UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

JUL 7 2014

In Response Refer To: 2013-9541

Mr. Tom Balkow
Senior Environmental Planner
Department of Transportation
Local Assistance, District 2
1657 Riverside Drive, MS 5
Redding, California 96001

Dear Mr. Balkow:

This document transmits the National Marine Fisheries Service's (NMFS) biological opinion (BO) (Enclosure 1) based on our review of the California Department of Transportation's (Caltrans) proposed Jellys Ferry Bridge Replacement Project (project) located in northern Tehama County, California, and its effects on the federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) evolutionary significant unit (ESU), threatened Central Valley (CV) spring-run Chinook salmon ESU (*O. tshawytscha*), threatened California Central Valley (CCV) steelhead distinct population segment (DPS) (*O. mykiss*), threatened North American green sturgeon southern DPS (*Acipenser medirostris*) and their respective designated critical habitats in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). Your request for initiation of formal section 7 consultation on this Project was received on October 25, 2013. On November 12, 2013, formal consultation was initiated by NMFS' California Central Valley Office (CCVO).

This BO is based on the biological assessment provided on October 25, 2013. Based on the best available scientific and commercial information, the BO concludes that the project is not likely to jeopardize the continued existence of the federally listed endangered Sacramento River winter-run Chinook salmon (*O. tshawytscha*) ESU, threatened CV spring-run Chinook salmon ESU, (*O. tshawytscha*), threatened CCV steelhead DPS (*O. mykiss*), or threatened Southern DPS of North American green sturgeon (*A. medirostris*), and is not likely to destroy or adversely modify their designated critical habitats. NMFS has also 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 species associated with the project.

This letter also transmits NMFS's essential fish habitat (EFH) conservation recommendations for Pacific salmon 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 project will adversely affect the EFH of Pacific salmon in the action area and adopts the ESA reasonable and prudent measures and associated terms and conditions from the BO as the EFH conservation recommendations.

Caltrans has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed written response to NMFS within 30 days of receipt of these conservation recommendations, and 10 days in advance of any action, that includes a description of measures for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR 600.920(j)). If unable to complete a final response within 30 days, Caltrans should provide an interim written response within 30 days before submitting its final response. In the case of a response that is inconsistent with our recommendations, Caltrans must explain its 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, or mitigate such effects.

Please contact Dylan Van Dyne at (916) 930-3725, or via e-mail at Dylan.VanDyne@noaa.gov, if you have any questions regarding this response or require additional information.

Sincerely,

Maria Rea
for William W. Stelle, Jr.
Regional Administrator

Enclosures (2)

cc: Copy to File: 2013SA00088
California Central Valley Office Division- File Copy

Enclosure 1

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

BIOLOGICAL OPINION

ACTION AGENCY: California Department of Transportation

ACTION: Jellys Ferry Bridge Replacement Project

CONSULTATION CONDUCTED BY: National Marine Fisheries Service, West Coast Region

FILE TRACKING NUMBER: 151422SWR2013SA00088 (T/N 2013/9541)

DATE ISSUED: JUL 7 2014

I. CONSULTATION HISTORY

On March 26, 2013, the California Department of Transportation (Caltrans) requested formal consultation with NOAA's National Marine Fisheries Service (NMFS) for the Jellys Ferry Bridge Replacement Project (project) located in northern Tehama County, California.

On May 21, 2013, NMFS sent an insufficiency letter to Caltrans requesting additional information which effectively closed out the consultation.

On October 25, 2013, NMFS received an amended biological assessment (BA) and letter from Caltrans requesting initiation of section 7 formal consultation under the Endangered Species Act (ESA).

On November 12, 2013, NMFS deemed the formal consultation package from Caltrans complete, and initiated formal consultation.

On July 2, 2014, NMFS and Caltrans discussed shifting in-water work window to further protect outmigrating juvenile winter-run Chinook salmon by phone. Caltrans agreed to the shift and sent a subsequent email describing the change to their original project description.

A complete administrative record of this consultation is on file at the NMFS' West Coast Region (WCR) California Central Valley Office (CCVO).

The U.S. Army Corps of Engineers (Corps) will be issuing Caltrans a permit for this project. This biological opinion will therefore satisfy the requirements for the Corps to consult with NMFS under section 7 of the ESA of 1973, as amended (16 U.S.C 1531 et seq.) for this project.

II. DESCRIPTION OF THE PROPOSED ACTION

A. Project Overview

The purpose of the project is to replace the structurally-obsolete and seismically deficient existing bridge structure over the Sacramento River. The project is located on Jellys Ferry Road over the Sacramento River, approximately 9 miles north of Red Bluff and 7.5 miles east of Interstate 5, in northern Tehama County, California (Figures 1 and 2). The proposed project consists of three elements; replacement of the existing bridge, realignment of Jellys Ferry Road, and relocation of a portion of the Bureau of Land Management (BLM) recreational facilities.

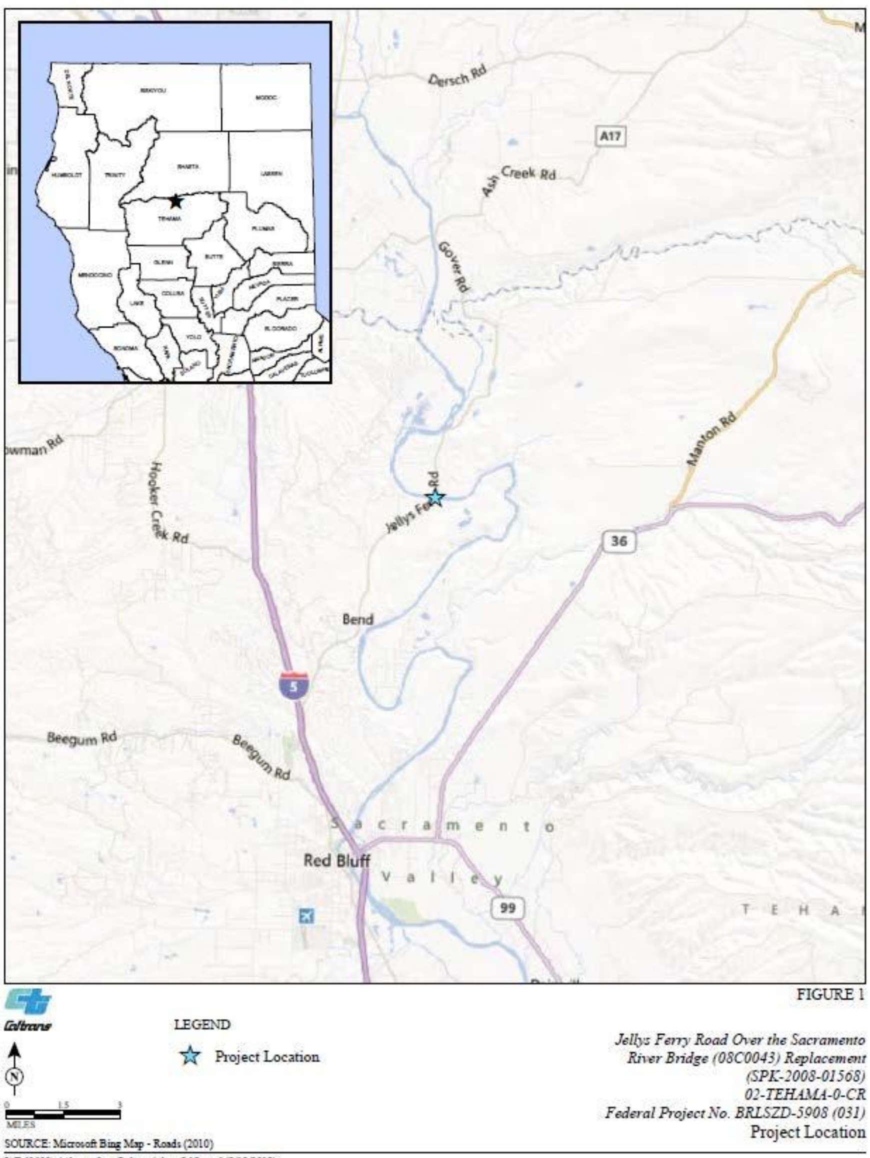

Figure 1—Project Location

Figure 2—Project Vicinity

The proposed bridge replacement project requires the realignment of a portion of Jellys Ferry Road, and temporary and permanent modification of a portion of the adjacent BLM recreational facilities in order to construct the new bridge over the Sacramento River channel. The existing Jellys Ferry Road is overtopped frequently by overflow from the Sacramento River at two locations. One location, Overflow No. 1, is located just north of the existing Sacramento River Bridge north abutment and the other location, Overflow No. 2, is approximately 2,200 feet north of the existing Sacramento River Bridge north abutment. The proposed bridge replacement project raises the road profile to increase safety by preventing overtopping of the road from Sacramento River overflow during the 100-year flood event. Overflow from the Sacramento River at the Overflow No. 1 location would be conveyed through the longer hydraulic opening of the proposed Sacramento River Bridge. Overflow from the Sacramento River at the Overflow No. 2 location would be conveyed through a new Overflow No. 2 Bridge (via passing under the newly constructed Overflow No. 2 Bridge.

The proposed new bridge and roadway alignment would begin approximately 4.3 miles north of the intersection with Bend Ferry Road and would end just south of the intersection with Saron Fruit Colony Road.

The south approach to the new Sacramento River Bridge would be approximately 800 feet in length with a maximum embankment fill height of approximately 6 to 10 feet. The north approach would be approximately 1,300 feet in length with a maximum embankment fill height of approximately 20 feet. The north approach roadway for the Sacramento River Bridge would be raised to prevent overtopping north of the existing abutment.

The proposed Overflow No. 2 Bridge would prevent frequent overtopping in the low lying area of Jellys Ferry Road north of the proposed Sacramento River Bridge north approach by passing flow from the adjacent Sacramento River overflow channel under this second bridge structure. At this location, the maximum embankment fill height would be approximately 11 feet corresponding to the 100-year flood level of hydraulic service to prevent overtopping of the roadway. The south approach roadway length for the Overflow No. 2 Bridge would be approximately 400 feet in length. The approach roadway length from the north end of the overflow bridge to the end of the project would be approximately 1,200 feet.

The proposed new Sacramento River Bridge would be constructed on a new alignment approximately 45 feet west (upstream) of the existing bridge, measured at the south bank of the Sacramento River and approximately 190 feet west (upstream) of the existing bridge measured at the north bank of the Sacramento River. The new bridge would be approximately 1,264 feet in length and would be comprised of a six span cast-in-place post-tensioned box girder superstructure with varying depth supported on single column piers (9-foot diameter columns for the main channel piers 2 and 3, and 6-foot diameter columns for piers 4, 5 and 6) founded on cast-in-drilled hole (CIDH) concrete piles. The bridge end spans would be supported on seat-type abutments with approximately 12 foot by 40 foot spread footings with rock slope protection (RSP) as needed for scour protection. The bridge would be wide enough to accommodate two 12-foot wide undivided lanes, two 6-foot (5-foot minimum, 6-foot preferred) wide shoulders classified as Class II bicycle lanes, and two approximately 2-foot wide solid or "see-through" concrete barriers.

The Overflow No. 2 Bridge would be constructed on a new alignment approximately 130 feet east of the existing road at the south abutment and approximately 50 feet east of the existing road at the north abutment. The Overflow No. 2 Bridge would be approximately 685 feet in length and would be comprised of an eleven-span cast-inplace post-tensioned slab bridge supported on multiple drilled shaft extensions at each pier. The end spans would be supported on seat-type abutments founded on CIDH piles. The bridge would be wide enough to accommodate two 12 foot wide undivided lanes, two 6-foot (5-foot minimum, 6-foot preferred) wide shoulders classified as Class II bicycle lanes, and two approximately 2-foot wide solid or "see-through" concrete barriers.

The proposed project would require the relocation of the BLM recreation area access road and realignment of the existing recreational area circulation road to accommodate the shift in alignment of Jellys Ferry Road. Access to the BLM recreational site would be relocated to the east side of Jellys Ferry road approximately 550 feet to the north of the existing entrance. The proposed project would also require potential retaining walls, storm water drainage facilities, bank protection, reconstruction of existing residential driveways, replacement or relocation of existing fencing, and the restoration of existing landscaping.

A retaining wall would be required along the west side of the north approach roadway to the Sacramento River Bridge. The wall would vary in height from a maximum of approximately 20 feet at the north abutment to a minimum of approximately 5 feet approximately 450 feet north of the north abutment. The purpose of this retaining wall would be to prevent encroachment of the north approach roadway fill into the adjacent wetlands and jurisdictional waters of the United States at this location.

Storm water run-off from Jellys Ferry Road south of the proposed Sacramento River Bridge would be collected in roadside ditches. The ditches would convey the run-off south and discharge into an existing ephemeral drainage system. Storm water run-off from the proposed Sacramento River Bridge would be collected in deck drains and conveyed to a new drainage system on the north side of the Sacramento River. This drainage system would consist of a series of ditches along the toe of the roadway embankment which would eventually convey the storm water runoff from the bridge and the north approach roadway into either the overflow channel, on the west side of the north approach, or through the BLM Park where it would eventually empty into the Sacramento River downstream of the Sacramento River Bridge. The drainage system would be designed to discharge water to the overflow channel or Sacramento River.

North of the Sacramento River Bridge, along the south approach of the proposed Overflow No. 2 Bridge, storm water run-off from Jellys Ferry Road would be collected in ditches along the toe of the roadway embankment on either side of the road and would be conveyed north to discharge into the Overflow No. 2 channel. Storm water run-off from the Overflow No. 2 Bridge would be collected along the curb or in deck drains and would be routed to the drainage systems at each abutment. Run-off from the north half of the bridge would be routed to the drainage system at the north abutment while run-off from the south half of the bridge would be routed to the drainage system at the south abutment. North of the Overflow No. 2 Bridge, storm water-runoff from Jellys Ferry Road would be collected in ditches at the toe the road embankment and would be conveyed south to eventually discharge into the Overflow No. 2 Channel. Vegetative swales may be used as part of the drainage systems described above to meet the runoff requirements of the County and the Regional Water Quality Control Board (RWQCB).

Bank protection would be likely required at several locations to prevent scour during high flow events. Slope protection may be required at the south abutment of the Sacramento River Bridge to protect the spread footing foundation from high flows in the Sacramento River. Slope protection would likely be required at the north abutment of the Sacramento River Bridge to protect the spread footing foundation and the base of the retaining wall along the west side of the north approach roadway during high flow events. Slope protection may also be required along portions of Jellys Ferry Road between the Sacramento River and Overflow No. 2 Bridges to protect against scour from high flows in the adjacent Sacramento River Overflow Channel. Slope protection would also likely be required at the south and north abutments of the Overflow No. 2 bridge to protect against scour due to high flows in the Sacramento River Overflow Channel and the Overflow No. 2 channel. Slope protection would be designed based on the anticipated velocities for the various design flood events. Slope protection would likely consist of RSP or other pervious slope protection measures.

B. Construction Activities

Staging of construction materials and equipment for periods longer than one construction season would be limited to areas above the 100-year flood plain. The staging of materials for shorter than one construction season, and in periods of relatively dry weather (i.e., the weather forecast indicates there is less than a 50 percent chance of rain), could be possible in other areas as well. The 100-year flood plain of the Sacramento River in the project area extends north into the northern portion of the project limits. All material and equipment stored in the 100-year flood plain would be removed upon notification of a potential for a 100-year flood event.

Staging of construction materials and equipment are proposed at two locations, one on each side of the river. The proposed staging area on the north side of the river is located east of and adjacent to existing Jellys Ferry Road, north of where the new bridge would touch down. The proposed staging area on the south side of the river is located west of and adjacent to the new south abutment.

The existing Sacramento River Bridge at Jellys Ferry Road would remain open throughout the construction of the new bridge to provide access across the Sacramento River. One of the first construction activities will be to install temporary access into the Sacramento River for erection of bridge piers, bridge foundation construction, and bridge falsework. Such access may be provided by means of gravel pads and platforms/trestles.

Anti-spawning mats would be installed in areas of suitable spawning habitat (including one identified area of fair quality spawning habitat for salmon and steelhead approximately 350 feet downstream of the existing bridge) between March 1 and April 15 during the first construction season. The mats would consist of chain-link fence and would be securely attached to the river bottom. Anti-spawning mats would be removed between November 1 and November 30 of the first construction season.

The anti-spawning mats are proposed for the first in-water work window since that is when the gravel pads will be constructed and when percussive driving of the temporary piles to support the construction access trestle and superstructure falsework supports will occur. Anti-spawning mats are not proposed for the second in-water work window since there will be no percussive driving operations. The in-water work activities in the second construction season consist of removal of the temporary piles, trimming of the CIDH casing and demolition of the in-water piers of the existing bridge.

Temporary work platforms are required for construction of the new bridge and removal of the existing bridge. In order to maintain water flows, at least a portion of the temporary work platforms must be an elevated structure (*i.e.*, a trestle) that would be supported on piles. Due to the number of piles required to support the trestles, it would not be feasible from an economic and time standpoint to twist or rotate the piles in place or drill a hole and then insert the pile; consequently, driving the piles is the only feasible method of installation. To minimize the quantity of piles required, and associated acoustic impacts, gravel approach pads would be constructed at both ends of the trestles.

