species and vegetation which may be used as cover for resting and protection from predators. NMFS believes that recolonization of this "virgin" material with invertebrates and vegetation will occur relatively quickly following placement of the material in the river. The areal extent of the disturbed streambed is relatively small (160 feet by 55 feet and 100 feet by 60 feet footprints). Suitable stocks of organisms and vegetation to serve as "seed" stock for the recolonization are present in the channel surrounding the action area. Typically, recolonization of new substrate occurs when these drifting invertebrate larvae and plants encounter open substrate as they are dispersed into the barren fill area by river flows sweeping through the channel. Although initially the community composition of the newly colonized substrate is likely to be different than the surrounding channel, a mature benthic community resembling the surrounding area is expected to form with the passage of time if the substrate does not encounter any further disturbances. Due to the temporary nature of the disturbance and the small amount of benthic substrate that will be impacted compared to its overall availability, NMFS believes that this short-term alteration will not have any adverse effects on listed salmonids and green sturgeon.

Approximately 1.29 acres of riparian forest, 0.13 acres of SRA habitat, and 0.1 acres of riparian shrubs will be disturbed by the placement of the two new diversions into the Sacramento River and approximately 600- and 160 linear feet of levee face would be impacted. Currently the levee slopes are vegetated with riparian forest, native shrubs and non-native weedy plants, some of which overhang the waters of the channel. The present vegetation provides a microhabitat of cool, shaded water during high temperatures of summer months. The roots of bank vegetation provide a web of bank holding structure and overhanging vegetation also contributes to the recruitment and retention of IWM. IWM is reported to be highly important to juvenile fish of the lower Sacramento River (USFWS 2000 a, b). In addition to providing shade, velocity breaks and cover from predators, IWM provides habitat for aquatic and terrestrial insects that act as a food source for salmonids and green sturgeon foraging along the margins of the river channel. The removal of all vegetation along these portions of the levee face will degrade the riparian habitat. The applicant plans to replant the surrounding disturbed area of the new diversion with new vegetation. Due to the small amount of levee face that will be affected compared to the overall availability of this habitat type, NMFS believes that adverse effects of this disturbance to listed salmonids and green sturgeon will be insignificant.

2. Long-Term Operational Effects

a. Habitat Alterations

The installation of subsurface structures in the channel of the Sacramento River has the potential to create holding habitat for predatory fish (*i.e.*, striped bass, largemouth bass, catfish (*Ictalurus* spp.), *etc.*) by creating alterations in the bathymetry and underwater topography within the action area. Human-induced habitat changes such as alteration of natural flow regimes and installation of bank revetment and structures such as dams, bridges, water diversions, piers, and wharves often provide conditions that disorient juvenile salmonids, delay their migration, and attract predators (Stevens 1961). However, the fish screens will meet NMFS's Fish Screen criteria guidelines and would be designed to minimize the creation of predator ambush habitat such as current breaks, eddies, and other flow velocity disruptions.

b. Operation and Maintenance Activities

The five existing diversions in the project area have no fish screens. Presently, these diversions are known to entrain migrating salmon, steelhead, and green sturgeon into Natomas Mutual's diversion facilities. Under the existing operating conditions, the unscreened diversions and the placement of Verona Dam likely result in higher levels of entrainment and impingement of juvenile fish and potentially may lead to migratory delay, harm, and death. Since the proposed ABFS project would decommission the smaller diversions without fish screens, and screen the new combined diversions, as well as discontinue the operation of the Verona Dam and its associated facilities, NMFS expects the new operation of the Natomas Mutual diversion facilities would improve the survival rates of salmon, steelhead, and green sturgeon through the action area.

NMFS review and approval of the operation and maintenance plans for the two new fish screens, as well as periodic inspections of the facilities by NMFS' engineering staff would ensure that the diversions work properly under all anticipated environmental conditions. Proper operation of the fish screens would minimize the entrainment and impingement of listed juveniles. The Fish Screen Operation Procedure plan includes procedures for operating the fish screen and the intake facility under a variety of environmental conditions and diversion needs, as well as specific maintenance procedures required to ensure the effectiveness of the screens over the design life of the facilities. Maintenance procedures include conducting hydraulic tests to ensure the approach and sweeping velocity do not exceed the NMFS' criteria; maintaining and cleaning the fish screens periodically; inspecting the fish screens for debris and damage; keeping a log-book, and providing annual reports. This would ensure juveniles are not impinged, injured, harm, and killed as they migrate pass the diversions. Provided that the operational procedures, maintenance, and inspections described above are strictly adhered to, NMFS expects the operation of the two diversions with fish screen would not adversely affect migrating salmon, steelhead, and green sturgeon.