Two gravel approach pads would be placed in the river, one extending from the south bank to pier 2 (approximately 120 feet in length), and one from the north bank extending to pier 3 (approximately 130 feet in length). To accommodate both an upstream and downstream work trestle, each gravel pad would have an approximate top width of 130 feet (approximate bottom width of 180 feet). These pads would consist of 1-inch to 4-inch diameter uncrushed, washed and rounded river rock (*i.e.*, spawning gravel). The gravel pads would vary in height depending on future hydraulic analysis and environmental restrictions with a maximum height of 40 feet and would be reinforced with stepped temporary barrier rail around the perimeter exposed to the river to prevent erosion in the river. A minimum 200-foot wide section of the river would remain open between the two gravel pads, throughout the duration of construction. No water diversions would be required.

Temporary work trestles would be built either upstream and or downstream of the new bridge to span between the gravel pads and access the proposed and existing bridges as required. The trestles would be offset from the proposed edge of deck and cross from the south bank to the north bank. A downstream trestle located between the existing and proposed structures could be used to construct the proposed bridge and could also be used to access the existing structure for removal. The temporary trestles would be up to 40 feet wide with spans of 25 feet to 30 feet. Each temporary trestle would be supported on approximately 50-thick-walled, 12-inch driven steel H-piles (or equivalent), with an additional 30-piles for finger piers to access and remove the existing bridge piers, for a total of approximately 130 piles (assuming two trestles are used). The trestles would be designed to resist the 100-year peak flow for the Sacramento River. The temporary trestle deck would consist of steel W-beams overlaid by timber decking.

It is expected that approximately 6 trestle piles per day could be driven, though it is likely some days fewer than 6 piles would be driven since the contractor would need to alternate pile driving and deck construction. It is estimated that pile driving for the temporary trestles and finger piers would take between 22 and 32 days to complete (Table 1).

Table 1—Summary of Pile Driving Assumptions

Activity	Pile Type	Pile Diameter	Total Number of Piles	Piles Per Day	Strikes Per Pile	Total Strikes Per Day	Total Number of Days of Pile Driving
Temporary Trestle (including finger piers)	thick-walled H-Pile	12 inch	130	6	550	3,300	22 to 32
Temporary Falsework	thick-walled H-Pile	12 inch	100	6	550	3,300	22 to 32
Totals	----	----	230	----	----	----	44 to 64

Once the contractor has built the work pads and trestles in the river, the pier foundations for the new bridge would be constructed. For the construction of the CIDH pile foundations, a temporary steel casing would be rotated into the ground or river bed (for the in-water piers) and then excavated to the required pile depth. Pile reinforcement would then be lowered into the pile, concrete would be placed (displacing the water in the pile) and the temporary steel casing would be removed. Water displaced from the pile would be collected and disposed of offsite. After construction of the CIDH pile shaft, the pier columns above would be formed and poured.

Prior to installation of the two CIDH main channel pier support piles, the temporary CIDH pile steel casings would have a 3/32-inch wire mesh attached to the bottom of the casings. The mesh would be installed prior to the casings being lowered into the water. The wire mesh would prevent any fish from being trapped during the installation of the CIDH pile temporary casings.

The mesh would be torn up as the casings are rotated into the ground, and excavated out of the center of the pile during pile excavation and clean out.

The next stage of work would be construction of the temporary falsework to support the bridge superstructure. The temporary false work would extend between the upstream and downstream trestles supported by steel beams and approximately 100, thick-walled, 12-inch driven steel H-piles (or equivalent; Table 1). The temporary steel piles would be designed to resist the 100 year peak flow for the Sacramento River. Some of the false work would also be supported by gravel pads.

Similar to the temporary trestles, it is expected that approximately 6 piles per day could be driven, for a total of approximately 22 and 32 days of pile driving for the falsework (Table 1).

Once the false work is in place, the new bridge superstructure can be constructed beginning with the soffit (bottom slab of box girder) and girder stems and ending with the bridge deck. The structure would be "post tensioned" followed by removal of the falsework.

Once the proposed Sacramento River Bridge and approaches have been completed, and are open to traffic, removal of the existing bridge and approaches will begin. Demolition of the existing Jellys Ferry Road Bridge would start with the removal of the bridge deck. Removal of the deck would require placement of heavy tarps or an equivalent debris collection device under the bridge to prevent materials or liquids from falling into the Sacramento River. The debris collection devices would be supported by the existing structure as long as the existing superstructure remains in place. Once the existing bridge superstructure is removed, work would proceed with removal of the bridge piers. During the removal of the bridge piers, construction equipment and personnel would work from finger piers extending from the downstream trestle to each of the existing piers located in the river channel. Alternatively, the contractor might choose to reconfigure the downstream trestle or use a floating barge system or combination of the two in order to access and support theexisting bridge superstructure during demolition. Due to the hard subsurface conditions present and the drilled shaft construction for the existing bridge in-water piers, removal of the existing bridge piers is not anticipated to be possible without the use of a wire saw operated by divers to cut the existing concrete piers in the water as close as possible to the bottom of the river.

Raising the road profile to prevent frequent overtopping of the roadway by the adjacent Sacramento River Overflow Channel No. 2 would require reconstructing Jellys Ferry Road on an offset alignment east of the existing road and providing a proposed new bridge to convey the flows in the Overflow No. 2 Channel which currently overtop Jellys Ferry Road. Once construction of the raised roadway has been completed, traffic would be shifted to the raised roadway and the old pavement would be removed and the ground returned to a natural state.

All removed debris and materials used for demolition of the existing structure, approach embankment and approach roadway and not slated for salvage, would become the property of the construction contractor and would be disposed of in conformance with the Caltrans Standard Specifications including any required permits, licenses or environmental clearances. After the existing bridge has been removed the temporary trestle would be removed. When removing the gravel pads, following completion of construction, the bottom one foot of gravel shall be left in the channel to avoid impacts to the natural bed of the river. Finally, the areas of the river banks that were disturbed during construction would be returned to pre-construction conditions.

Construction of the proposed project would last approximately 18 months and span two construction seasons; construction is scheduled to begin in April and end in October of the following year (*e.g.*, April 2016 to October 2017). In-water work activities in the Sacramento River would be conducted during two discreet periods as described below.

The first in-water work period would last approximately 15 weeks, from May 1 through August 15 of the first construction season. Construction activities that would be conducted during the first in-water work period include construction of the gravel work pads and the temporary work trestles, construction of the in-water CIDH piles for piers 2 and 3, and driving the piles for the temporary falsework. All pile driving activities (*i.e.*, for construction of the temporary trestles and the temporary falsework) would be completed during the first in-water work period.

The second in-water work period would last approximately 20 weeks, from late March through mid-August of the second construction season. Construction activities that would be conducted during the second in-water work period include removing the falsework piling, removing / demolishing in-water piers from the existing bridge, and removing the temporary trestles and gravel construction pads.

Installation and removal of the anti-spawning mats would occur independent from the in-water work periods, between March 1 and April 15, and between November 1 to 30, respectively. Installation of the mats is an exception to the in-water work periods where the intent is to avoid impacts to incubating eggs by keeping spawning winter- and spring-run Chinook salmon out of the action area.

The construction contractor would be permitted to work during daylight hours to complete all construction activities associated with construction of the new bridge and demolition of the existing bridge, including construction of the temporary gravel work pads, temporary trestles, and temporary falsework. The contractor may be permitted to work during nighttime hours to complete detour maintenance/traffic control only.

The installation of two permanent CIDH piles equates to a 226 square feet (sq ft) area of project impacts. The installation of gravel pads equates to 11,700 sq ft of project impacts. The existing bridge piers founded on the CIDH piles will be removed from the river at the end of the demolition of the existing bridge. This work equates to 199 sq ft of project impacts. Therefore, the total square foot area project footprint estimate for in-water work during construction is 12,125 sq ft.

C. Avoidance, Minimization and Conservation Measures

The following measures will be implemented to ensure impacts to Sacramento River winter-run Chinook salmon, Central Valley (CV) spring-run Chinook salmon, California Central Valley (CCV) steelhead, and North American green sturgeon and their habitat are minimized to the greatest extent possible:

1) The contractor will prepare a storm water pollution prevention plan (SWPPP) for Caltrans review and approval. Along with the SWPPP preparation, any needed species surveys or awareness training will be conducted including any initial species protection measures that are not ground disturbing;

2) The contractor will protect environmentally sensitive areas with highly visible type environmentally sensitive area temporary fencing;

3) Mobilization of the contractor will begin with the placement of temporary construction entrances at staging areas and construction areas and the completion of any initial species protection measures that are ground disturbing;

4) In-water work shall be limited to the period of May 1 to August 15 during the first construction season, and during the period of late March to mid-August during the second construction season. The spring/summer in-water work window would avoid in-water work during the peak of winter- and spring-run Chinook juvenile outmigration;

5) Anti-spawning mats shall only be utilized during the first construction season. The mats shall be installed between March 1 and April 15 to avoid effects to incubating eggs of winter- and spring-run Chinook salmon that could utilize the small area of spawning habitat located downstream of the bridge. Installation shall be monitored by a qualified fisheries biologist;

6) Anti-spawning mats shall be removed between November 1 through 30 (of the first construction season), which is after the spawning period for winter- and spring-run Chinook salmon. Removal shall be monitored by a qualified fisheries biologist;

7) Anti-spawning mats shall be monitored on a weekly basis, by a qualified fisheries biologist, and maintained in proper functioning condition *(i.e.*, secured to substrate without holes or establishment of spawning gravels on top of the mats). Should the anti-spawning mats not be functioning properly, all percussive construction work shall cease until the mats have been restored to proper functioning condition;

8) Temporary gravel work pads would be constructed on either end of the temporary work trestles to minimize the length of the trestles and, therefore, the number of piles required to support the trestles, which results in less pile driving and associated acoustic impacts;

9) Gravel used for the temporary work pads shall consist of 1-inch to 4-inch diameter uncrushed, washed and rounded river rock (aka spawning gravel) and shall meet Caltrans Gravel Cleanliness Specifications (Caltrans 2013). The stable layer that would need to be placed for the gravel approaches shall consist of the cleanest possible materials (*i.e.*, metal sheets similar to air craft landing mats). If unclean materials such as dirt need to be used, they shall be enveloped in geotextile fabric over the clean gravel to contain the material and allow for a more complete and clean gravel removal from the river;

10) Following completion of construction, the bottom one-foot of gravel pad shall be left in the channel to avoid impacts to the natural bed of the river and to provide a source of suitable spawning gravel to be dispersed by natural flows in the river;

11) Water collected in the CIDH casings shall be pumped into settling basins on the bank or into trucks for off-site disposal;

12) If the temporary CIDH casing is installed in free standing water, water trapped inside the casing shall be inspected by a qualified fishery biologist, prior to the next step in CIDH pile construction immediately following embedment of the temporary casing in the stream bead to ensure that no salmonids or sturgeon have been trapped within the casing

(3/32-inch wire mesh would be installed on the bottom of the CIDH casing to prevent entrapment of salmonids or sturgeon inside the casing). Any trapped salmonids or sturgeon shall be removed and returned to the river. The fishery biologist shall note the number and condition of individuals trapped, the number of individuals relocated, and the date and time of collection and relocation. One or more of the following NMFS approved capture techniques shall be used: dip net, seine, throw net, minnow trap, or by hand. Electro fishing may be used if NMFS has reviewed the biologist's qualifications and provided written approval. When and if necessary, a qualified fishery biologist may halt work activity and recommend measures for avoiding adverse effects to salmonids and their habitat and inform NMFS of any such occurrences;

13) Any water to be removed from the CIDH casings shall be pumped into settling basins on the bank with no return drainage to the river or into trucks for off-site disposal;

14) Measures consistent with the current Caltrans' Construction BMP Manual, including the SWPPP and Water Pollution Control Plan (WPCP) Manuals, shall be implemented to minimize effects to listed fish and their critical habitat resulting from erosion, siltation, and other water quality impacts during and after construction;

15) Adequate fish passage within the Sacramento River at the project site would be maintained at all times. Approximately 200 feet of river channel width would remain open for fish passage (total width of the river is approximately 300-350 feet). This would allow the opportunity for fish to move away from active work areas and to have unabated passage to and through the project area;

16) During removal of the deck, heavy tarps or an equivalent debris collection device shall be placed under the bridge to minimize the potential for materials or liquids from falling into the Sacramento River; and

17) All construction activities associated with construction of the new bridge and demolition of the existing bridge, including construction of the temporary gravel work pads, temporary trestles, and temporary falsework, shall be conducted during daylight hours. The only allowed exception is minor activities associated with detour maintenance and/or traffic control, which may be conducted during nighttime hours.

D. Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR § 402.02). Direct effects include those resulting from interdependent or interrelated actions. Indirect effects are defined as those effects that are caused by or will result from the proposed action and are later in time, but still reasonably certain to occur (50 CFR §402.02). The action area is not the same as the project boundary area because the action area must delineate all areas where federally-listed populations of salmon, steelhead and green sturgeon may be affected by the implementation of the proposed action.

The proposed project action area consists of two components:

1. The terrestrial component of the action area is defined by:

    a. The project footprint, including all cleared areas, and staging areas; and

    b. The area where construction noise levels are in excess of ambient conditions.

2. The aquatic component of the action area is defined by:

    a. The segment of the Sacramento River upstream and downstream of bridge construction sites where pile driving sound noise levels in water are expected to exceed current threshold criteria (maximum zone of impact distance is 178 meters, or 356 meters in diameter);

    b. Construction-related water quality impacts in excess of ambient conditions; and

    c. Operational stormwater quality impacts in excess of ambient conditions.

The action area includes the Sacramento River (at river mile (RM) 36) and associated floodplains and riparian areas that could be affected directly or indirectly by the project. The action area is within the immediate construction area that extends 32 meters upstream and 32 meters downstream to the outer limits of vibratory effects for the Project. For construction activities, the action area is defined as the entire width of the river. The riverbed is wide (approximately 350 feet to bankfull channel width from side to side) and varied, composed of a narrow riparian corridor and undeveloped natural habitats (e.g., mixed riparian forest, annual grassland, riverine).

The reach of the river in the action area is relatively shallow, ranging from approximately 6 to 8 feet deep in the summer and 14 to 16 feet deep in the winter. The substrate of the channel consists of approximately 20 feet of gravel and cobbles underlain by a cemented volcanic layer. The Sacramento River is inhabited by aquatic species that use the river for foraging, migration, and breeding.

The action area of the entire project encompasses approximately 72.61 acres. The action area located within the OHWM of the Sacramento River is approximately 4.78 acres and represents the area within and adjacent to the Sacramento River that is used by Sacramento River winter-run Chinook salmon, CCV steelhead, CV spring-run Chinook salmon, and North American green sturgeon where these fish could potentially be exposed to construction related effects including changes in water turbidity, sedimentation, near shore impacts to riparian habitat, the acoustic sounds of pile driving within the water column and the area of potential fish rescue actions.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following federally listed species ESUs or DPS' and designated critical habitat occur in the action area and may be affected by the proposed action:

Sacramento River winter-run Chinook salmon ESU (*Oncorhynchu tshawytscha*)
Listed as endangered (70 FR 37160, June 28, 2005)

Sacramento River winter-run Chinook salmon designated critical habitat (June 16, 1993, 58 FR 33212)

CV spring-run Chinook salmon ESU (*O. tshawytscha*)
Listed as threatened (70 FR 37160, June 28, 2005)

CV spring-run Chinook salmon designated critical habitat (70 FR 52488, September 2, 2005)

CCV steelhead DPS (*O. mykiss*)
Listed as threatened (71 FR 834, January 5, 2006)

CCV steelhead designated critical habitat
(70 FR 52488, September 2, 2005)

Southern DPS of North American green sturgeon (*Acipenser medirostris*)
Listed as threatened (71 FR 17757, April 7, 2006)

Southern DPS of North American green sturgeon designated critical habitat (74 FR 52300, October 9, 2009)

NMFS has recently completed an updated status review of five Pacific salmon ESUs and one steelhead DPS, including Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and California Central Valley steelhead, and concluded that the species' status should remain as previously listed (76 FR 50447; August 15, 2011). The 2011 status reviews (NMFS 2011a, 2011b, 2011c) additionally stated that, although the listings should remain unchanged, the status of these populations have worsened over the past five years since the 2005/2006 reviews and recommended that status be reassessed in two to three years as opposed to waiting another five years.

A. Species and Critical Habitat Listing Status

Sacramento River winter-run Chinook salmon were listed as threatened under ESA emergency listing procedures on August 4, 1989 (54 FR 32085) and again on April 2, 1990 (55 FR 12191) . A final rule to list winter-run Chinook salmon as a threatened species was published on November 5, 1990 (55 FR 46515). NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). The Sacramento River winter-run Chinook salmon ESU was reclassified as endangered in a final rule published on January 4, 1994 (59 FR 440) due to continuing decline and increased variability of run sizes since their listing as a threatened species, expected weak returns as a result of two small year classes in 1991 and 1993, and continuing threats to the population. The draft winter-run Chinook salmon recovery plan (NMFS

1997) recommended the implementation and continuation of several conservation measures, including the continued development of an enhancement program. The winter-run Chinook salmon ESU includes both naturally spawned winter-run Chinook salmon and the hatchery produced component of the population produced at Livingston Stone NFH. The abundance of the Sacramento River winter-run Chinook salmon population increased significantly leading into the early 2000s, prompting NMFS to propose reclassification of the ESU to "threatened" status in their review of 27 West Coast salmonid ESUs (69 FR 33102; June 14, 2004). The Sacramento River winter-run Chinook salmon ESU retained its "endangered" listing status as described in the final rule (70 FR 37160; June 28, 2005). Beginning in 2007, the abundance of Sacramento River winter-run Chinook salmon again declined, likely resulting from poor environmental conditions at the time juveniles entered the marine environment (Lindley *et al*. 2009).