VI. CUMULATIVE EFFECTS

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

1. <u>Agricultural practices and water use</u>

Non-Federal actions that may affect the action area include ongoing agricultural activities and increased urbanization. Agricultural practices along the Sacramento River near the Cities of Sacramento, Marysville, Yuba City, Verna and Knights Landing may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the Sacramento River. Numerous unscreened small agricultural diversions from 40 to 100 cfs upstream and downstream from the project area entrain fish including juvenile salmonids (Rick Wantuck, NMFS, pers com 2008). Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the Sacramento River. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides, herbicides and other toxins that may adversely affect salmonid reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003a,b).

2. <u>Development</u>

The General Plans for the city of Sacramento particularly in the North and South Natomas Community Area, Metro Air Park, and Camino Norte/Keona Circle, Sacramento, South Sutter and West Placer Counties, and other surrounding communities in the Sacramento Watershed anticipate rapid growth for several decades to come. Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns, as well as increasing the inflow of urban toxins such as hydrocarbons, lawn and garden chemicals and litter. All of these increased impacts have the potential to adversely affect listed species critical habitat and reproductive success and survival rates.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

The purpose of this section is to summarize the effects of the action and integrate the analysis of those effects with the current and future conditions described in the *Environmental Baseline* and *Cumulative Effects* sections of this biological opinion. The integration and synthesis of these conditions and effects provides the basis for the conclusion as to whether or not the proposed action is likely to jeopardize the continued existence of the listed species.

A. Overview of baseline conditions and future cumulative affects within the action area

The Environmental Baseline section of this document describes how the condition and function of the habitat in the action area has been severely impaired through several factors such as constriction of the river through a levee system for flood control, loss of riparian vegetation and SRA habitat due to armoring of the banks, depletion of river flows through diversions and human consumption, and degraded water quality from agricultural runoff and increased urban development. The result has been a reduction in quantity and quality of several essential elements of migration and rearing habitat required by juvenile anadromous fish to grow and survive.

Because the action area does not provide spawning habitat for any particular population of the listed ESUs/DPSs, but instead acts as rearing and migrational habitat for the majority of the fish that make up these ESUs/DPSs, the likelihood of survival and recovery of these fish in the action area is directly linked to the likelihood of survival and recovery of the overall ESUs/DPSs in the Sacramento River watershed. In their recent evaluation of the viability of Central Valley salmonids, Lindley et al. (2007) found that the remaining population of Sacramento River winter-run Chinook salmon and three populations of Central Valley spring-run Chinook salmon appear to be fairly viable. These populations meet several viability criteria including population size, growth, and risk from hatchery strays. However, the viability of the ESUs to which these populations belong appears low to moderate, as the ESUs remain vulnerable to extirpation due to their limited spatial distribution, low diversity, and potential for being affected by a significant catastrophic event.

Lindley et al. (2007) were not able to determine the viability of existing steelhead populations, but believe that the DPS has a moderate to high risk of extinction since most of the historic habitat is inaccessible due to dams, the remaining accessible habitat has been severely degraded by human activities, and the anadromous life-history strategy is being replaced by residency.

Recent population estimates for the southern DPS of North American green sturgeon indicate that there are few fish relative to historic conditions, and that loss of habitat has affected population size and distribution. However, the southern DPS of North American green sturgeon remain widely distributed along the Pacific coast from California to Washington, and recent findings of fish in the Feather and the Yuba River indicate that their distribution in the Central Valley may be more broad than previously thought. This suggests that the DPS probably meets several viable species population criteria for distribution and diversity, and indicates that the southern DPS of North American green sturgeon faces a low to moderate risk of extinction.

Future State, tribal, local and private actions that are reasonably certain to occur in the action area are described in the Cumulative Effects section of this document and include ongoing effects of agricultural practices in the area and the expected increase in urbanization and industrial development of the surrounding watershed.

B. Summary of Impacts of the Proposed Action on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead and Southern DPS of North American Green Sturgeon

NMFS expects that the proposed action will result in short-term, adverse, construction-related impacts that will have the potential to injure and kill juvenile Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead and North American green sturgeon. North American green sturgeon which may occur year-round in the Sacramento River are most likely to be affected by the construction activities. Juvenile salmonids and green sturgeon are expected to be affected most significantly because of their small size, reliance on aquatic food supplies (allochthonous food production), and vulnerability to factors that affect their feeding success and exposure to predation. Construction-related effects include noise from the installation of the cofferdam and reduced water quality that may cause temporary modification of natural behavior and may expose juvenile fish to increased predation. Adults should not be injured or killed because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance.

A very small number of listed fish are expected to be caught inside of the coffer. During the installation, noise from the vibratory hammer is expected to deter fish from entering the construction site. If listed species are found inside the cofferdam, fish rescue efforts will be implemented, which, while likely saving most of the fish encountered, may result in injury, harm, and/or death of individuals.

The implementation of BMPs and other on-site measures will minimize impacts to the aquatic environment and reduce project-related effects on fish. As the construction activities are completed and the cofferdam removed, a small percentage of early emigrating juvenile winter-run Chinook could potentially be present in September. Their migration downstream may be slightly delayed. However, by avoiding the peak of migratory movements from late winter through late spring (February through May) for listed salmonids in the Sacramento River basin, the impacts resulting from the sheet pile driving will be minimized. Thus, NMFS expects that actual injury and mortality levels will be low relative to the overall population abundance of these ESUs/DPSs. Because of this consideration, construction-related impacts will be a small, spontaneous impact, and not likely to persist or result in negative population trends.

Construction related impacts on the PCEs of critical habitat will be short-term and will not significantly reduce the conservation value within the action area. The restoration and enhancement of riparian vegetation along the bank, upstream and downstream of the new diversion facilities is expected to closely replace the rearing and refugia habitat that currently exists in the area. It is expected to take up to 5 years for the new riparian vegetation to become established and cover the wetted perimeter of the river channel. The permanent loss of habitat due to the presence of the two new diversion pumps is unavoidable. Because the impacts to riparian vegetation will be limited to two small sites, NMFS expects individual fish will seek out and rear in nearby habitat with higher values, and will be unaffected by the minor long-term impacts to riparian habitat.

Listed adult salmonids are not expected to be affected by the short term construction effects of the proposed project because they are unlikely to be abundant in the action area during the proposed in-water work window (July through September). Adult steelhead and green sturgeon have the potential to be present during in-water construction activities but are not expected to be significantly impacted due to their large size, high level of mobility, and their tendency to migrate through deep, mid-channel habitats. Neither adult salmonids nor adult green sturgeon are expected to be affected by the longer-term changes in nearshore riparian habitat conditions because they generally migrate through deep, mid-channel habitats and do not rely on overhanging vegetation for cover or food production.

C. Integration of Baseline and Cumulative Effects with the Effects of the Proposed Action on the Survival and Recovery of Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, Central Valley Steelhead, and Southern DPS of North American Green Sturgeon.

The current condition of the habitat in the action area is degraded and the effects of future human activities are expected to continue or possibly further degrade those conditions. While the action area continues to function appropriately as a migratory corridor (aside from the unscreened diversions that are being remedied by the proposed action), the primary impacts are to its ability to function as rearing habitat for juvenile fish. The short term impacts from the construction phase of the project (pile driving noise, increased turbidity, reduced riparian vegetation, and entrapment and rescue from within the cofferdam) are expected to add low-level effects on a very small proportion of a single year class of juvenile salmonids, and juvenile and adult green sturgeon to the baseline conditions. While a very small proportion of the fish affected by the construction impacts may actually be killed or severely injured, the level of effects described in the previous section are not expected to appreciably reduce the population size, reproductive potential or distribution of any of the listed ESUs or DPSs.

The long term operation of the ABFS project is expected to improve fish passage and survival in the project area by preventing entrainment of juvenile fish into irrigation diversions. The design, operation and maintenance if the new facilities will meet NMFS Fish Screen criteria to ensure the operation of the diversions will not result in harm, injury, or death of listed salmonids and green sturgeon. With NMFS fish screen criteria and approved O&M plans in place, it is expected that the long term effects of the proposed operation of the ABFS would not appreciably reduce, and may actually improve, the population size, reproductive potential or distribution of the listed ESUs or DPSs that utilize the action area.