CV spring-run Chinook salmon were listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Hatchery (FRH) spring-run Chinook salmon population has been included as part of the Central Valley spring-run Chinook salmon ESU in the most recent modification of the CV spring-run Chinook salmon listing status (70 FR 37160, June 28, 2005). Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005 (70 FR 52488), and includes the action area for the proposed study.

CCV steelhead were listed as threatened under the ESA on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento River and San Joaquin River (inclusive of and downstream of the Merced River) basins in California's CV. The Coleman National Fish Hatchery and FRFH steelhead populations have been included as part of the CCV steelhead DPS in the most recent modification of the CCV steelhead listing status (71 FR 834, January 5, 2006). 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 steelhead in the CV on September 2, 2005 (70 FR 52488). Critical habitat includes the stream channels to the ordinary high water line within designated stream reaches such as those of the American, Feather, and Yuba rivers, and Deer, Mill, Battle, Antelope, and Clear creeks in the Sacramento River basin; the Calaveras, Mokelumne, Stanislaus, and Tuolumne rivers in the San Joaquin River basin; and, the Sacramento and San Joaquin rivers and Delta. Designated critical habitat for CCV steelhead is found within the action area.

The Southern DPS of North American green sturgeon was listed as threatened on April 7, 2006, (71 FR 17757). Aside from recent confirmations of spawning in the Feather River (DWR 2011), the Southern DPS contains only a single spawning population in the Sacramento River, and rearing individuals may occur within the action area year round. Critical habitat was designated for the Southern DPS of green sturgeon on October 9, 2009, (74 FR 52300). Critical habitat includes the stream channels and waterways in the Delta to the ordinary high water line except for certain excluded areas. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, and the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery. Coastal Marine areas include waters out to a depth of 60 meters from Monterey Bay, California, to the Juan De Fuca Straits in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are also included as critical habitat for Southern DPS green sturgeon.

B. Species Life History and Population Dynamics

1. Chinook Salmon

a. General Life History

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 main stem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

During their upstream migration, adult Chinook salmon require stream flows sufficient to provide olfactory and other orientation cues used to locate their natal streams. Adequate stream flows are necessary to allow adult passage to upstream holding habitat. The preferred temperature range for upstream migration is 38^{o} Fahrenheit (F) to 56^{o}F (Bell 1991, CDFG 1998). Boles *et al.* (1988) recommends water temperatures below 65^{o}F for adult Chinook salmon migration, and Lindley *et al.* (2004) report that adult migration is blocked when temperatures reach 70^{o}F, and that fish can become stressed as temperatures approach 70^{o}F. Spring-run Chinook salmon holding in upper watershed locations prefer water temperatures below 60^{o}F; although Chinook salmon can tolerate temperatures up to 65^{o}F before they experience an increased susceptibility to disease.

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 and Sanford, 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 and Sanford (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 migrating upstream over the course of several days at a time (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 salmon, 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 showed peak upstream movement of adult CV spring-run Chinook salmon in lower Mill Creek, a tributary to the Sacramento River, occurring in the 4-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 1995a). The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad. The upper preferred water temperature for spawning Chinook salmon is 55°F to 57°F (Chambers 1956, Smith 1973, Bjornn and Reiser 1991, and Snider 2001).

Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, disease, predation, poor gravel percolation, and poor water quality. Studies of Chinook salmon egg survival to hatching conducted by Shelton (1995) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. A significant reduction in egg viability occurs at water temperatures above 57.5°F and total embryo mortality can occur at temperatures above 62°F (NMFS 1997). Alderdice and Velsen (1978) found that the upper and lower temperatures resulting in 50 percent pre-hatch mortality were 61°F and 37°F, respectively, when the incubation temperature was held constant. As water temperatures increase, the rate of embryo malformations also increases, as well as the susceptibility to fungus and bacterial infestations. The length of development for Chinook salmon embryos is dependent on the ambient water temperature surrounding the egg pocket in the redd. Colder water necessitates longer development times as metabolic processes are slowed. Within the appropriate water temperature range for embryo incubation, embryos hatch in 40 to 60 days, and the alevins (yolk-sac fry) remain in the gravel for an additional 4 to 6 weeks before emerging from the gravel.

During the 4 to 6 week period when alevins remain in the gravel, they utilize their yolk-sac to nourish their bodies. As their yolk-sac is depleted, fry begin to emerge from the gravel to begin exogenous feeding in their natal stream. The post-emergent fry disperse to the margins of their natal stream, 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 zooplankton, small insects, and other micro-crustaceans. As they switch from endogenous nourishment to exogenous feeding, the fry's yolk-sac is reabsorbed, and the belly suture closes over the former location of the yolk-sac (button-up fry). Fry typically range from 25 mm to 40 mm during this stage. Some fry may take up residence in their natal stream for several weeks to a year or more, while others are displaced downstream by the stream's current. Once started downstream, fry may continue downstream to the estuary and rear, or may take up residence in other river reaches for a period of time ranging from weeks to a year (Healey 1991). Fry then seek near-shore 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 1996a). 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).

When juvenile Chinook salmon reach a length of 50 to 57 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures. In the mainstems of larger rivers, juveniles tend to migrate along the margins and avoid the elevated water velocities found in the thalweg of the channel. When the channel of the river is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1982b). Migrational cues, such as increasing turbidity from runoff, increased flows, changes in day length, or intraspecific competition from other fish in their natal streams may spur outmigration of juveniles when they have reached the appropriate stage of maturation (Kjelson *et al.* 1982, Brandes and McLain 2001).

As fish begin their emigration, they are displaced by the river's current downstream of their natal reaches. Similar to adult movement, juvenile salmonid downstream movement is crepuscular. Documents and data provided to NMFS in support of ESA section 10 research permit applications depicts that the daily migration of juveniles passing Red Bluff Diversion Dam (RBDD) is highest in the four hour period prior to sunrise (Martin *et al.* 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 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).

Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, the Delta, and their tributaries. In addition, Central Valley spring-run Chinook salmon juveniles have been observed rearing in the lower reaches of non-natal tributaries and intermittent streams in the Sacramento Valley during the winter months (Maslin *et al.* 1997, Snider 2001). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels, and sloughs (McDonald 1960, Dunford 1975). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, Sommer *et al.* 2001, MacFarlane and Norton 2002).

Shallow water habitats are 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). Optimal water temperatures for the growth of juvenile Chinook salmon in the Delta are between 54°F to 57°F (Brett 1952). In Suisun and San Pablo bays water temperatures reach 54°F by February in a typical year. Other portions of the Delta (*i.e.*, South Delta and Central Delta) can reach 70°F by February in a dry year. However, cooler temperatures are usually the norm until after the spring runoff has ended.

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 1982, Levings 1982, Levings *et al.* 1986, Healey 1991). As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tides into shallow water habitats to feed (Allen and Hassler 1986). In Suisun Marsh, Moyle *et al.* (1989) reported that Chinook salmon fry tend to remain close to the banks and vegetation, near protective cover, and in dead-end tidal channels. 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. Available data indicates that juvenile Chinook salmon use Suisun Marsh extensively both as a migratory pathway and rearing area as they move downstream to the Pacific Ocean. Juvenile Chinook salmon were found to spend about 40 days migrating through the Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallones (MacFarlane and Norton 2002). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon) MacFarlane and Norton (2002) 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.

b. Sacramento River Winter-Run Chinook salmon

Winter-run Chinook salmon exhibit characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in winter-run or early spring, and delay spawning until early summer (stream-type). However, juvenile winter-run Chinook salmon migrate to sea after only 4 to 7 months of river life (ocean-type). Adult winter-run Chinook salmon enter San Francisco Bay from November through June (Hallock and Fisher 1985), enter the Sacramento River basin between December and July, the peak occurring in March (Table 2; Yoshiyama *et al.* 1998, Moyle 2002), and migrate past the Red Bluff Diversion Dam (RBDD) from mid-December through early August (NMFS 1997). The majority of the run passes RBDD from January through May, with the peak passage occurring in mid-March (Hallock and Fisher 1985). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type (Yoshiyama *et al*. 1998, Moyle 2002). Spawning occurs primarily from mid-April to mid-August, with the peak activity typically occurring in June in the Sacramento River reach between Keswick Dam and Red Bluff (Vogel and Marine 1991). The majority of winter-run Chinook salmon spawners are 3 years old.

Table 2. The temporal occurrence of (a) adult and (b) juvenile winter-run in the Sacramento River. Darker shades indicate months of greatest relative abundance.

a) Adult migration												
Location	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Sac. River basin[a]	Medium	Medium	High	Medium	Medium	Medium	Medium					Medium
Sac. River basin[b]	Medium	Medium	Medium	Medium	Medium	Medium						
b) Juvenile migration												
Location	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Sac. River @ Red Bluff[c]	Low	Low	Low				Low/Medium	Medium	Medium	Medium	Medium	Medium
Sac. River @ Red Bluff[b]	Low	Low	Low				Low	Medium	Medium	Medium	Medium	Medium
Sac. River @ KL[d]	Medium	Medium	Medium	Low	Low			Low	Low	Low	High	High
Lower Sac. River (seine)[e]	High	High	Medium	Low	Low					Low	Medium	High
West Sac. River (trawl)[e]	Medium	Medium	High	Medium	Low						Low	Medium

KL=Knights Landing
Relative Abundance: ■ =High ■ =Medium ■ =Low

Sources: [a]Yoshiyama *et al*. (1998); Moyle (2002); [b]Myers *et al*. (1998); Vogel and Marine (1991) ; [c]Martin *et al.* (2001); [d]Snider and Titus (2000); [e]USFWS (2001a, 2001b)

Winter-run Chinook salmon fry begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994). Emigration of juvenile winter-run Chinook salmon past RBDD may begin as early as mid-July, typically peaks in September, and can continue through March (Vogel and Marine 1991, NMFS 1997). From 1995 to 1999, all winter-run Chinook salmon emigrating as fry passed RBDD by October, and all pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). Juvenile 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 2001a, Gaines and Martin 2001). The timing of migration by March (Martin *et al.* 2001). Juvenile 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 2001a, Gaines and Martin 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 mm and are from 5 to 10 months of age, and then begin emigrating to the ocean as early as November and continue through May (Fisher 1994, Myers *et al.* 1998).

1. Range-Wide (ESU) Status and Trends

The historical distribution of winter-run Chinook salmon spawning and rearing occurred primarily in the upper Sacramento River and its tributaries, where spring-fed streams provided cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (Slater 1963, Yoshiyama *et al.* 1998). The headwaters of the McCloud, Pit, and Little Sacramento rivers, and Hat and Battle creeks, historically provided clean, loose gravel; cold, well-oxygenated water; and suitable stream flow in riffle habitats for spawning and incubation. These areas also provided the cold, productive waters necessary for egg and fry development and survival, and juvenile rearing over the summer. The construction of Shasta Dam in 1943 permanently blocked access to all of these waters except Battle Creek, which had its own impediments to upstream migration (*i.e.*, hydroelectric facilities; Moyle *et al.* 1989; NMFS 1997, 1998a, 1998b). Approximately, 299 miles of spawning habitat in the upper Sacramento River watershed is now inaccessible to anadromous fish. Most facets of winter-run Chinook salmon life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by habitat blockage in the upper Sacramento River.

Lindley *et al.* (2004) theorized about the historical population structure of Central Valley salmon based on historical distributions, geography, hydrography, ecology, population genetics, life history information, and trends in abundance. The authors postulated that four geographically-based, independent populations comprised the historical Sacramento River winter-run Chinook salmon ESU, including: the Little Sacramento River, Pit River-Fall Creek-Hat Creek Basin, McCloud River, and Battle Creek. The single extant population of winter-run Chinook salmon, now confined downstream of Keswick Dam, was founded by some unknown combination of fish from these original populations (Lindley *et al.* 2004). The remnant winter-run Chinook salmon population is dependent on cold water releases from Shasta Dam.

Fisher (1994) estimated that the abundance of winter-run Chinook salmon may have been 200,000 fish in the late 1800s. By the late 1960s, a quarter century after the construction of Shasta Dam, the population size of winter-run Chinook salmon continued to exceed 100,000 (Good *et al.* 2005). A rapid decline occurred from 1969 to 1979, after completion of the RBDD. Over the next 20 years, the population was reduced to a low of only 186 adults in 1994. At that point, winter-run Chinook salmon were at a high risk of extinction, as defined in the most recent guideline for recovery of Central Valley salmonids (Lindley *et al*. 2007). Over the following decade several conservation measures were implemented to rebuild the run of winter-run Chinook salmon and to prevent its extinction, including the development and operation of a hatchery supplementation and captive broodstock program, construction of a temperature control device (TCD) on Shasta Dam, changes to the timing of seasonal operations at the RBDD, and restrictions of the ocean harvest. In the early 2000's population estimates of winter-run Chinook salmon rebounded, reaching a recent high of 17,296 in 2006 (Table 3). Following that peak, winter-run Chinook salmon abundance again declined, with an estimated return of 1,596 fish in 2010, and 827 in 2011 (Grandtab 2013). This recent population decline is coincident with a large-scale decline of Central Valley fall-run Chinook salmon, which has been attributed to unusually low ocean productivity at the time juvenile salmonids entered saltwater (Lindley et al., 2009).

Estimates of winter-run Chinook salmon abundance and cohort replacement rates, which have fluctuated broadly since 1986, are shown in Table 3. Annual population estimates decreased nearly 93 percent between 1986 (2,596) and 1994 (186) and then increased by nearly two orders of magnitude to 17,296 in 2006 before again declining by about 90 percent in 2010 (1,596). The 5-year moving average of population estimates shows a population increase from 491 in 1994 to 11,333 in 2006, followed by a sharp downturn extending into 2011, ending in a slight increase in 2012 with an estimate of 2,767. Cohort replacement rates (CRR) are the ratio of adult spawners divided by the number of spawners that produced those recruits. Because the majority of winter-run Chinook salmon spawners are 3 years old, NMFS calculated the CRR using the ratio of spawner abundance for a given year divided by the abundance of spawners three years prior. Between 1996 and 2008 the 5-year moving average of CRRs has been consistently above replacement level (i.e., CRR greater than 1.0). The recent population decline has resulted in a CRR less than 1 since 2006.

Although the winter-run Chinook salmon population showed a general positive trend from the early 1990s through 2006, winter-run Chinook salmon abundance and CRR's since that time have decreased, indicating a rapidly declining population. The population is presently below the recovery goals listed in the draft Central Valley Recovery Plan. Low abundance coupled with high levels of year-to-year variability of abundance and population growth rates are indicative of a population that is particularly susceptible to extinction by stochastic events. Poor ocean productivity in recent years has affected all Central Valley Chinook salmon runs to some extent, and the sharp drop in abundance of the winter-run Chinook salmon population since 2007 accentuates the vulnerability of this ESU. Since there is only one extant population of winter-run Chinook salmon, there are no other populations to buffer the effects of a catastrophe in the mainstem Sacramento River. Additionally, the winter-run Chinook salmon population is completely dependent on cold water releases from Shasta Dam in order to sustain the remnant population, and the entire ESU is therefore susceptible to a multi-year drought.

Estimates of abundance of naturally produced juvenile winter-run Chinook salmon generally track that of the adult parent population. Two current methods are utilized to estimate juvenile production of winter-run Chinook salmon: the Juvenile Production Estimate (JPE) method, and the Juvenile Production Index (JPI) method (Gaines and Poytress 2004). The JPE estimates juvenile abundance using estimated adult escapement from either fish counts at the RBDD or carcass surveys, whereas the JPI uses capture of juvenile winter-run Chinook salmon and trap efficiency relationships developed using rotary screw traps at the RBDD. The two methods show similar trends and there is generally a high degree of concordance between the estimates using the two methodologies. The average abundance of juvenile winter-run Chinook salmon fry passing the RBDD between 1995 and 2009 (excluding 2000 and 2001 for which there are no data) is 4,069,184 using the JPI (Bill Poytress, personal communication, USFWS, RBFWO, 2008). Using the JPE method, and estimates of adult abundance based on the Sacramento River carcass survey, provides an estimate of 4,721,436 (Bill Poytress, personal communication, USFWS, RBFWO, 2008).

The winter-run Chinook salmon ESU includes both naturally-spawned winter-run Chinook salmon and the hatchery-produced component of the population produced at the Livingston Stone NFH. USFWS conducts a conservation program for winter-run Chinook salmon at the

Livingston Stone NFH. The winter-run Chinook salmon supplementation program at Livingston Stone NFH releases up to 250,000 smolts annually into the upper Sacramento River. The winter-run Chinook salmon hatchery operates under strict guidelines that limit spawning to no more than 15 percent of the total run with a maximum of 120 fish and includes genetic-based run verification of each individual fish considered for broodstock. The program incorporates only broodstock of natural-origin to reduce the potential for perpetuating traits associated with domestication.

Table 3. Winter-run Chinook salmon population estimates and corresponding Cohort Replacement Rate.

Year	Population Estimate[1]	5-Year Moving Average of Population Estimate	Cohort Replacement Rate (Age-3)	5-Year Moving Average of Cohort Replacement Rate
1986	2,596	-	-	-
1987	2,185	-	-	-
1988	2,878		-	-
1989	696		0.27	-
1990	430	1,757	0.20	-
1991	211	1,280	0.07	
1992	1,240	1,091	1.78	
1993	387	593	0.90	0.64
1994	186	491	0.88	0.77
1995	1,297	664	1.05	0.94
1996	1,337	889	3.45	1.61
1997	880	817	4.73	2.20
1998	2,992	1,338	2.31	2.48
1999	3,288	1,959	2.46	2.80
2000	1,352	1,970	1.54	2.90
2001	8,224	3,347	2.75	2.76
2002	7,441	4,659	2.26	2.26
2003	8,218	5,705	6.08	3.02
2004	7,869	6,621	0.96	2.72
2005	15,839	9,518	2.13	2.84
2006	17,296	11,333	2.10	2.71
2007	2,542	10,353	0.32	2.32
2008	2,830	9,275	0.18	1.14
2009	4,537	8,609	0.26	1.00
2010	1,596	5,760	0.63	0.70
2011	827	2,466	0.29	0.34
2012	2,767	2,511	0.61	0.39
median	**2,542**	**2,466**	**1.00**	**2.00**

c.   CV Spring-Run Chinook salmon

Historically the CV spring-run Chinook salmon were the second most abundant salmon run in the Central Valley (CDFG 1998). These fish occupied the upper and middle reaches (1,000 to 6,000 feet elevation) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). Before the construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry 1961). Construction of other low elevation dams in the foothills of the Sierras on the American, Mokelumne, Stanislaus, Tuolumne, and Merced rivers extirpated Central Valley spring-run Chinook salmon from these watersheds. Naturally-spawning populations of Central Valley spring-run Chinook salmon currently are restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (CDFG 1998).

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 (see Table 4 in text; Yoshiyama *et al*. 1998, Moyle 2002). Lindley *et al*. (2004) 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 spawning occurs between September and October depending on water temperatures. Between 56 and 87 percent of adult spring-run Chinook salmon that enter the Sacramento River basin to spawn are 3 years old (Calkins *et al.* 1940, Fisher 1994).

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 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*. 2004). Studies in Butte Creek (Ward *et al*. 2002, 2003, McReynolds *et al*. 2005) found the majority of CV spring-run Chinook salmon 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 later in the spring. 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 migration and an earlier yearling migration (Lindley *et al*. 2004).

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

(a) Adult migration												
Location	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Sac.River basin[a,b]	– / –	– / –	M / M	M / M	H / H	H / H	M / M	M / M	M / M	L / L	– / –	– / –
Sac. River mainstem[c]	– / L	L / L	M / M	M / M	M / M	M / M	M / M	L / L	– / –	– / –	– / –	– / –
Mill Creek[d]	– / –	– / –	L / L	M / H	H / H	H / M	M / L	L / –	– / –	– / –	– / –	– / –
Deer Creek[d]	– / –	– / –	L / L	M / H	H / H	H / M	M / –	– / –	– / –	– / –	– / –	– / –
Butte Creek[d]	– / –	M / M	M / M	M / H	H / H	H / M	L / –	– / –	– / –	– / –	– / –	– / –
(b) Adult Holding	– / –	M / M	M / M	M / H	H / H	H / H	H / H	H / H	H / M	M / L	– / –	– / –
(c) Adult Spawning	– / –	– / –	– / –	– / –	– / –	– / –	– / –	L / M	H / H	M / L	– / –	– / –

(d) Juvenile migration												
Location	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Sac. River Tribs[e]	M / M	M / M	M / M	– / –	– / –	– / –	– / –	– / –	– / –	M / M	H / H	H / H
Upper Butte Creek[f]	H / H	H / H	M / M	M / M	M / M	L / L	– / –	– / –	– / –	L / L	L / L	H / H
Mill, Deer, Butte Creeks[d]	H / H	H / H	M / M	M / M	M / M	L / L	– / –	– / –	– / –	L / L	L / L	L / L
Sac. River at RBDD[c]	H / H	L / L	L / L	L / L	L / –	– / –	– / –	– / –	– / –	– / –	H / H	H / H
Sac. River at KL[g]	M / M	M / M	H / H	H / H	M / M	– / –	– / –	– / –	– / –	– / –	M / M	H / H

Relative Abundance: H = High; M = Medium; L = Low

Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Young of the year spring-run Chinook salmon emigrate during the first spring after they hatch.

Sources: [a]Yoshiyama *et al*. (1998); [b]Moyle (2002); [c]Myers *et al*. (1998); [d]Lindley *et al*. (2007); CDFG (1998); [f]McReynolds *et al*. (2005); Ward *et al*. (2002, 2003); [g]Snider and Titus (2000)

Once juveniles emerge from the gravel they initially seek areas of shallow water and low velocities while they finish absorbing the yolk sac and transition to exogenous feeding (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 larger. 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). The emigration period for spring-run Chinook salmon extends from November to early May, with up to 69 percent of the young-of-the-year fish outmigrating through the lower Sacramento River and

Delta during this period (CDFG 1998). 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). Based on the available information, the emigration timing of CV spring-run Chinook salmon appears highly variable (CDFG 1998) (Table 4). Some fish may begin emigrating soon after emergence from the gravel, whereas others over summer and emigrate as yearlings with the onset of intense fall storms (CDFG 1998).

On the Feather River, significant numbers of CV spring-run Chinook salmon, as identified by run timing, return to the FRFH. In 2002, the FRFH 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 have not always been 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). Because the Feather River spring-run Chinook salmon population is not genetically distinct from fall-run, the Feather River spring-run Chinook population numbers are typically not included in discussions of ESU abundance when referring to CV spring-run Chinook salmon population discussions, and therefore will be excluded from the following discussion.

The CV spring-run Chinook salmon ESU has displayed broad fluctuations in adult abundance, ranging from 1,403 in 1993 to 24,903 in 1998 (Table 5). Sacramento River tributary populations in Mill, Deer, and Butte creeks are probably the best trend indicators for the CV spring-run Chinook salmon ESU as a whole because these streams contain the primary independent populations within 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 2002 and 2003, mean water temperatures in Butte Creek exceeded 21^{o} Celsius (C) for 10 or more days in July (reviewed by Williams 2006). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of Columnaris Disease (*Flexibacter columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiis*) in the adult spring-run Chinook salmon over-summering in Butte Creek. In 2002, this contributed to the pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek.

Table 5. CV Spring-run Chinook salmon population estimates from CDFG Grand Tab (2013) with corresponding cohort replacement rates for years since 1986.

Year	Sacramento River Basin Escapement Run Size[a]	FRFH Population	Tributary Populations	Trib CRR[b]	Basin CRR
1986	3,638	1,433	2,205		
1987	1,517	1,213	304		
1988	9,066	6,833	2,233		
1989	7,032	5,078	1,954	0.89	1.93
1990	3,485	1,893	1,592	5.24	2.30
1991	5,101	4,303	798	0.36	0.56
1992	2,673	1,497	1,176	0.60	0.38
1993	5,685	4,672	1,013	0.64	1.63
1994	5,325	3,641	1,684	2.11	1.04
1995	14,812	5,414	9,398	7.99	5.54
1996	8,705	6,381	2,324	2.29	1.53
1997	5,065	3,653	1,412	0.84	0.95
1998	30,534	6,746	23,788	2.53	2.06
1999	9,838	3,731	6,107	2.63	1.13
2000	9,201	3,657	5,544	3.93	1.82
2001	16,869	4,135	12,734	0.54	0.55
2002	17,224	4,189	13,035	2.13	1.75
2003	17,691	8,662	9,029	1.63	1.92
2004	13,612	4,212	9,400	0.74	0.81
2005	16,096	1,774	14,322	1.10	0.93
2006	10,948	2,181	8,767	0.97	0.62
2007	9,726	2,674	7,052	0.75	0.71
2008	6,368	1,624	4,744	0.33	0.40
2009	3,801	989	2,812	0.32	0.35
2010	3,792	1,661	2,131	0.30	0.39
2011	4,967	1,969	3,067	0.65	0.78
2012	18,275	7,465	10,810	3.84	4.81
2013	38,556	20,057	18,499	8.68	2.00
Median	10,962	4,456	6,508	2.08	1.00

[a] NMFS included both the escapement numbers from the Feather River Fish Hatchery (FRFH) and the Sacramento River and its tributaries in this table. Sacramento River Basin run size is the sum of the escapement numbers from the FRFH and the tributaries.
[b] Abbreviations: CRR = Cohort Replacement Rate, Trib = tributary

Lindley *et al*. (2007) indicated that the spring-run population of Chinook salmon in the Central Valley had a low risk of extinction in Butte and Deer creek, according to their PVA model and the other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence). The Mill Creek population of spring-run Chinook salmon is at moderate extinction risk according to the PVA model, but appears to satisfy the other viability criteria for low-risk status. However, like the winter-run Chinook salmon population, the CV spring-run Chinook salmon population fails to meet the "representation and redundancy rule" since there is only one demonstrably viable population out of the three diversity groups that historically contained them. The spring-run population is only represented by the group that currently occurs in the northern Sierra Nevada. The spring-run Chinook salmon populations that formerly occurred in the basalt and porous-lava region and southern Sierra Nevada region have been extirpated. The northwestern California region contains a few ephemeral populations of spring-run Chinook salmon that are likely dependent on the Northern Sierra populations for their continued existence. Over the long term, these remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

c. Description of Viability for CV Spring-Run Chinook Salmon ESU

The abundance of spawners is just one of several criteria that must be met for a population to be considered viable. McElhany *et al*. (2000) acknowledged that a viable salmonid population at the ESU scale is not merely a quantitative number that needs to be attained. Rather, for an ESU to persist, populations within the ESU must be able to spread risk and maximize future potential for adaptation. ESU viability depends on the number of populations and subunits within the ESU, their individual status, their spatial arrangement with respect to each other and sources of catastrophic disturbance, and diversity of the populations and their habitats (Lindley *et al*. 2007). Populations comprise subunits, which are intended to capture important components of habitat, life history or genetic diversity that contribute to the viability of the ESU (Hilborn et al. 2003 *op. cit*. Lindley *et al.* 2007, Bottom *et al*. 2005 *op. cit*. Lindley *et al*. 2007). Lindley *et al*. (2007) concludes that at least two viable populations within each subunit are required to ensure the viability of the subunit, and hence, the ESU. The current Draft Recovery Plan criteria for achieving ESU recovery includes four viable populations in the Northern Sierra Nevada Diversity Group. The watersheds identified as having the highest likelihood of success for achieving viability/low risk of extinction include, Butte, Deer and Mill creeks as well as the upper Yuba River (NMFS 2011a).

In order to determine the current likelihood of viability of Central Valley spring-run Chinook salmon, we used the historical population structure presented in Lindley *et al*. (2004) and the concept of VSP for evaluating populations described by McElhany *et al.* (2000). While McElhany *et al.* (2000) introduced and described the concept of VSP, Lindley *et al*. (2007) applied the concept to the Central Valley spring-run Chinook salmon ESU.

Lindley *et al*. (2004) identified 26 historical populations within the spring-run Chinook salmon ESU; 19 were independent populations, and 7 were dependent populations. There is an additional extant population in the Feather River downstream of Oroville Dam. This population became restricted to the lower reaches of the Feather River following the construction of Oroville Dam and is essentially maintained by the FRFH. Of the 19 independent populations of spring-run Chinook salmon that occurred historically, only three independent populations remain, in Deer, Mill, and Butte Creeks. Dependent populations of spring-run Chinook salmon continue to occur in Battle, Big Chico, Antelope, Clear, Thomes, and Beegum creeks, and the Yuba River, but rely on the three extant independent populations for their continued survival.

Although Lindley *et al*. (2007) did not provide numerical goals for each population of Pacific salmonid to be categorized at low risk for extinction, they did provide various quantitative criteria to evaluate the risk of extinction (Table IV-c). A population must meet all the low-risk thresholds to be considered viable. The following provides the evaluation of the likelihood of viability of the Central Valley spring-run Chinook salmon ESU based on the viable salmonid population parameters of population size, population growth rate, spatial structure, and diversity. These specific parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of salmon (McElhany *et al.* 2000).

1. Population Size

Information about population size provides an indication of the type of extinction risk that a population faces. For instance, smaller populations are at a greater risk of extinction than large populations because the processes that affect populations operate differently in small populations than in large populations (McElhany *et al.* 2000). One risk of low population sizes is depensation. Depensation occurs when populations are reduced to very low densities and per capita growth rates decrease as a result of a variety of mechanisms [*e.g.,* failure to find mates and therefore reduced probability of fertilization, failure to saturate predator populations (Liermann and Hilborn 2001)].

From 2005 through 2011, abundance numbers in most of the tributaries have declined. Adult returns from 2006 to 2009, indicate that population abundance for the entire Sacramento River basin is declining from the peaks seen in the five years prior to 2006. Declines in abundance from 2005 to 2011, placed the Mill Creek and Deer Creek populations in the high extinction risk category due to the rates of decline, and in the case of Deer Creek, also the level of escapement (NMFS 2011b). Butte Creek has sufficient abundance to retain its low extinction risk classification, but the rate of population decline in years 2006 through 2011 is nearly sufficient to classify it as a high extinction risk based on this criteria. Some other tributaries to the Sacramento River, such as Clear Creek and Battle Creek have seen population gains in the years from 2001 to 2009, but the overall abundance numbers have remained low. Year 2012 appeared to be a good return year for most of the tributaries with some, such as Battle Creek, having the highest return on record (799). Additionally, 2013 escapement numbers increased in most tributary populations, which resulted in the second highest number of CV spring-run Chinook salmon returning to the tributaries since 1960.

2. Population Growth Rate

The productivity of a population (*i.e.,* production over the entire life cycle) can reflect conditions (*e.g.,* environmental conditions) that influence the dynamics of a population and determine abundance. In turn, the productivity of a population allows an understanding of the performance of a population across the landscape and habitats in which it exists and its response to those habitats (McElhany *et al.* 2000). In general, declining productivity equates to declining population abundance. McElhany *et al.* (2000) suggested a population's natural productivity should be sufficient to maintain its abundance above the viable level (a stable or increasing population growth rate). In the absence of numeric abundance targets, this guideline is used.

Cohort replacement rates are indications of whether a cohort is replacing itself in the next generation. As mentioned in the previous subsection, until recently the cohort replacement rate since the late 1990s has fluctuated, and has not appeared to have a pattern. Since the cohort replacement rate is a reflection of population growth rate, there did not appear to be an increasing or decreasing trend. However, the five-year moving average cohort replacement rate of tributary population estimate over the last five years has decreased to low of 0.47.

3. *Spatial Structure*

In general, there is less information available on how spatial processes relate to salmonid viability than there is for the other VSP parameters (McElhany *et al.* 2000). Understanding the spatial structure of a population is important because the population structure can affect evolutionary processes and, therefore, alter the ability of a population to adapt to spatial or temporal changes in the species' environment (McElhany *et al*. 2000).
Lindley *et al*. (2007) indicated that of the 19 independent populations of spring-run Chinook salmon that occurred historically, only three (Butte, Mill, and Deer creeks) remain, and their current distribution makes the spring-run Chinook salmon ESU vulnerable to catastrophic disturbance. Butte, Mill, and Deer Creeks all occur in the same biogeographic region (diversity group), whereas historically, independent spring-run Chinook salmon populations were distributed throughout the Central Valley among at least three diversity groups (*i.e*., basalt and porous lava, northern Sierra Nevada, and southern Sierra Nevada). In addition, dependent spring-run Chinook salmon populations historically persisted in the Northwestern California diversity group (Lindley *et al*. 2004). Currently, there are dependent populations of spring-run Chinook salmon in the Big Chico, Antelope, Clear, Thomes, Battle, and Beegum creeks, and in the Sacramento, Feather, and Yuba rivers (Lindley *et al*. 2007).

4. *Diversity*

Diversity, both genetic and behavioral, is critical to success in a changing environment. Salmonids express variation in a suite of traits, such as anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, and physiology and molecular genetic characteristics. The more diverse these traits (or the more these traits are not restricted), the more adaptable a population is, and the more likely that individuals, and therefore the species, would survive and reproduce in the face of environmental variation (McElhany *et al.* 2000). However, when this diversity is reduced due to loss of entire life history strategies or to loss of habitat used by fish exhibiting variation in life history traits, the species is in all probability less able to survive and reproduce given environmental variation.

Diversity provides a species the opportunity to track environmental changes. As a species' abundance decreases, and spatial structure of the ESU is reduced, a species has less flexibility to track changes in the environment. Historical populations of spring-run Chinook salmon have been entirely extirpated from the basalt and porous lava region and the southern Sierra Nevada region. The only viable and independent populations (*i.e*., Mill, Deer, and Butte creeks) of spring-run Chinook salmon are limited to the northern Sierra Nevada region, although some smaller dependent populations are currently found in the Northwestern California, Basalt and Porous lava, and Northern Sierra Nevada regions. A single catastrophe, for example, the eruption of Mount Lassen, a large wildland fire at the headwaters of Mill, Deer, and Butte creeks, or a drought, poses a significant threat to the extinction risk of the ESU that otherwise would not be there if the ESU's spatial structure and diversity were greater. Spring-run Chinook salmon do however reserve some genetic and behavioral variation in that in any given year, at least two cohorts are in the marine environment, and therefore, not exposed to the same environmental stressors as their freshwater cohorts.