D. Impacts of the proposed action on Critical Habitat

The purpose of this section is to consider the effects of the action on critical habitat in light of the current condition and function of the PCEs and their contribution to the conservation value of habitat, in order to determine whether or not the proposed action is likely to destroy or adversely modify designated critical habitat.

Project impacts to critical habitat of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead include the short- and long-term modification of approximately 0.26 acres of aquatic (footprint behind the cofferdam) and 1.75 acres of riparian (riparian forest, SRA, and shrubs) habitat within the action area. PCEs in the action area include riverine areas for rearing and migration. NMFS CHART (2005b) described existing PCEs within the action area as ranging from good condition to degraded, with isolated fragments of high quality habitat. Even with these degraded conditions, the CHART report rated the conservation value of the entire action area as high because it is used as a rearing and migration corridor for the entire population of winter-run Chinook salmon and a large proportion of Central Valley spring-run Chinook salmon and Central Valley steelhead.

Because of the project's integrated conservation measures and BMPs, include restoring the stream banks upstream and downstream of the diversions with a higher density of vegetation, NMFS expects that the action will contribute to the growth and survival of fish using the habitat, and ultimately maintaining the rearing and migration PCEs. Additionally, NMFS expects the construction of fish screens on the new diversions will minimize the entrainment of listed species. State and Federal permit requirements for controlling the discharge of pollutants into the Sacramento River during construction activities are also expected to be strictly adhered to, preventing degradation of water quality within critical habitat. Therefore, NMFS does not expect project-related impacts to significantly reduce the conservation value of designated critical habitat of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.

VIII. CONCLUSION

After reviewing the best scientific and commercial data available, including the environmental baseline, the effects of the proposed project, and the cumulative effects, it is NMFS biological opinion that the American Basin Fish Screen and Habitat Improvement project is not likely to jeopardize the continued existence of endangered winter-run Chinook salmon, threatened spring-run Chinook salmon, threatened steelhead, and threatened North American green sturgeon, and is not likely to destroy or adversely modify designated or proposed critical habitat.

IX. 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 to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are nondiscretionary, and must be undertaken by Reclamation so that they become binding conditions of any grants, licenses, or contracts issued, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activities covered by this incidental take statement. If the Reclamation: 1) fails to assume and implement the terms and conditions; or 2) fails to require the project proponent to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to any grants, licenses, or contracts issued, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to NMFS as specified in this Incidental Take Statement (50 CFR §402.14(I)(3)).

A. Amount or Extent of Take

NMFS anticipates incidental take of Sacramento River winter-run Chinook salmon, Central Valley steelhead, Central Valley spring-run Chinook salmon, and North American green sturgeon from impacts related to construction and effluent discharge through direct construction impacts and impairment of essential behavior patterns as a result of reductions in the quality of their habitat.

NMFS cannot, using the best available information, quantify the anticipated incidental take of individual listed fish because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the project area. However, it is possible to designate ecological surrogates for the extent of take anticipated to be caused by the project, and to monitor those surrogates to determine the level of take that is occurring. The three most appropriate ecological surrogates for the extent of take caused by the project are the level of instream turbidity created by construction activities associated with the project, the amount and duration of pile driving conducted during project construction, and the appropriate design, monitoring and maintenance of new fish screens to insure that they continue to operate in a manor that meets all NMFS fish screening criteria throughout the life of the project.

- The analysis of the effects of the proposed project anticipates that construction-related turbidity will extend a maximum of 100 feet from the shoreline, and 300 feet downstream, of any construction related activities. Turbidity levels exceeding the requirements set under the California Central Valley Regional Water Quality Control Board waste discharge, between July and November would result in an exceedence of the anticipated take levels. If the turbidity levels have not been set by the CVRWQCB, then all instream activities and any discharge due to the project activities shall at all times maintain turbidity levels of no more than 20 percent above the background level.

- The analysis of the effects of the proposed project anticipates that the construction of a sheet pile coffer dam would require driving 500 to 1000 square feet of sheet piles for a total of 45 days (8 hours per day), over a period of five months (July 1 through November 30). The total square feet for both diversions is 11,300 and the pile driving activities would be reviewed and approved by NMFS prior to construction.