Although spring-run Chinook salmon produced at the FRFH are part of the Central Valley spring-run Chinook salmon ESU (June 28, 2005, 70 FR 37160), since they have been introgressed with fall-run Chinook salmon, they may compromise the genetic diversity of the rest of the ESU. More than 523,000 FRFH spring-run Chinook salmon fry were planted at the base of Whiskeytown Dam during the 3-year period 1991−1993 (CDFG 1998 *op. cit*. CVP/SWP operations BA), and thousands are trucked to the San Pablo Bay every year instead of being released in-river, which has been shown to increase straying. The fact that these hatchery fish behave more like fall-run Chinook salmon (spawn later than spring-run Chinook salmon in Deer, Mill, and Butte creeks), likely increases the rate of introgression of the spring- and fall- runs, and reduces diversity. The Yuba River population is heavily impacted by FRFH fish straying into the Yuba River.

d. Summary of Central Valley Spring-Run Chinook Salmon ESU Viability

Lindley *et al*. (2007) concluded that the Butte Creek and Deer Creek spring-run Chinook salmon populations are at low risk of extinction, satisfying both the population viability analysis (PVA) and other viability criteria. Mill Creek is at moderate extinction risk according to the PVA, but appears to satisfy the other viability criteria for low-risk status (Lindley *et al*. 2007). Spring-run Chinook salmon failed to meet the representation and redundancy rule for ESU viability, as distribution of independent populations has been constricted to only one of their former geographic diversity groups. Therefore Lindley *et al*. (2007) reported that the spring-run Chinook salmon ESU was at moderate risk of extinction.

In the 2011 California CV status review for spring-run Chinook salmon, NMFS identified the status of CV spring-run Chinook salmon ESU as having declined since the 2005 status review and Lindley *et al.*'s (2007) assessment, with two of the three extant independent populations (Deer and Mill creeks) of CV spring-run Chinook salmon slipping from low or moderate extinction risk to high extinction risk.

In the 2011, status review for CV spring-run Chinook salmon, the ESU as a whole could not be considered viable because there were no extant viable populations in the three other diversity groups. Since 2011, the abundance of several populations has increased and the extinction risk of Sacramento tributary populations generally has improved from high to moderate.

2. CCV Steelhead

a. Life history

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. 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].

CCV 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 (Table 6; Hallock *et al.* 1961, McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches at river mouths, and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Barnhart 1986, 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, Shapovalov 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 4 to 6 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 CCV steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Juvenile CCV steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002).

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.

Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
[1,3]Sac. River	L	L	L	L	L	L						L	L	L	L	M	M	H	H	M	L	L	L	L
[2,3]Sac R at Red Bluff	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M	H	M	L	L	L	L
[4]Mill, Deer creeks	M	M	H	M	M	L	L	L	L	L	L	L							M	H	H	L	L	L
[6]Sac R. at Fremont Weir	L	L	L	L											M	M	H	H	M	M	L	L	L	L
[6]Sac R. at Fremont Weir	L	L	L	L											M	M	H	H	M	M	L	L	L	L
[7]San Joaquin River	H	H	M	M	L	L							L	L	L	L	M	M	M	M	M	M	H	H
(b) Juvenile migration																								
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
[1,2]Sacramento River	L	L	L	L	M	M	M	M	M	M	M	M	L	L	L	L	L	L	M	M	M	M	L	L
[2,8]Sac. R at KL	L	L	L	L	H	H	L	L	L															L
[9]Sac. River @ KL	M	M	M	M	H	H	H	H	M	M											L	L	L	L
[10]Chipps Island (wild)	L	L	L	L	H	H	H	H	M	M	M	M	L	L					L	L	L	L	L	L
[8]Mossdale					L	L	H	H	H	H	L	L	L											
[11]Woodbridge Dam	M	M	M	M	M	M	M	M	M	M	M	M	M	M										
[12]Stan R. at Caswell	L	L	M	M	H	H	M	M	M	M	M	L												
[13]Sac R. at Hood	L	L	H	H	H	H	H	H	H	H	H										L	L	L	L

Relative Abundance: H = High; M = Medium; L = Low

Sources: [1]Hallock *et al*. 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; [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. 2000,2001; [13]Schaffter 1980, 1997.

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.

Historic CCV 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.

Nobriga and Cadrett (2003) compared CWT and untagged (wild) steelhead smolt catch ratios at Chipps Island trawl from 1998 through 2001 to estimate that about 100,000 to 300,000 steelhead juveniles are produced naturally each year in the Central Valley. In the *Updated Status Review of West Coast Salmon and Steelhead* (Good *et al.* 2005), the Biological Review Team (BRT) made the following conclusion based on the Chipps Island data:

> "If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1 percent of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire Central Valley. This can be compared with McEwan's (2001) estimate of 1 million to 2 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 2008) indicate that steelhead are present in Clear Creek (Giovannetti and Brown 2008, Good *et al.* 2005) as well as monitoring from 2005 to 2009 in Battle Creek (Newton and Stafford 2011). Until recently, CCV 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 (RSTs) at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000, 2001). Zimmerman *et al.* (2008) has documented Central Valley steelhead in the Stanislaus, Tuolumne and Merced rivers based on otilith microchemistry.

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 CV (Good *et al*. 2005). CDFG staff has prepared catch summaries for juvenile migrant CCV steelhead on the San Joaquin River near Mossdale which represents migrants from the Stanislaus, Tuolumne, and Merced rivers. Based on trawl recoveries at Mossdale between 1988 and 2002, as well as RST 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 Michael Aceituno, NMFS, 2004). The documented returns on the order of single fish in these tributaries suggest that existing populations of CCV steelhead on the Tuolumne, Merced, and lower San Joaquin rivers are severely depressed.

Good *et al.* (2005) indicated that prior population census estimates completed in the 1990s found the CCV 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). CCV steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates. The future of CCV steelhead is uncertain due to limited data concerning their status. However, Lindley *et al.* (2007), citing evidence presented by Yoshiyama *et al.* (1996); McEwan (2001); and Lindley *et al.* (2006), concluded that there is sufficient evidence to suggest that the DPS is at moderate to high risk of extinction.

b. Viability of the Central Valley Steelhead DPS

The earlier analysis to determine the likelihood of spring-run Chinook salmon becoming viable described the process that NMFS uses to apply the VSP concept in McElhany *et al*. (2000). In order to determine the current likelihood of the Central Valley steelhead DPS becoming viable, we used the historical population structure of Central Valley steelhead presented in Lindley *et al*. (2006, 2007) and the concept of VSP for evaluating populations described by McElhany *et al.* (2000). While McElhany *et al.* (2000) introduced and described the concept of VSP, Lindley *et al*. (2007) applied the concept to the Central Valley steelhead DPS.

1. Population Size

All indications are that the naturally produced California Central Valley steelhead population has continued to decrease in abundance and in the proportion of naturally spawned fish to hatchery produced fish over the past 25 years (Good *et al.* 2005, NMFS 2011b); the long-term abundance trend remains negative. There has been little comprehensive steelhead population monitoring, despite 100 percent marking of hatchery steelhead since 1998. Efforts are underway to improve this deficiency, and a long term adult escapement monitoring plan is being considered (NMFS 2011b). Hatchery production and returns are dominant over natural fish and include significant numbers of non-DPS-origin Eel River steelhead stock. Hatcheries affect productivity of wild populations (Chilcote 2003). Continued decline in the ratio between wild juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases have remained relatively constant over the past decade, yet the proportion of ad-clipped fish to wild adipose fin bearing fish has steadily increased over the past several years.

2. Population Growth Rate

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). Recent data from the Chipps Island fish monitoring trawls indicates that in recent years over 90 percent of captured steelhead smolts have been of hatchery origin. In 2010, the data indicated hatchery fish made up 95 percent of the catch.

3. Spatial Structure

Lindley *et al*. (2006) identified 81 historical and independent populations within the Central Valley steelhead DPS. These populations form eight clusters, or diversity groups, based on the similarity of the habitats they occupied for spawning and rearing. About 80 percent of the habitat that was historically available to Central Valley steelhead is now behind impassable dams, and 38 percent of the populations have lost all of their habitats. Although much of the habitat has been blocked by impassable dams, or degraded, small populations of Central Valley steelhead are still found throughout habitat available in the Sacramento River and many of the tributaries, and some of the tributaries to the San Joaquin River (Good *et al.* 2005, NMFS 2011b, Zimmerman *et al.* 2009). Until recently, there was very little documented evidence of steelhead due to the lack of monitoring efforts. The efforts to provide passage of salmonids over impassable dams may increase the spatial diversity of Central Valley Steelhead.

4. Diversity

Diversity, both genetic and behavioral, provides a species the opportunity to track environmental changes. Central Valley steelhead naturally experience the most diverse life history strategies of the listed Central Valley anadromous salmonid species. In addition to being iteroparous, they reside in freshwater for two to four years before emigrating to the ocean. However, as the species' abundance decreases, and spatial structure of the DPS is reduced, it has less flexibility to track changes in the environment. Central Valley steelhead abundance and growth rate continue to decline, largely the result of a significant reduction in the diversity of habitats available to Central Valley steelhead (Lindley *et al*. 2006). Consistent with the life-history strategy of spring-run Chinook salmon, some genetic and behavioral variation is conserved when there are spawning-year cohorts in the marine and freshwater environment. This allows spawning-year cohorts in the marine environment to be exposed to different environmental conditions and stressors than their freshwater cohorts.

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 currently not included in the Central Valley steelhead DPS. However, recent work (Garza and Pearse 2008) has identified introgression of stray domestic rainbow trout genes with steelhead, which may be occurring either during egg taking practices in hatcheries or in-river spawning between domesticated strains of rainbow trout and steelhead. Garza and Pearse (2008) also found that all below-dam steelhead populations in the Central Valley were genetically closely related and that these populations had a high level of genetic similarity to populations of steelhead in the Klamath and Eel river basins. This genetic data suggests that the progeny of out-of basin steelhead reared in the Nimbus and Mokelumne river hatcheries have become widely introgressed with natural steelhead populations throughout the anadromous sections of rivers and streams in the Central Valley, including the tail-water sections downstream of impassable dams. This suggests the potential for the loss of local genetic diversity and population structure over time in these waters. Their work also indicates that in contrast to the similarity of the steelhead genetics downstream of dams in the Central Valley, the ancestral genetic structure is still relatively intact upstream of the impassable barriers. This would indicate that extra precautions should be included in restoration plans before above-dam access is provided to the steelhead from the below-dam populations in order to maintain genetic heritage and structure in *O. mykiss* populations upstream of dams.

c. *Summary of Central Valley Steelhead DPS Viability*

Good *et al*. (2005) indicated that prior population census estimates completed in the 1990s found the Central Valley steelhead spawning population upstream of RBDD had a fairly strong negative population growth rate and small population size. Good *et al.* (2005) also indicated the decline was continuing as evidenced by new information from Chipps Island trawl data. Central Valley steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates, and the future of Central Valley steelhead is tentative due to limited data concerning their status. Lindley *et al.* (2007) concluded that there is sufficient evidence to suggest that the DPS is at moderate to high risk of extinction.

NMFS (2011b) completed a five-year species status reviews for Central Valley steelhead and recommend that the Central Valley steelhead DPS remain classified as a threatened species. However, the most recent biological information that was evaluated during NMFS' 2011 status review suggests that the extinction risk of Central Valley steelhead has increased since the last status review and that several of the listing factors have contributed to the decline, including recent years of drought and poor ocean conditions. There continue to be ongoing threats to the genetic integrity of natural or wild steelhead from hatchery steelhead programs in the Central Valley, but it is unclear if or how this factor has influenced the overall viability of the DPS.

The widespread distribution of wild steelhead in the Central Valley provides the spatial distribution necessary for the DPS to survive and avoid localized catastrophes. However, these populations are frequently very small, and lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011c).

The most recent status review of the CCV steelhead DPS (NMFS 2011c) found that the status of the population appears to have worsened since the 2005 status review (Good et al. 2005), when it was considered to be in danger of extinction.

3. Southern DPS of North American Green Sturgeon

a. Life History

In North America, spawning populations of green sturgeon are currently found in only three river systems: the Sacramento and Klamath rivers in California and the Rogue River in southern Oregon. Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. Data from commercial trawl fisheries and tagging studies indicate that the green sturgeon occupy waters within the 110 meter contour (Erickson and Hightower 2007). During the late summer and early fall, subadults and nonspawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991, Moser and Lindley 2007). Particularly large concentrations of green sturgeon from both the northern and southern populations occur in the Columbia River estuary, Willapa Bay, Grays Harbor and Winchester Bay, with smaller aggregations in Humboldt Bay, Tillamook Bay, Nehalem Bay,and San Francisco and San Pablo Bays (Emmett *et al* 1991, Moyle *et al.* 1992, and Beamesderfer *et al.* 2007). Lindley *et al.* (2008) reported that green sturgeon make seasonal migratory movements along the west coast of North America, overwintering north of Vancouver Island and south of Cape Spencer, Alaska. Individual fish from the Southern DPS of green sturgeon have been detected in these seasonal aggregations. Information regarding the migration and habitat use of the Southern DPS of green sturgeon has only recently emerged. Lindley *et al*. (2006) presented preliminary results of large-scale green sturgeon migration studies, and verified past population structure delineations based on genetic work and found frequent large-scale migrations of green sturgeon along the Pacific Coast. This work was further expanded by recent tagging studies of green sturgeon conducted by Erickson and Hightower (2007) and Lindley *et al.* (2008). To date, the data indicates that North American green sturgeon are migrating considerable distances up the Pacific Coast into other estuaries, particularly the Columbia River estuary. This information also agrees with the results of previous green sturgeon tagging studies (CDFG 2002), where CDFG tagged a total of 233 green sturgeon in the San Pablo Bay 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 the Oregon and Washington coasts. Eight of the 12 recoveries were in the Columbia River estuary (CDFG 2002).

The Southern DPS of green sturgeon includes all green sturgeon populations south of the Eel River, with the only known spawning population being in the Sacramento River and recent confirmed spawning in the Feather River. (DWR 2011). Green sturgeon life history can be broken down into four main stages: eggs and larvae, juveniles, sub-adults, and sexually mature adults. Sexually mature adults are those fish that have fully developed gonads and are capable of spawning. Female green sturgeon are typically 13 to 27 years old when sexually mature and have a total body length (TL) ranging between 145 and 205 cm at sexual maturity (Nakamoto *et al. 1995*, Van Eenennaam *et al.* 2006). Male green sturgeon become sexually mature at a younger age and smaller size than females. Typically, male green sturgeon reach sexual maturity between 8 and 18 years of age and have a TL ranging between 120 cm to 185 cm (Nakamoto *et al. 1995*, Van Eenennaam *et al.* 2006). The variation in the size and age of fish upon reaching sexual maturity is a reflection of their growth and nutritional history, genetics, and the environmental conditions they were exposed to during their early growth years. Adult green sturgeon are believed to feed primarily upon benthic invertebrates such as clams, mysid shrimp, grass shrimp, and amphipods (Radtke 1966). 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). It is unknown what forage species are consumed by adults in the Sacramento River upstream of the Delta.

Adult green sturgeon are gonochoristic (sex genetically fixed), oviparous and iteroparous. They are believed to spawn every 2 to 5 years (Beamesderfer *et al.* 2007). Upon maturation of their gonadal tissue, but prior to ovulation or spermiation, the sexually mature fish enter freshwater and migrate upriver to their spawning grounds. The remainder of the adult's life is generally spent in the ocean or near-shore environment (bays and estuaries) without venturing upriver into freshwater. Younger females may not spawn the first time they undergo oogenesis and subsequently they reabsorb their gametes without spawning. Adult female green sturgeon produce between 60,000 and 140,000 eggs, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al*. 2001). They have the largest egg size of any sturgeon, and the volume of yolk ensures an ample supply of energy for the developing embryo. The outside of the eggs are adhesive, and are more dense than than those of white sturgeon (Kynard *et al.* 2005, Van Eenennaam *et al.* 2009). Adults begin their upstream spawning migrations into freshwater in late February with spawning occuring between March and July (CDFG 2002. Heublin 2006, Heublin *et al.* 2009, Vogel 2008). Peak spawning is believed to occur between April and June in deep, turbulent, mainstem channels over large cobble and rocky substrates with crevices and interstices. Females broadcast spawn their eggs over this substrate, while the male releases its milt (sperm) into the water column. Fertilization occurs externally in the water column and the fertilized eggs sink into the interstices of the substrate where they develop further (Kynard *et al.* 2005, Heublin *et al.* 2009).

Known historic and current spawning occurs in the Sacramento River (Adams *et al.* 2002, Beamesderfer *et al.* 2004, Adams *et al*. 2007). Currently, Keswick and Shasta dams on the mainstem of the Sacramento River block passage to the upper river. Although no historical accounts exist for identified green sturgeon spawning occuring above the current dam sites, suitable spawning habitat existed and the geographic extent of available suitable spawning habitat has been reduced due to the impassable barriers constructed on the river.

Spawning on the Feather River is suspected to have occurred in the past due to the continued presence of adult green sturgeon in the river below Oroville Dam. This continued presence of adults below the dam suggests that fish are trying to migrate to upstream spawning areas now blocked by the dam, which was constructed in 1968.

Spawning in the San Joaquin River system has not been recorded historically or observed recently, but alterations of the San Joaquin River and its tributaries (Stanislaus, Tuolumne, and Merced rivers) occurred early in the European settlement of the region. During the latter 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 approximately 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.

Additional impacts to the watershed include the increased loads of selenium entering the system through agricultural practices in the western side of the San Joaquin Valley. Green sturgeon have recently been identified by University of California at Davis (UC Davis) researchers as being highly sensitive to selenium levels. Currently, only white sturgeon have been encountered in the San Joaquin River system upstream of the Delta, and adults have been captured by sport anglers as far upstream on the San Joaquin River as Hills Ferry and Mud Slough which are near the confluence of the Merced River with the mainstem San Joaquin River (2007 sturgeon report card, CDFG 2008).

Kelly *et al.* (2007) indicated that green sturgeon enter the San Francisco Estuary during the spring and remain until autumn (Table 7). 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 Kelly *et al*. (2007) surmised that they are related to resource availability and foraging behavior. Recent acoustical tagging studies on the Rogue River (Erickson *et al*. 2002) have shown that adult green sturgeon will hold for as much as 6 months in deep (> 5m), low gradient reaches or off channel sloughs or coves of the river during summer months when water temperatures were between 15°C and 23°C. When ambient temperatures in the river dropped in autumn and early winter (<10°C) and flows increased, fish moved downstream and into the ocean. Erickson *et al.* (2002) surmised that this holding in deep pools was to conserve energy and utilize abundant food resources. Benson *et al.* (2007) found similar behaviour on the Klamath and Trinity River systems with adult sturgeon acoustically tagged during their spawning migrations. Most fish held over the summer in discrete locations characterized by deep, low velocity pools until late fall or early winter when river flows increased with the first storms of the rainy season. Fish then moved rapidly downstream and out of the system. Recent data gathered from acoustically tagged adult green sturgeon revealed comparable behavior by adult fish on the Sacramento River based on the positioning of adult green sturgeon in holding pools on the Sacramento River above the Glenn Colusa Irrigation District (GCID) diversion (river mile [RM] 205). Studies by Heublin *et al.* (2006, 2009) and Vogel (2008) have documented the presence of adults in the Sacramento River during the spring and through the fall into the early winter months. These fish hold in upstream locations prior to their emigration from the system later in the year. Like the Rogue and Klamath river systems, downstream migration appears to be triggered by increased flows, decreasing water temperatures, and occurs rapidly once initiated. It should also be noted that some adults rapidly leave the system following their suspected spawning activity and enter the ocean only in early summer (Heublin 2006). This behaviour has also been observed on the other spawning rivers (Benson *et al*. 2007*)* but may have been an artifact of the stress of the tagging procedure in that study.

Eggs and Larvae. Currently spawning appears to occur primarily above RBDD, based on the recovery of eggs and larvae at the dam in monitoring studies (Gaines and Martin 2001, Brown 2007). Green sturgeon larvae hatch from fertilized eggs after approximately 169 hours at a water temperature of 59°F (Van Eenennaam *et al.* 2001, Deng *et al.* 2002), which is similar to the sympatric white sturgeon development rate (176 hours). Studies conducted at the University of California, Davis by Van Eenennaam et al. (2005) indicated that an optimum range of water temperature for egg development ranged between 57.2°F and 62.6°F. Temperatures over 73.4°F resulted in 100 percent mortality of fertilized eggs before hatching. Eggs incubated at water temperatures between 63.5°F and 71.6°F resulted in elevated mortalities and an increased occurrence of morphological abnormalities in those eggs that did hatch. At incubation temperatures below 57.2°F, hatching mortality also increased significantly, and morphological abnormalities increased slightly, but not statistically so.

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

(a) Adult-sexually mature (≥145 – 205 cm TL for females and ≥ 120 – 185 cm TL old for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Sac. River[a,b,c,i]	Low	Low	Medium	Medium/High	High	High/Medium	Medium	Medium	Medium	Low	Low	Low
SF Bay Estuary[d,h,i]	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low	Low

(b) Larval and juvenile (≤10 months old)

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

1.

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

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

(d) Sub-Adult/non-sexually mature (approx. 75 cm to 145 cm for females and 75 to 120 cm for males)

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

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

* Fish Facility salvage operations

Sources: [a]USFWS (2002); [b]Moyle *et al*. (1992); [c]Adams *et al*. (2002) and NMFS (2005); [d]Kelly *et al*. (2007); [e]CDFG (2002); [f]IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [g]Nakamoto *et al*. (1995); [h]Heublein (2006); [i]CDFG Draft Sturgeon Report Card (2008)

Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length and have a large ovoid yolk sac that supplies nutritional energy until exogenous feeding occurs. These yolksac larvae are less developed in their morphology than older juveniles and external morphology resembles a "tadpole" with a continuous fin fold on both the dorsal and ventral sides of the caudal trunk. The eyes are well developed with differentiated lenses and pigmentation.

Olfactory and auditory vesicles are present while the mouth and respiratory structures are only shallow clefts on the head. At 10 days of age, the yolk sac has become greatly reduced in size and the larvae initiates exogenous feeding through a functional mouth. The fin folds have become more developed and formation of fin rays begins to occur in all fin tissues. By 45 days of age, the green sturgeon larvae have completed their metamorphosis, which is characterized by the development of dorsal, lateral, and ventral scutes, elongation of the barbels, rostrum, and caudal peduncle, reabsorption of the caudal and ventral fin folds, and the development of fin rays. The juvenile fish resembles the adult form, including the dark olive coloring, with a dark mid-ventral stripe (Deng *et al*. 2002) and are approximately 75 mm TL. At this stage of development, the fish are considered juveniles and are no longer larvae.

Green sturgeon larvae do not exhibit the initial pelagic swim–up behavior characteristic of other Acipenseridae. The are strongly oriented to the bottom and exhibit nocturnal activity patterns. After 6 days, the larvae exhibit nocturnal swim-up activity (Deng *et al*. 2002) and nocturnal downstream migrational movements (Kynard *et al.* 2005). Juvenile fish 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 6 months of life. When ambient water temperatures reached 46.4^{o}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.

Green sturgeon juveniles tested under laboratory conditions had optimal bioenergetic performance (*i.e.* growth, food conversion, swimming ability) between 59^{o}F and 66.2^{o}F under either full or reduced rations (Mayfield and Cech 2004). This temperature range overlaps the egg incubation temperature range for peak hatching success previously discussed. Ambient water temperature conditions in the Rogue and Klamath river systems range from 39^{o}F to approximately 75.2^{o}F. The Sacramento River has similar temperature profiles, and, like the previous two rivers, is a regulated system with several dams controlling flows on its mainstem (Shasta and Keswick dams), and its tributaries (Whiskeytown, Oroville, Folsom, and Nimbus dams).

Larval and juvenile green sturgeon are subject to predation by both native and introduced fish species. Prickly sculpin (*Cottus asper*) have been shown to be an effective predator on the larvae of sympatric white sturgeon (Gadomski and Parsley 2005). This study also indicated that the lowered turbidity found in tailwater streams and rivers due to dams increased the effectiveness of sculpin predation on sturgeon larvae under laboratory conditions.

Larval and juvenile sturgeons have been caught in traps at two sites in the upper Sacramento River: below the RBDD (rm 243) and from the GCID pumping plant (rm 205) (CDFG 2002). Larvae captured at the RBDD site are typically only a few days to a few weeks old, with lengths ranging from 24 to 31 mm. This body length is equivalent to 15 to 28 days post hatch as determined by Deng *et al.* (2002). Recoveries of larvae at the RBDD RSTs occur between late April/early May and late August with the peak of recoveries occurring in June (1995-1999 and 2003–2008 data). The mean yearly total length of post-larval green sturgeon captured in the GCID rotary screw trap, approximately 30 miles downstream of RBDD, ranged from 33 mm to

44 mm between 1997 and 2005 (CDFG 2002) indicating they are approximately 3-4 weeks old (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Taken together, the average length of larvae captured at the two monitoring sites indicate that fish were hatched upriver of the monitoring site and drifted downstream over the course of 2 to 4 weeks of growth. According to the CDFG document commenting on the NMFS proposal to list the southern DPS (CDFG 2002), some green sturgeon rear to larger sizes above RBDD, or move back to this location after spending time downstream. Two sturgeon between 180 and 400 mm tail length were captured in the RST during 1999 and green sturgeon within this size range have been impinged on diffuser screens associated with a fish ladder at RBDD (CDFG 2002).

Juvenile green sturgeon have been salvaged at the Harvey O. Banks Pumping Plant and the John E. Skinner Fish Collection Facility (Fish Facilities) in the South Delta, and captured in trawling studies by 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 that juveniles of the Southern DPS of green sturgeon likely hold in the mainstem Sacramento River, as suggested by Kynard *et al.* (2005).

Population abundance information concerning the Southern DPS green sturgeon is described in the NMFS status reviews (Adams *et al*. 2002, NMFS 2005). 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 zero 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, April 6, 2005). 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, April 6, 2005). In light of the increased water exports, particularly during the previous 10 years, it is clear that the abundance of the Southern DPS 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, April 6, 2005). 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 spawning populations 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).

As described previously, the majority of spawning by green sturgeon in the Sacramento River system appears to take place above the location of RBDD. This is based on the length and estimated age of larvae captured at RBDD (approximately 2-3 weeks of age) and GCID (downstream, approximately 3-4 weeks of age) indicating that hatching occurred above the sampling location. Note that there are many assumptions with this interpretation (*i.e.*, equal sampling efficiency and distribution of larvae across channels) and this information should be considered cautiously.

Available information on green sturgeon indicates that, as with winter-run, the mainstem Sacramento River may be the last viable spawning habitat (Good *et al.* 2005) for the Southern DPS of green sturgeon. Lindley *et al.* (2007) pointed out that an ESU represented by a single population at moderate risk is at a high risk of extinction over the long term. Although the extinction risk of the Southern DPS of green sturgeon has not been assessed, NMFS believes that the extinction risk has increased because there is only one known population.

b. Current Viability of the Green Sturgeon Southern DPS

Viability parameters have not been established for North American green sturgeon. NMFS assumes that the general categories for assessing salmonid population viability will also be useful in assessing the viability of the green sturgeon Southern DPS. The following summary has been compiled from the best available data and information on North American green sturgeon to provide a general synopsis of the viability parameters for this DPS.

1. *Population Size*

The current population status of green sturgeon Southern DPS is unknown (Beamesderfer *et al.* 2007, Adams *et al.* 2007). It is believed, based on captures of green sturgeon during surveys for the sympatric white sturgeon in the San Francisco Bay estuary that the population is relatively small (USFWS 1995), ranging from several hundred to a few thousand adults. The sole population of green sturgeon Southern DPS spawns within the Sacramento River basin and is believed to spawn primarily in the mainstem of the Sacramento River between Keswick Dam (RM 302) and Hamilton City (RM 200). Israel (2006) indicated that between 2002 and 2005, a range of 18 to 42 adult green sturgeon were estimated to have bred upstream of RBDD, based on genetic analysis of captured larvae in the Sacramento River.

2. *Population Growth Rate*

Recruitment data for the green sturgeon Southern DPS are essentially nonexistent. Incidental catches of larval green sturgeon in the mainstem Sacramento River and juvenile fish at the CVP and SWP pumping facilities in the South Delta suggest that green sturgeon are successful at spawning, but that annual year class strength may be highly variable (Beamesderfer *et al*. 2007, Adams *et al*. 2007). Recent declines in the number of larvae captured in the RSTs near the RBDD may indicate a reduction in spawning success in the past several years, with resulting depressions in the year class strengths for those years. Green sturgeon are iteroparous and long-lived, so that spawning failure in any 1 year may be rectified in a succeeding spawning year. This would give the potential for a succesion of multiple, strong year classes, interspersed with weaker year classes.

3. Spatial Structure

Green sturgeon are found throughout the Sacramento – San Joaquin Delta and the San Francisco Bay estuary. Coastal migrants, which include both adult and subadult life stages, are found from approximately Central California to southeastern Alaska with aggregations of green sturgeon Southern DPS occurring in several estuaries along the West Coast from California northwards to Washington during the late summer and early fall. An aggregation of green sturgeon has also recently been identified off of the northwestern tip of Vancouver Island. Although both northern and southern populations mix in the ocean and coastal estuaries, it is believed that each DPS maintains a high fidelity to their natal watershed and little straying occurs between the two DPSs.

Until 2011, green sturgeon Southern DPS spawning had only been confirmed in one principle spawning area in the Sacramento River. In 2011 confirmed green sturgeon spawning occurred in the Feather River (DWR 2011). In 2011 in the Yuba River there were documented observations of green sturgeon exhibiting spawning behavior. Remaining spawning sites are, for the most part, outside of its historical spawning area. The recent habitat evaluations conducted in the upper Sacramento River for salmonid recovery suggest that significant spawning habitat was made inaccessible or altered by dams (Lindley *et al.* 2004, 2006; Adams *et al.* 2007). The historical spawning habitat may have extended up into the three major branches of the upper Sacramento upstream of the current location of Shasta Dam; the Little Sacramento River, the Pitt River, and the McCloud River. Additional spawning habitat is believed to have once existed upstream of the current location of Oroville Dam on the Feather River. Other watersheds, including the San Joaquin River basin may also have supported opportunistic green sturgeon spawning in the past (Adams *et al.* 2007*,* Beamesderfer *et al.* 2007)

The reduction of the green sturgeon Southern DPS spawning habitat into one reach on the Sacramento River between Keswick Dam and Hamilton City increases the vulnerability of this spawning population to catastrophic events. The necessary water temperatures required for normal egg development in the spawning reach is reliant on the cold-water releases in place for winter-run Chinook salmon. Extended drought conditions could imperil the spawning success for green sturgeon, particularly those that are restricted to the river reaches downstream of RBDD.

4. Diversity

Diversity, both genetic and behavioral, provides a species the opportunity to track and adapt to environmental changes. As a species' abundance decreases, and spatial structure of the ESU/DPS is reduced, a species has less flexibility to track changes in the environment. The reduction of the green sturgeon Southern DPS to one extant population reduces the potential variation of life history expression and genetic diversity within this population. The Southern

DPS of green sturgeon faces greater risks to long term persistence of the population due to the lack of this flexibilty in their current condition.

c. Summary of Green Sturgeon Southern DPS Viability

The green sturgeon Southern DPS is at substantial risk of future population declines (Adams *et al*. 2007). The potential threats faced by the green sturgeon include enhanced vulnerability due to the reduction of spawning habitat into one concentrated area on the Sacramento River, lack of good empirical population data, vulnerability of long-term cold water supply for egg incubation and larval survival, loss of juvenile green sturgeon due to entrainment at the project fish collection facilities in the South Delta and agricultural diversions within the Sacramento River and Delta systems, alterations of food resources due to changes in the Sacramento River and Delta habitats, and exposure to various sources of contaminants throughout the basin to juvenile, sub-adult, and adult life stages. Available information on green sturgeon indicates that the mainstem Sacramento River may be the last viable spawning habitat (Good *et al.* 2005) for the green sturgeon Southern DPS.

Recent improvements at RBDD are likely to improve upstream migration of green sturgeon and contribute to greater spawning success and possibly population abundance, however no restoration strategies exist for expanding the current range of the species. Lindley *et al.* (2007) pointed out that a salmon or steelhead ESU or DPS represented by a single population at moderate risk is at a high risk of extinction over the long term; this is also true for green sturgeon (Anderson *et al*. 2009). For these reasons, the extinction risk of the green sturgeon Southern DPS is high.

C. Critical Habitat Condition and Function for Species' Conservation

1. <u>Winter-run Chinook salmon Designated Critical Habitat</u>

The designated critical habitat for the Sacramento River winter-run Chinook salmon ESU includes the Sacramento River from Keswick Dam (RM 302) downstream 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 (June 16, 1993, 58 FR 33212). In the Sacramento River, critical habitat includes the river water column, river bottom, and adjacent riparian zone (those areas above a streambank that provide cover and shade to the nearshore aquatic areas) 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 winter-run as part of their juvenile emigration or adult spawning migration.

In designating critical habitat, NMFS considers those physical and biological features that are essential to the conservation of a species and that may require special management considerations or protection, including, but not limited to: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, generally, (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species [see 50 CFR 424.12(b)]. In addition, NMFS focuses on the known principal biological or physical constituent elements within the designated area that are essential to the conservation of the species (primary constituent elements). The final rule designating critical habitat for winter-run Chinook salmon (June 16, 1993, 58 FR 33212) identifies the following physical and biological features that are essential for the conservation of winter-run Chinook salmon: (1) access from the Pacific Ocean to appropriate spawning areas in the upper Sacramento River; (2) the availability of clean gravel for spawning substrate; (3) adequate river flows for successful spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles; (4) water temperatures between 42.5°F and 57.5°F for successful spawning, egg incubation, and fry development; (5) habitat areas and adequate prey that are not contaminated; (6) riparian habitat that provides for successful juvenile development and survival; and (7) access downstream so that juveniles can migrate from spawning grounds to San Francisco Bay and the Pacific Ocean. All of these essential features of critical habitat have been affected by anthropogenic activities, thereby contributing to the decline of Sacramento River winter-run Chinook salmon.

a. Access to Spawning Areas in the Upper Sacramento River

Adult migration corridors should provide satisfactory water quality, water quantity, water temperature, water velocity, cover, shelter and safe passage conditions in order for adults to reach spawning areas. Adult winter-run Chinook salmon generally migrate to spawning areas during the winter-run and spring. At that time of year, the migration route is mostly free of obstructions. However, the value of the Sacramento River migratory corridor has been reduced when the gates at the RBDD are lowered to divert river water into the Tehama-Colusa and Corning canals, thereby delaying or blocking 15 percent of the tail end of the spawning migration. Reasonable and Prudent Alternative (RPA) actions of the 2009 NMFS biological opinion on the Long Term Operations of the Central Valley Project-State Water Project (CVP-SWP) provided a prescription for modified operations of the RBDD gates to reduce impacts on migrating winter-run Chinook salmon (NMFS 2009a). Construction of the pumping plant at the RBDD was completed in September of 2012 and replaced the need for lowering the RBDD gates, thereby providing unimpeded passage for winter-run Chinook salmon to available spawning areas. Beginning September, 2011, the gates of the RBDD have remained open year round.

b. The Availability of Clean Gravel for Spawning Substrate

Spawning habitat for winter-run Chinook salmon is restricted to the Sacramento River between Keswick Dam and RBDD; however, the vast majority of spawning occurs upstream of the Airport Road bridge in Anderson, a distance of only 13 miles of river. Available spawning habit is completely outside the historical range utilized by winter-run Chinook salmon for spawning. Because Shasta and Keswick dams preclude spawning gravel recruitment, Reclamation injects spawning gravel into various areas of the upper Sacramento River. With the supplemented gravel injections, the reach of the upper Sacramento River continues to support the current populations of winter-run Chinook salmon.

c. Adequate River Flows for Successful Spawning, Incubation of Eggs, Fry Development and Emergence, and Downstream Transport of Juveniles

All historical spawning habitats of Sacramento River winter-run Chinook salmon have been blocked by essentially permanent and impassable barriers. Remaining spawning areas are completely outside of the historical range of winter-run Chinook salmon spawning, and are completely dependent on releases of cold water from Shasta Dam.