- The analysis of the effects of the proposed project anticipates that the new fish screens will be designed and built to meet NMFS fish screen criteria, and screen performance will be monitored and maintained to continue to meet all NMFS fish screening criteria throughout the life of the project.

If these ecological surrogates are not met and maintained, the proposed project will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the project.

B. Effect of the Take

In the accompanying biological opinion, NMFS determined that the construction and continued operation of the proposed project is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley steelhead, Central Valley spring-run Chinook salmon, or the southern DPS of North American green sturgeon, and is not likely to destroy or adversely modify the respective designated and proposed critical habitat for these species.

C. Reasonable and Prudent Measures

Pursuant to section 7(b)(4) of the ESA, the following reasonable and prudent measures are necessary and appropriate to avoid or minimize take of endangered Sacramento River winter-run salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, and threatened southern DPS of North American green sturgeon:

1. Reclamation shall avoid or minimize entrainment or stranding of juvenile Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and southern DPS of North American green sturgeon within the project cofferdam.

2. Reclamation shall avoid or minimize adverse effects of the long-term operation of the New Sankey and New Elkhorn Diversions on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and southern DPS of North American green sturgeon by monitoring and maintaining the operation of the fish screens.

3. Reclamation shall assess bank restoration designs on salmonids using the Standard Assessment Methodology (SAM) for the Sacramento River Bank Protection Project (SRBPP) and provide either onsite or offsite compensation for the loss of habitat.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline prescribed monitoring and reporting requirements. These terms and conditions are non-discretionary:

1. **Reclamation shall avoid or minimize entrainment or stranding of juvenile Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and southern DPS of North American green sturgeon within the project cofferdam.**

    a. Cofferdam construction shall be completed at the downstream end to minimize the potential for entrainment of salmonids and green sturgeon within the closed cofferdam.

    b. A qualified fishery biologist shall sample the closed cofferdam to ensure that no salmonids and green sturgeon have been trapped within the cofferdam.

    i. All rescued salmonids and green sturgeon shall be removed and returned to the river. The fishery biologist shall note the number of individuals entrained, the number of individuals relocated, and the date and time of collection and relocation; and provide a report to the address below.

    ii. One or more of the following NMFS-approved capture techniques shall be used: dip net, seine, throw net, minnow trap, or hand.

    iii. Electrofishing may be used if NMFS has reviewed the biologist's qualifications and provided written approval.

    iv. The fishery biologist shall be empowered to halt work activity and to recommend measures for avoiding adverse effects to salmonids and green sturgeon and their habitat.

2. **Reclamation shall avoid or minimize adverse effects of the long-term operation of the new Sankey and new Elkhorn Diversions on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and southern DPS of North American green sturgeon by conducting post-construction evaluation tests, monitoring and maintenance of the fish screens.**

a. Prior to the construction of the fish screen and removal of Verona Dam, a fish monitoring plan shall be developed and implemented. The monitoring plan should evaluate and assess the presence and abundance of listed species utilizing the Natomas Cross canal during the pumping season.

   i. The monitoring plan shall be developed with the guidance of NMFS and CDFG staff, reviewed and approved by NMFS and CDFG.

   ii. The study shall be conducted by a qualified biologist and a report shall be written and sent to the address below.

b. Prior to the operation of the diversion, a detailed report of the post-construction evaluation and assessment of the fish screens shall be submitted to NMFS within 30 days from test completion. The evaluation should test the mechanical and electrical systems, automatic cleaning systems, fish entrainment, and fish screen hydraulics. The report can be sent to the address below.

   i. The mechanical and electrical systems tests should include alarm systems including audible alarms, pagers and other warning systems, automated data recording equipment, emergency shut-off systems, cleaning systems, actuators and solenoid, and other mechanical and electrical systems.

   ii. Cleaning systems and their components shall be tested in the dry, when possible, and again when screen facilities are operable prior to initiating normal operations. Using operations and maintenance documentation provided by the designer and/or fabricator of the cleaning systems, all cleaning systems shall be tested in automatic and manual operating modes. Emergency blow-out panels shall be tested and calibrated by applying the design force to each panel. In cases where in situ testing can cause damage to the screen panel, the trip mechanism should be tested under controlled conditions prior to installation in the facility.

   iii. The hydraulic test shall include a description of the screen site and environmental conditions at the time of testing; a diagram indicating the location of the velocity measurements taken; river flow conditions and diversion rates; a list of technicians performing the tests; materials and methods employed in the test including locations of velocity measurements in the final iteration of baffle adjustment and the justification of the number of points at which velocity measurements were taken; a description of the final baffle adjustments; tabulated approach and sweeping velocity data for measured points in the final iteration of baffle adjustments; approach velocity values for measurement points in the final iteration of baffle adjustments presented in a graphical format; and an objective evaluation of hydraulics at the site and anticipated screen performance.

- Diversion rates should be calculated from average approach velocity values for each sub-section and the known area of each sub-section.

- Calculated values should be compared with measured values and discussed in the report.

- Approach velocity values measured before and after adjustments to baffle systems also should be discussed in the report.

- Areas where approach velocities exceed accepted criteria (hot sots) should be noted.

- Solutions for eliminating hot spots should be listed in the report, including possible alternative operating procedures, and retrofit baffling systems.

b. A draft operations and maintenance (O&M) plan to monitor the performance of the fish screen shall be developed and submitted to NMFS at least 30 days prior to completion of project construction for review and approval. The O&M plan shall include preventive and corrective maintenance procedures; inspections and reporting requirements; and maintenance logs, particularly with respect to debris, screen cleaning, and sedimentation issues. The plan shall act as a manual for operating and maintaining the fish screen. The plan shall be developed in accordance with the NMFS' fish screen operations and maintenance criteria (listed below). Draft plans can be sent to the address below.

i. Fish screens shall be automatically cleaned as frequently as necessary to prevent accumulation of debris. The cleaning system and protocol must be effective and reliable. Proven cleaning technologies are preferred.

ii. Open channel intakes shall include a trash rack in the screen facility design, which shall be kept free of debris. In certain cases, a satisfactory profile bar screen design can substitute for a trash rack.

iii. The head differential to trigger screen cleaning for intermittent type systems shall be a maximum of 0.1 feet (0.03 meters), unless otherwise agreed by NMFS' engineering staff.

iv. The completed screen shall be made available for inspection by NMFS, to verify compliance with design and operational criteria.

v. Screen shall be evaluated for biological effectiveness, and to verify that hydraulic design objectives are achieved.

c. An easy-to-follow list of operating procedures should be posted in a highly visible location at the diversion site. The list should state specific operating procedures to achieve uniform approach velocities across the screen face at different flows. Emergency power cut-off switches, pressure relief valves, instructions for operating any auxiliary equipment, and emergency shut down procedures should also be posted in an easy-to-find location.

d. An operations and maintenance log shall be maintained on a daily basis. The logbook shall include the operating procedure list, periodic maintenance schedule, and the date and initialed records of regularly scheduled and unscheduled maintenance procedures performed. The logbook shall be made available for inspection to NMFS personnel with 24 hours notice to Natomas Mutual.

c. Visual inspections of the screens shall be conducted on an annual basis, or as agreed to with NMFS and Natomas Mutual. The results of the inspections shall be documented in a report and sent to NMFS with thirty day of their completion. The report should include recommendations on corrective actions (*i.e.*, repairs to facilities, changes in operation procedures, and changes in setting of baffles and automatic equipment for assuring the diversion will function as designed and as required to satisfy NMFS' fish screen standards. Inspectors should examine system performance, structural integrity of the screen area, and other factors affecting screen facility performance. Inspectors should determine if maintenance procedures being conducted are sufficient to ensure that screen performance will continue to meet design criteria into the future. This type of inspection shall be conducted through the following procedures:

i. The Audit Maintenance Records Procedure should include the review of the operations and maintenance logbook for recurring problems and a comparison of logged records with the O&M plan for compliance and troubleshooting.

ii. The Underwater Inspection Procedure should include following:

- Check for gaps at joints and seams that could compromise screen efficiency.
- Note accumulation of debris.
- Inspect screen material for damage and material integrity.
- Check screens and structure for corrosion, wear, or other deterioration.
- Check sacrificial anodes and replace if necessary.
- Check screen hold-down plates and other protrusions from the screen face

for damage and debris accumulation.