An April 5, 1960, Memorandum of Agreement (MOA) between Reclamation and the CDFG originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. In addition, Reclamation complies with the flow releases required in Water Rights Order (WRO) 90-05. Additional measures to improve juvenile rearing habitat in the lower Sacramento River and northern Delta are required through the NMFS biological opinion on the Long Term Operations of the CVP-SWP (NMFS 2009a).

d. Water Temperatures for Successful Spawning, Egg Incubation, and Fry Development

Summer flow releases from Shasta Reservoir for agriculture and other consumptive uses drive operations of Shasta and Keswick dams during the period of winter-run Chinook salmon migration, spawning, egg incubation, fry development, and emergence. However, cold water releases also benefit winter-run Chinook salmon. The extent to which winter-run Chinook salmon habitat needs are met depends on Reclamation's other operational commitments, including those to water contractors, State Water Resources Control Board Water Rights Decision 1641 (D-1641) regulations and criteria, and projected end of September storage volume. Based on these commitments and Reclamation's modeled February and subsequent monthly forecasts, Reclamation determines how far downstream 56°F can be maintained and sustained throughout the winter-run Chinook salmon spawning, egg incubation, and fry development stages. Although Water Rights Order (WRO) 90-05 and 91-1 require Reclamation to operate Keswick and Shasta dams, and the Spring-run Creek Power Plant, to meet a daily average water temperature of 56°F at RBDD, they also provide the exception that the water temperature compliance point (TCP) may be modified when the objective cannot be met at RBDD. In every year since the State Water Resources Control Board (SWRCB) issued WRO 90-05 and 91-1, operations plans have included modifying the RBDD compliance point to make best use of the cold water resources based on the location of spawning Chinook salmon. Once a TCP has been identified and established, it generally does not change, and therefore, water temperatures are typically adequate for successful egg incubation and fry development for those redds constructed upstream of the TCP. However, the annual change in TCP has degraded the conservation value of spawning habitat (based on water temperature). As part of the RPA for NMFS' biological opinion on the Long Term Operations of the CVP-SWP, a year-round temperature and Shasta reservoir storage management program to minimize effects to winter-run Chinook salmon spawning, egg incubation, and rearing is included (NMFS 2009a).

e. Habitat Areas and Adequate Prey that are not Contaminated

Current water quality conditions are better than in previous decades, however legacy contaminants such as mercury (and methyl mercury), polychlorinated biphenyls (PCB), heavy metals, and persistent organochlorine pesticides continue to be found in watersheds throughout the Central Valley. Although most of these contaminants are at low concentrations in the food chain, they continue to work their way into the base of the food web, particularly when sediments are disturbed and previously entombed compounds are released into the water column. Exposure to these contaminated food sources may create delayed sublethal effects that reduce fitness. Contaminants are typically associated with areas of urban development or other anthropogenic activities (*e.g.*, mercury contamination as a result of gold mining or processing). Areas with low human impacts frequently have low contaminant burdens, and therefore lower levels of potentially harmful toxicants in the aquatic system.

f. Riparian Habitat that Provides for Successful Juvenile Development and Survival

The channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system typically have low habitat complexity, low abundance of food organisms, and offer little protection from predators. Juvenile life stages of salmonids are dependent on the natural functioning of this habitat for successful survival and recruitment. Some complex, productive habitats with floodplains [*e.g.*, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa)] and flood bypasses (*i.e.*, Yolo and Sutter bypasses) remain in the system. Nevertheless, the current condition of riparian habitat for winter-run Chinook salmon is degraded.

g. Unobstructed emigration corridor from Spawning Grounds to the Pacific Ocean

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the mainstem of the Sacramento River.

Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. Prior to 2012, when the gates were in, RBDD reduced the value of the migratory corridor for downstream migration. Predators of juvenile salmonids, such as striped bass (*Morone saxatilis*) and Sacramento pikeminnow (*Ptychocheilus grandis*), concentrated downstream of dam structures, resulting in increased mortality of juvenile Chinook salmon from predation.

Unscreened diversions that entrain juvenile salmonids are prevalent throughout the mainstem Sacramento River. Although actual entrainment rates are not known, the CVP-SWP operations biological assessment provided calculations of estimated entrainment of salmonids through unscreened diversions along the Sacramento River (Reclamation 2008). According to the calculations, over 7,000 juvenile winter-run Chinook salmon are lost to unscreened diversions annually.

Emigrating juvenile salmonid are also affected by diversion into the interior Delta through the DDCC. When the DCC gates are open during winter-run Chinook salmon outmigration, a portion of the flow, and therefore, a portion of the out-migrating winter-run Chinook salmon, is entrained through the DCC into the interior Delta, where their chances of survival and successful migration to San Francisco Bay and the Pacific Ocean are reduced.
D-1641 provides for 45 days of discretionary gate closures of the DCC between November 1 and January 31, which leaves the DCC gates open half the time during those three months. Additional gate closures to keep young fish out of artificial channels and to allow them to migrate safely towards the Ocean are included in the RPA of NMFS' biological opinion on the Long Term Operations of the CVP-SWP (NMFS 2009a).

Water pumping at the CVP-SWP export facilities in the South Delta causes reverse flows, further disrupting the emigration of juvenile winter-run Chinook salmon by attracting and diverting them to the inner Delta, where they are exposed to increased rates of predation and entrainment at pumping stations. NMFS' biological opinion on the Long Term Operations of the CVP-SWP (NMFS 2009a) set limits to the strength of reverse flows in the Old and Middle Rivers, thereby keeping salmon away from areas of highest mortality.

Based on impediments caused by the RBDD (up until 2012), unscreened diversions, the schedule of DCC gates operations, and reverse flows in the Delta, the current condition of the freshwater migration corridor in the Sacramento River is much degraded during the emigration of Sacramento River winter-run Chinook salmon.

h. Summary of Sacramento River Winter-run Chinook salmon Critical Habitat

Critical habitat for winter-run Chinook salmon is composed of physical and biological features that are essential for the conservation of winter-run Chinook salmon, including upstream and downstream access, and the availability of certain habitat conditions necessary to meet the biological requirements of the species. Currently, many of these physical and biological features are impaired, and provide limited conservation value. Additional factors degrading the quality of the migratory corridor for juveniles include unscreened diversions throughout the mainstem Sacramento River, open DCC gates during the outmigration of winter-run Chinook salmon, and reverse flows in the Sacramento-San Joaquin Delta.

In addition, the annual change in the TCP has degraded the conservation value of available spawning habitats (based on water temperature). The current condition of riparian habitat for winter-run Chinook salmon rearing is degraded by the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system. However, some complex, productive habitats with floodplains remain in the system, including reaches of the Sacramento River with setback levees located upstream of the City of Colusa and flood bypasses (*i.e.*, Yolo and Sutter bypasses). Based on the impediments caused by unscreened diversions, annual changes to the temperature compliance point, diversions into the inner Delta when DCC gates are open, reverse flows in the Delta, and the degraded condition of spawning habitat and riparian habitat, the current condition of critical habitat of Sacramento River winter-run Chinook salmon is degraded, and has low value for the conservation of the species.

2. Critical Habitat for CV Spring-run Chinook Salmon and CCV Steelhead

Critical habitat was designated for CV spring-run Chinook salmon and CCV steelhead on September 2, 2005 (70 FR 52488). Critical habitat for CV 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, the Sacramento River, as well as portions of the northern Delta. Critical habitat for CCV 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; the San Joaquin River, including its tributaries, and the waterways of 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 (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) (Bain and Stevenson 1999; 70 FR 52488). Critical habitat for CV spring-run Chinook salmon and steelhead is defined as 50 C.F.R. 226.211(c), wherein primary constituent elements (PCE's) are identified for the species. Following are the relevant inland habitat types used as PCEs for CV spring-run Chinook salmon and CCV steelhead.

3. PCEs for CV Spring-run Chinook salmon and CCV Steelhead

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. CV 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 (however, little spawning activity has been recorded in recent years on the Sacramento River mainstem for spring-run Chinook salmon). Spawning habitat for CCV 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) on perennial watersheds throughout the Central Valley. These reaches can be subjected to variations in flows and temperatures, particularly over the summer months, which can have adverse effects upon salmonids spawning below them. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects 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 woody material, log jams and 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 the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, 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 also has a high conservation value even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

c. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks, and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower main-stems of the Sacramento and San Joaquin rivers 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 (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For this reason, freshwater migration corridors are considered to have a high conservation value even if the migration corridors are significantly degraded compared to their natural state.

4. <u>Critical Habitat for the Southern DPS of North American Green Sturgeon</u>

Critical habitat was designated for the Southern DPS of North American green sturgeon on October 9, 2009 (74 FR 52300). Critical habitat for Southern DPS green sturgeon includes the stream channels and waterways in the Delta to the ordinary high water line except for certain excluded areas. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, and the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery. Coastal Marine areas include waters out to a depth of 60 meters from Monterey Bay, California, to the Juan De Fuca Straits in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are also included as critical habitat for Southern DPS green sturgeon.

a. Critical Habitat and Primary Constituent Elements

The critical habitat for the Southern DPS of green sturgeon includes principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. PCEs for green sturgeon have been designated for freshwater riverine systems, estuarine habitats, and nearshore coastal areas.

<u>Freshwater Riverine Systems</u>

Water Flow - An adequate flow regime (*i.e*., magnitude, frequency, duration, seasonality, and groundwater recharge) is necessary for normal behavior, growth, and survival of all life stages in the upper Sacramento River. Such a flow regime should include 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, 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, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning success is associated with water flow and water temperature compared to other variables. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs (average daily water flow during spawning months: 6,900 – 10,800 cfs; Brown 2007). Post-spawning downstream migrations are triggered by increased flows, ranging from 6,150 – 14,725 cfs in the late summer (Vogel 2008) and greater than 3,550 cfs in the winter (Erickson *et al.* 2002; Benson *et al.* 2007). The current suitability of these flow requirements is almost entirely dependent on releases from Shasta Dam. High winter flows associated with the natural hydrograph do not occur within the section of the river utilized by green sturgeon with the frequency and duration that was seen in pre-dam conditions. Continued operations of Shasta Dam and the CVP are likely to further attenuate these high flow events. Rearrangement of the river channel and the formation of new pools and holes are unlikely to occur given the management of the river's discharge to prevent flooding downstream of Shasta Dam.

Food Resources - Abundant food items for larval, juvenile, subadult, and adult life stages should be present in sufficient amounts to sustain growth (larvae, juveniles, and subadults) or support basic metabolism (adults). Although we lack specific data on food resources for green sturgeon within freshwater riverine systems, nutritional studies on white sturgeon suggest that juvenile green sturgeon most likely feed on macro benthic invertebrates, which can include plecoptera (stoneflies), ephemeroptera (mayflies), trichoptera (caddis flies), chironomid (dipteran fly larvae), oligochaetes (tubifex worms) or decapods (crayfish). 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 or on non-spawning migrations within freshwater rivers. Subadult and adult green sturgeon in freshwater rivers most likely feed on benthic invertebrates similar to those fed on in bays and estuaries, including freshwater shrimp and amphipods. Many of these different invertebrate groups are endemic to and readily available in the Sacramento River from Keswick Dam downstream to the Delta. Heavy hatches of mayflies, caddis flies, and chironomids occur in the upper Sacramento River, indicating that these groups of invertebrates are present in the river system. NMFS anticipates that the aquatic life stages of these insects (nymphs, larvae) would provide adequate nutritional resources for green sturgeon rearing in the river.

Substrate Type or Size - Suitable critical *habitat* in the freshwater riverine system should include substrate 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, and free of excessive silt and debris that could smother eggs during incubation), larval development (*e.g*., substrates with interstices or voids providing refuge from predators and from high flow conditions), and subadults and adult life stages (*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 (Van Eenennaam *et al.* 2001, and Deng *et al.* 2002). Both embryos and larvae exhibited 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 use flat-surfaced substrates for foraging (Nguyen and Crocker 2007). Recent stream surveys by USFWS and Reclamation biologists have identified approximately 54 suitable holes and pools between Keswick Dam and approximately GCID that would support spawning or holding activities for green sturgeon based on the identified physical criteria. Many of these locations are at the confluence of tributaries with the mainstem Sacramento River or at bend pools. Observations of channel type and substrate compositions during these surveys indicate that appropriate substrate is available in the Sacramento River between GCID and Keswick Dam. Ongoing surveys are anticipated to further identify river reaches with suitable substrate characteristics in the upper river and their utilization by green sturgeon.

Water Quality - Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages are required for the properly functioning of the freshwater habitat. 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). Due to the temperature management of the releases from Keswick Dam for winter-run in the upper Sacramento River, water temperatures in the river reaches utilized currently by green sturgeon appear to be suitable for proper egg development and larval and juvenile rearing. Suitable salinity levels range from fresh water (< 3 ppt) for larvae and early juveniles [about 100 days post hatch (dph)] to brackish water (10 ppt) 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). Salinity levels are suitable for green sturgeon in the Sacramento River and freshwater portions of the Delta for early life history stages. Adequate levels of DO 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). Current mainstem DO levels are suitable to support the growth and migration of green sturgeon in the Sacramento River. Suitable water quality would also include water free 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. Water free of such contaminants would protect green sturgeon from adverse impacts on growth, reproductive development, and reproductive success (*e.g*., reduced egg size and abnormal gonadal development, abnormal embryo development during early cleavage stages and organogenesis) likely to result from exposure to contaminants (Fairey *et al.* 1997, Foster *et al.* 2001, Kruse and Scarnecchia 2002, Feist *et al.* 2005, and Greenfield *et al.* 2005). Legacy contaminants such as mercury still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River basin.

Migratory Corridor - Safe and unobstructed migratory pathways are necessary for passage within riverine habitats and between riverine and estuarine habitats (*e.g*., an unobstructed river or dammed river that still allows for passage). Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning/rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick Dam (RM 302) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242). Recent improvements at RBDD have replaced to gate operation and a new fish screen became operational in 2012. These improvements will abate the upstream fish passage threat historically faced by sturgeon.

Depth - Deep pools of ≥ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River above Glenn Colusa Irrigation District (GCID). The significance and purpose of these aggregations are unknown at the present time, although it is likely that they are the result of an intrinsic behavioral characteristic of green sturgeon. 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). As described above approximately 54 pools with adequate depth have been identified in the Sacramento River above the GCID location.

Sediment Quality - Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants [*e.g*., elevated levels of heavy metals (*e.g.*, mercury, copper, zinc, cadmium, and chromium), PAHs, and organochlorine pesticides] that can result in negative effects on any life stages of green sturgeon. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may negatively affect the growth, reproductive development, and reproductive success of green sturgeon. The Sacramento River and its tributaries have a long history of contaminant exposure from abandoned mines, separation of gold ore from mine tailings using mercury, and agricultural practices with pesticides and fertilizers which result in deposition of these materials in the sediment horizons in the river channel. Disturbance of these sediment horizons by natural or anthropogenic actions can liberate the sequestered contaminants into the river. This is a continuing concern throughout the watershed.

For Estuarine Habitats

Food Resources - Abundant food items within estuarine habitats and substrates for juvenile, subadult, and adult life stages are required for the proper functioning of this PCE for green sturgeon. Prey species for juvenile, subadult, and adult green sturgeon within bays and estuaries primarily consist of benthic invertebrates and fish, including crangonid shrimp, callianassid 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. Currently, the estuary provides these food resources, although annual fluctuations in the population levels of these food resources may diminish the contribution of one group to the diet of green sturgeon relative to another food source. The recent spread of the Asian overbite clam has shifted the diet profile of white sturgeon to this invasive species. The overbite clam now makes up a substantial proportion of the white sturgeon's diet in the estuary. NMFS assumes that green sturgeon have also altered their diet to include this new food source based on its increased prevalence in the benthic invertebrate community.

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 is required. Sufficient flows are needed to attract adult green sturgeon to the Sacramento River from the bay and to initiate the upstream spawning migration into the upper river. Currently, flows provide the necessary attraction to green sturgeon to enter the Sacramento River. Nevertheless, these flows are substantially less than what would have been available historically to stimulate the spawning migration.

Water Quality - Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth and viability of all life stages. Suitable water temperatures for juvenile green sturgeon should be below 24°C (75°F). 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 in the estuary range from brackish water (10 ppt) to salt water (33 ppt). 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 DO levels, but may need a minimum DO level of at least 6.54 mg O_2/l (Kelly *et al.* 2007, Moser and Lindley 2007). As described above, adequate levels of DO 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 water free 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. In general, water quality in the Delta and estuary meets these criteria, but local areas of the Delta and downstream bays have been identified as having deficiencies. Water quality in the areas such as the Stockton turning basin and Port of Stockton routinely have depletions of DO and episodes of first flush contaminants from the surrounding industrial and urban watershed. Discharges of agricultural drain water have also been implicated in local elevations of pesticides and other related agricultural compounds within the Delta and the tributaries and sloughs feeding into the Delta. Discharges from petroleum refineries in Suisun and San Pablo Bay have been identified as sources of selenium to the local aquatic ecosystem (Linville *et al.* 2002).