- View cleaning system operation. Intentionally foul screen with locally available materials, if possible, to view cleaning efficiency.
- Check spray orifices for fouling (water and spray systems).
- Check Screen face for undulations in the screen material that may reduce cleaning efficiency (traveling brush systems).
- Check brush for wear and deterioration (traveling brush systems)
- Check seals for wear and deterioration.
- Assess overall efficiency of cleaning system and suggest solutions in inspection report.
- Inspect moving parts below water surface for corrosion and damage.
- Inspect channel morphology in the immediate vicinity of the screen for debris, erosion, and sedimentation that may potentially damage screens and their supporting structures, or adversely affect screen operation.

iii. If problems warrant velocity measurements, they should be conducted by measuring the approach and sweeping flow velocities along the screen face, calculating the diversion rates from measured approach velocity values, and comparing the values with the measured diversion rates.

iv. The backup and alarm systems should be tested to ensure they are working properly during emergency situations.

3. Reclamation shall assess bank restoration designs on salmonids using the Standard Assessment Methodology (SAM) for the Sacramento River Bank Protection Project and provide either onsite or offsite compensation for the permanent loss of habitat.

a. A written report regarding the results of the SAM modeling for the bank restoration plan shall be submitted to NMFS for approval prior to construction. The report shall include fish response indices and bank length (or wetted area) for each season, target year, and relevant species and life stage.

b. Reclamation shall develop an irrigation schedule appropriate for establishing vegetation plantings consistent with the SAM assumptions for riparian survival.

c. These reports and documents shall be sent to the address below a minimum of 60 days prior to their implementation to allow NMFS personnel sufficient time to review them.

d. Prior to the diversion and fish screen becoming operational, a post-construction inspection of the project area must be conducted by NMFS, to insure that the streambank is planted according to the design plans as suggested by the SAM analysis to ensure the riparian habitat is properly planted and restored.

e. Reclamation shall develop and implement a NMFS-approved off-site mitigation plan or purchase credits at a 1:1 ratio (in linear feet) at a NMFS approved conservation bank to compensate the temporal and permanent loss of habitat resulting from the construction of the diversion structures on the Sacramento River. This condition must be met within 6 months of the issuance of this biological opinion.

Reports and notifications required by these terms and conditions shall be submitted to:

Sacramento Area Office
National Marine Fisheries Service
650 Capitol Mall, Suite 8-300
Sacramento California 95814-4706
FAX: (916) 930-3629
Phone: (916) 930-3600

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. These conservation recommendations include discretionary measures that Reclamation can implement to avoid or minimize adverse effects of a proposed action on a listed species or critical habitat or regarding the development of information. NMFS provides the following conservation recommendations that would avoid or reduce adverse impacts to listed salmonids:

1. Reclamation, under the authority of section 7(a)(1) of the ESA, should implement recovery plan-based actions within and outside of traditional water management projects. Such actions may include, but are not necessarily limited to restoring natural river function and floodplain development, maintaining water quality and appropriate hydrographs, and screening of water diversions.

2. The Reclamation should continue to focus on acquiring, retaining, restoring and creating river riparian corridors to assist in the recovery of the listed salmonid and sturgeon species

within their right of way property along the Sacramento River.

3. Reclamation should implement biotechnical measures in place of traditional revetment techniques should any of the project riprap begin to cause scour and require additional bank stabilization in the future.

4. Reclamation should conduct or fund studies to help quantify fish predation and changes of migration patterns in the area of the two new screened diversions.

5. Reclamation should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects within the Sacramento River.

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

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the ABFS project. Reinitiation of formal consultation is required if: (1) the amount or extent of taking specified in any incidental take statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the action, including the avoidance, minimization, and compensation measures listed in the *Description of the Proposed Action* section is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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Enclosure 2

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

Agency:	U.S. Bureau of Reclamation
Activity:	American Basin Fish Screen and Habitat Improvement Project
Consultation Conducted By:	Southwest Region, National Marine Fisheries Service
File Number:	151422SWR2004SA9112 F/SWR/2008/0196
Date Issued:	

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

This document represents the National Marine Fisheries Service's (NMFS) Essential Fish Habitat (EFH) consultation based on our review of information provided by the U.S Bureau of Reclamation (Reclamation), California Department of Fish and Game (CDFG), and the Natomas Central Mutual Company on the proposed American Basin Fish Screen and Habitat Improvement Project (ABFS). The Magnuson-Stevens Fishery Conservation Act (MSA) as amended (U.S.C 180 et seq.) requires that EFH be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NMFS on activities which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies. The geographic extent of freshwater EFH for Pacific salmon in the Sacramento River includes waters currently or historically accessible to salmon within the Sacramento River.

EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle.

The biological opinion for the ABFS project addresses Chinook salmon listed under the both the

Endangered Species Act (ESA) and the MSA that potentially will be affected by the proposed action. These salmon include Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), and Central Valley spring-run Chinook salmon (*O. tshawytscha).* This EFH consultation will concentrate on Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) because they are covered under the MSA but not listed under the ESA.

Historically, Central Valley fall-run Chinook salmon generally spawned in the Central Valley and lower-foothill reaches up to an elevation of approximately 1,000 feet. Much of the historical fall-run spawning habitat was located below existing dam sites and the run therefore was not as severely affected by water projects as other runs in the Central Valley.

Although fall-run Chinook salmon abundance is relatively high, several factors continue to affect habitat conditions in the Sacramento River, including loss of fish to unscreened agricultural diversions, predation by warm-water fish species, lack of rearing habitat, regulated river flows, high water temperatures, effluents from wastewater treatment plants, and reversed flows in the Delta that draw juveniles into State and Federal water project pumps.

A. Life History and Habitat Requirements

Central Valley fall-run Chinook salmon enter the Sacramento River from July through December, and late fall-run enter between October and March. Fall-run Chinook salmon generally spawn from October through December, and late fall-run fish spawn from January to April. The physical characteristics of Chinook salmon spawning beds vary considerably. Chinook salmon will spawn in water that ranges from a few centimeters to several meters deep provided that the there is suitable sub-gravel flow (Healey 1991). Spawning typically occurs in gravel beds that are located in marginally swift riffles, runs and pool tails with water depths exceeding one foot and velocities ranging from one to 3.5 feet per second. Preferred spawning substrate is clean loose gravel ranging from one to four inches in diameter with less that 5 percent fines (Reiser and Bjornn 1979).

Fall-run Chinook salmon eggs incubate between October and March, and juvenile rearing and smolt emigration occur from January through June (Reynolds *et al.* 1993). Shortly after emergence, most fry disperse downstream towards the Sacramento-San Joaquin Delta and estuary while finding refuge in shallow waters with bank cover formed by tree roots, logs, and submerged or overhead vegetation (Kjelson *et al.* 1982). These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Smolts generally spend a very short time in the Delta and estuary before entry into the ocean.

II. PROPOSED ACTION.

Reclamation proposes to provide funding and technical assistance to the Natomas Central Mutual

Company to consolidate five existing unscreened water pumping plants on the Sacramento River and Natomas Cross Canal (NCC) into two screened diversion facilities. The proposed action is described in the *Description of the Proposed Action* section of the preceding biological opinion (Enclosure 1).

III. EFFECTS OF THE PROPOSED ACTION

The effects of the proposed action on Pacific Coast salmon EFH would be similar to those discussed in the *Effects of the Proposed Action* section of the preceding biological opinion (Enclosure 1) for endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, and threatened Central Valley steelhead. A summary of the effects of the proposed action on Central Valley fall-/late fall-run Chinook salmon are discussed below.

Adverse effects to Chinook salmon habitat will result from the permanent removal of shaded riverine aquatic habitat at the two diversion sites.

IV. CONCLUSION

Upon review of the effects of the ABFS project, NMFS believes that the project will result in adverse effects to the EFH of Pacific salmon protected under the MSA.

V. EFH CONSERVATION RECOMMENDATIONS

Considering that the habitat requirements of fall-run within the action area are similar to the Federally listed species addressed in the preceding biological opinion (Enclosure 1), NMFS recommends that Terms and Condition 3 a-e as well as all the Conservation Recommendations in the preceding biological opinion prepared for the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead ESUs be adopted as EFH Conservation Recommendations.

VI. ACTION AGENCY STATUTORY REQUIREMENTS

Section 305(b)(4)(B) of the MSA and Federal regulations (50 CFR § 600.920) to implement the EFH provisions of the MSA require Federal action agencies to provide a detailed written response to NMFS, within 30 days of its receipt, responding to the EFH conservation recommendations. The response must include a description of measures adopted by the Agency for avoiding, mitigating, or offsetting the impact of the project on Pacific salmon EFH. In the case of a response that is inconsistent with NMFS' recommendations, the Agency must explain their reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(j)).

VII. LITERATURE CITED

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