Migratory Corridor - Safe and unobstructed migratory pathways are necessary for the safe and timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. Within the waterways comprising the Delta, and bays downstream of the Sacramento River, safe and unobstructed passage is needed for juvenile green sturgeon during the rearing phase of their life cycle. Rearing fish need the ability to freely migrate from the river through the estuarine waterways of the delta and bays 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. Within bays and estuaries outside of the Delta and the areas comprised by Suisun, San Pablo, and San Francisco bays, safe and 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. Currently, safe and unobstructed passage has been diminished by human actions in the Delta and bays. The CVP and SWP water projects alter flow patterns in the Delta due to export pumping and create entrainment issues in the Delta at the pumping and Fish Facilities. Power generation facilities in Suisun Bay create risks of entrainment and thermal barriers through their operations of cooling water diversions and discharges. Installation of seasonal barriers in the South Delta and operations of the radial gates in the DCC facilities alter migration corridors available to green sturgeon. Actions such as the hydraulic dredging of ship channels and operations of large ocean going vessels create additional sources of risk to green sturgeon within the estuary. Hydraulic dredging can result in the entrainment of fish into the dredger's hydraulic cutterhead intake. Commercial shipping traffic can result in the loss of fish, particularly adult fish, through ship and propeller strikes.

Water Depth - A diversity of depths is necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Subadult and adult green sturgeon occupy deep (≥ 5 m) holding pools within bays and estuaries as well as within freshwater rivers. These deep holding pools may be important for feeding and energy conservation, or may serve as thermal refugia for subadult and adult green sturgeon (Benson *et al*. 2007). 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 3 – 8 feet 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.

Currently, there is a diversity of water depths found throughout the San Francisco Bay estuary and Delta waterways. Most of the deeper waters, however, are comprised of artificially maintained shipping channels, which do not migrate or fluctuate in response to the hydrology in the estuary in a natural manner. The channels are simplified trapezoidal shapes with little topographical variation along the channel alignment. Shallow waters occur throughout the Delta and San Francisco Bay. Extensive "flats" occur in the lower reaches of the Sacramento and San

Joaquin River systems as they leave the Delta region and are even more extensive in Suisun and San Pablo bays. In most of the region, variations in water depth in these shallow water areas occur due to natural processes, with only localized navigation channels being dredged (*e.g.*, the Napa River and Petaluma River channels in San Pablo Bay).

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

b. Green Sturgeon Critical Habitat Summary

The current condition of critical habitat for the Southern DPS of green sturgeon is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the survival and recovery of the species, particularly in the upstream riverine habitat. In particular, passage and water flow PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the Southern DPS of green sturgeon evolved. The habitat values proposed for green sturgeon critical habitat have suffered similar types of degradation as already described for winter-run critical habitat. In addition, the alterations to the Sacramento-San Joaquin River Delta, as part of critical habitat, may have a particularly strong impact on the survival and recruitment of juvenile green sturgeon due to the protracted rearing time in the delta and estuary. Loss of individuals during this phase of the life history of green sturgeon represents losses to multiple year classes rearing in the Delta, which can ultimately impact the potential population structure for decades to come.

D. Factors Impacting Listed Species

1. <u>Habitat Blockage</u>

Hydropower, flood control, and water supply dams of the Central Valley Project (CVP and SWP), and other municipal and private entities have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. Clark (1929) estimated that originally there were 6,000 linear miles of salmon habitat in the CV 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 was actually available before dam construction and mining, and concluded that 82 percent is not accessible today.

As a result of migrational barriers, winter-run Chinook salmon, spring-run Chinook salmon, and steelhead populations have been confined to lower elevation mainstems that historically only were used for migration. Population abundances have declined in these streams due to decreased quantity and quality of spawning and rearing habitat. Higher temperatures at these lower elevations during late-summer and fall are also a major stressor to adult and juvenile salmonids. Similarly, of the 18 independent populations of CV spring-run Chinook salmon that occurred historically, only three independent populations remain in Deer, Mill, and Butte creeks. Dependent populations of CV spring-run Chinook salmon continue to occur in Big Chico, Antelope, Clear, Thomes, Beegum, and Stony creeks, but rely on the three extant independent populations for their continued survival. CCV steelhead historically had at least 81 independent populations based on Lindley *et al.*'s (2006) analysis of potential habitat in the CV. However, due to dam construction, access to 38 percent of all spawning habitat has been lost as well as access to 80 percent of the historically available habitat. Green sturgeon populations would be similarly affected by these barriers and alterations to the natural hydrology. In particular, RBDD blocks access to a significant portion of the adult spawning run under current operational procedures.

The Suisun Marsh Salinity Control Gates (SMSCG), located on Montezuma Slough, were installed in 1988, and are operated with gates and flashboards to decrease the salinity levels of managed wetlands in Suisun Marsh. The SMSCG have delayed or blocked passage of adult Chinook salmon migrating upstream (Edwards *et al.* 1996, Tillman *et al.* 1996,). The effects of the SMSCG on sturgeon are unknown at this time.

2. Water Development

The diversion and storage of natural flows by dams and diversion structures on CV waterways have depleted stream flows and altered the natural cycles by which juvenile and adult salmonids base their migrations. 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 DO levels, and decreased recruitment of gravel and large woody material (LWM). 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 bed load movement (Mount 1995, Ayers and Associates 2001), 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. The storage of unimpeded runoff in these large reservoirs also has altered the normal hydrograph for the Sacramento and San Joaquin river watersheds. Rather than seeing peak flows in these river systems following winter rain events (Sacramento River) or spring snow melt (San Joaquin River), the current hydrology has truncated peaks with a prolonged period of elevated flows (compared to historical levels) continuing into the summer dry season.

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). Elevated water temperatures in the Sacramento River have limited the survival of young salmon in those waters. Juvenile fall-run Chinook salmon survival in the Sacramento River is also directly related with June streamflow and June and July Delta outflow (Dettman *et al*. 1987).

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Thousands of small and medium-size water diversions exist along the Sacramento River, San Joaquin River, and their tributaries. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile salmonids. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001). Most of the 370 water diversions operating in Suisun Marsh are unscreened (Herren and Kawasaki 2001).

Outmigrant juvenile salmonids in the Delta have been subjected to adverse environmental conditions created by water export operations at the CVP and SWP facilities. Specifically, juvenile salmonid survival has been reduced by the following: (1) water diversion from the mainstem Sacramento River into the Central Delta via the Delta Cross Channel; (2) upstream or reverse flows of water in the lower San Joaquin River and southern Delta waterways; (3) entrainment at the CVP/SWP export facilities and associated problems at Clifton Court Forebay; and (4) increased exposure to introduced, non-native predators such as striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*), and sunfishes (Centrarchidae). On June 4, 2009, NMFS issued a biological and conference opinion on the long-term operations of the CVP and SWP (NMFS 2009a). As a result of the jeopardy and adverse modification determinations, NMFS provided a reasonable and prudent alternative that reduces many of the adverse effects of the CVP and SWP resulting from the stressors described above.

3. Water Conveyance and Flood Control

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. As Mount (1995) indicates, there is an "underlying, fundamental conflict inherent in this channelization." Natural rivers strive to achieve dynamic equilibrium to handle a watersheds supply of discharge and sediment (Mount 1995). The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects.

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 near shore 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 near shore 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).

Prior to the 1970s, there was so much debris resulting from poor logging practices that many streams were completely clogged and were thought to have been total barriers to fish migration. As a result, in the 1960s and early 1970s it was common practice among fishery management agencies to remove woody material thought to be a barrier to fish migration (NMFS 1996b). However, it is now recognized that too much LWM was removed from the streams resulting in a loss of salmonid habitat and it is thought that the large scale removal of woody debris prior to 1980 had major, long-term negative effects on rearing habitats for salmonids in northern California (NMFS 1996b). Areas that were subjected to this removal of LWM are still limited in the recovery of salmonid stocks; this limitation could be expected to persist for 50 to 100 years following removal of debris.

Large quantities of downed trees are a functionally important component of many streams (NMFS 1996b). LWM influences stream morphology by affecting channel pattern, position, and geometry, as well as pool formation (Keller and Swanson 1979, Bilby 1984, Robison and Beschta 1990). Reduction of wood in the stream channel, either from past or present activities, generally reduces pool quantity and quality, alters stream shading which can affect water temperature regimes and nutrient input, and can eliminate critical stream habitat needed for both vertebrate and invertebrate populations. Removal of vegetation also can destabilize marginally stable slopes by increasing the subsurface water load, lowering root strength, and altering water flow patterns in the slope.

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.

4. Land Use Activities

Land use activities continue to have large impacts on salmonid habitat in the Central Valley watershed. Until about 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation extending outward for 4 or 5 miles (California Resources Agency 1989). Starting with the gold rush, these vast riparian forests were cleared for building materials, fuel, and to clear land for farms on the raised natural levee banks. The degradation and fragmentation of riparian habitat continued with extensive flood control and bank protection projects, together with the conversion of the fertile riparian lands to agriculture outside of the natural levee belt. By 1979, riparian habitat along the Sacramento River diminished to 11,000 to 12,000 acres, or about 2 percent of historic levels (McGill 1987). The clearing of the riparian forests removed a vital source of snags and driftwood in the Sacramento and San Joaquin river basins. This has reduced the volume of LWM input needed to form and maintain stream habitat that salmon depend on in their various life stages. In addition to this loss of LWM sources, removal of snags and obstructions from the active river channel for navigational safety has further reduced the presence of LWM in the Sacramento and San Joaquin rivers, as well as the Delta.

Increased sedimentation resulting from agricultural and urban practices within the Central Valley is one of the primary causes of salmonid habitat degradation (NMFS 1996a). Sedimentation can adversely affect salmonids during all freshwater life stages by: clogging or abrading gill surfaces, adhering to eggs, hampering fry emergence (Phillips and Campbell 1961), burying eggs or alevins, scouring and filling in pools and riffles, reducing primary productivity and photosynthesis activity (Cordone and Kelley 1961), and affecting intergravel permeability and DO levels. Excessive sedimentation over time can cause substrates to become embedded, which reduces successful salmonid spawning and egg and fry survival (Waters 1995).

Land use activities associated with road construction, urban development, logging, mining, agriculture, and recreation have significantly altered fish habitat quantity and quality through the alteration of stream bank and channel morphology; alteration of ambient water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of LWM; and removal of riparian vegetation, resulting in increased stream bank erosion (Meehan and Bjornn 1991). Urban stormwater and agricultural runoff may be contaminated with herbicides and pesticides, petroleum products, sediment, *etc.* Agricultural practices in the Central Valley have eliminated large trees and logs and other woody material that would otherwise be recruited into the stream channel (NMFS 1998).

Since the 1850s, wetlands reclamation for urban and agricultural development has caused the cumulative loss of 79 and 94 percent of the tidal marsh habitat in the Delta downstream and upstream of Chipps Island, respectively (Conomos *et al.* 1985, Nichols *et al.* 1986, Wright and Phillips 1988, Monroe *et al.* 1992, Goals Project 1999). Prior to 1850, approximately 1400 km^2 of freshwater marsh surrounded the confluence of the Sacramento and San Joaquin rivers, and another 800 km^2 of saltwater marsh fringed San Francisco Bay's margins. Of the original 2,200 km^2 of tidally influenced marsh, only about 125 km^2 of undiked marsh remains today. In Suisun Marsh, saltwater intrusion and land subsidence gradually has led to the decline of agricultural production. Presently, Suisun Marsh consists largely of tidal sloughs and managed wetlands for duck clubs, which first were established in the 1870s in western Suisun Marsh (Goals Project 1999). Even more extensive losses of wetland marshes occurred in the Sacramento and San Joaquin river basins. Little of the extensive tracts of wetland marshes that existed prior to 1850 along the valley's river systems and within the natural flood basins exist today. Most has been "reclaimed" for agricultural purposes, leaving only small remnant patches.

Dredging of river channels to enhance inland maritime trade and to provide raw material for levee construction has significantly and detrimentally altered the natural hydrology and function of the river systems in the Central Valley. Starting in the mid-1800s, the Corps and private consortiums began straightening river channels and artificially deepening them to enhance shipping commerce. This has led to declines in the natural meandering of river channels and the formation of pool and riffle segments. The deepening of channels beyond their natural depth also has led to a significant alteration in the transport of bed load in the riverine system as well as the local flow velocity in the channel (Mount 1995). The Sacramento Flood Control Project at the turn of the nineteenth century ushered in the start of large scale Corps actions in the Delta and along the rivers of California for reclamation and flood control. The creation of levees and the deep shipping channels reduced the natural tendency of the San Joaquin and Sacramento rivers to create floodplains along their banks with seasonal inundations during the wet winter season and the spring snow melt periods. These annual inundations provided necessary habitat for rearing and foraging of juvenile native fish that evolved with this flooding process. The armored riprapped levee banks and active maintenance actions of Reclamation Districts precluded the establishment of ecologically important riparian vegetation, introduction of valuable LWM from these riparian corridors, and the productive intertidal mudflats characteristic of the undisturbed Delta habitat.

Urban storm water and agricultural runoff may be contaminated with pesticides, oil, grease, heavy metals, polycyclic aromatic hydrocarbons (PAHs), and other organics and nutrients (California Regional Water Quality Control Board-Central Valley Region [Regional Board] 1998) that can potentially destroy aquatic life necessary for salmonid survival (NMFS 1996a, b). Point source (PS) and non-point source (NPS) pollution occurs at almost every point that urbanization activity influences the watershed. Impervious surfaces (*i.e.*, concrete, asphalt, and buildings) reduce water infiltration and increase runoff, thus creating greater flood hazard (NMFS 1996a, b). Flood control and land drainage schemes may increase the flood risk downstream by concentrating runoff. A flashy discharge pattern results in increased bank erosion with subsequent loss of riparian vegetation, undercut banks and stream channel widening. In addition to the PS and NPS inputs from urban runoff, juvenile salmonids are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges.

Past mining activities routinely resulted in the removal of spawning gravels from streams, the straightening and channelization of the stream corridor from dredging activities, and the leaching of toxic effluents into streams from mining operations. Many of the effects of past mining operations continue to impact salmonid habitat today. Current mining practices include suction dredging (sand and gravel mining), placer mining, lode mining and gravel mining. Present day mining practices are typically less intrusive than historic operations (hydraulic mining); however, adverse impacts to salmonid habitat still occur as a result of present-day mining activities. Sand and gravel are used for a large variety of construction activities including base material and asphalt, road bedding, drain rock for leach fields, and aggregate mix for concrete to construct buildings and highways.

Most aggregate is derived principally from pits in active floodplains, pits in inactive river terrace deposits, or directly from the active channel. Other sources include hard rock quarries and mining from deposits within reservoirs. Extraction sites located along or in active floodplains present particular problems for anadromous salmonids. Physical alteration of the stream channel may result in the destruction of existing riparian vegetation and the reduction of available area for seedling establishment (Stillwater Sciences 2002). Loss of vegetation impacts riparian and aquatic habitat by causing a loss of the temperature moderating effects of shade and cover, and habitat diversity. Extensive degradation may induce a decline in the alluvial water table, as the banks are effectively drained to a lowered level, affecting riparian vegetation and water supply (NMFS 1996b). Altering the natural channel configuration will reduce salmonid habitat diversity by creating a wide, shallow channel lacking in the pools and cover necessary for all life stages of anadromous salmonids. In addition, waste products resulting from past and present mining activities, include cyanide (an agent used to extract gold from ore), copper, zinc, cadmium, mercury, asbestos, nickel, chromium, and lead.

Juvenile salmonids are exposed to increased water temperatures in the Delta during the late spring and summer due to the loss of riparian shading, and by thermal inputs from municipal, industrial, and agricultural discharges. Studies by DWR on water quality in the Delta over the last 30 years show a steady decline in the food sources available for juvenile salmonids and sturgeon and an increase in the clarity of the water due to a reduction in phytoplankton and zooplankton. These conditions have contributed to increased mortality of juvenile Chinook salmon, steelhead, and sturgeon as they move through the Delta.

5. Water Quality

The water quality of the Delta has been negatively impacted over the last 150 years. Increased water temperatures, decreased DO levels, and increased turbidity and contaminant loads have degraded the quality of the aquatic habitat for the rearing and migration of salmonids. The Regional Board, in its 1998 Clean Water Act §303(d) list characterized the Delta as an impaired waterbody having elevated levels of chlorpyrifos, dichlorodiphenyltrichlor (*i.e.* DDT), diazinon, electrical conductivity, Group A pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes [including lindane], endosulfan and toxaphene), mercury, low DO, organic enrichment, and unknown toxicities (California Regional Water Quality Control Board-Central Valley Region [Regional Board] 1998, 2001).

In general, water degradation or contamination can lead to either acute toxicity, resulting in death when concentrations are sufficiently elevated, or more typically, when concentrations are lower, to chronic or sublethal effects that reduce the physical health of the organism, and lessens its survival over an extended period of time. Mortality may become a secondary effect due to compromised physiology or behavioral changes that lessen the organism's ability to carry out its normal activities. For example, increased levels of heavy metals are detrimental to the health of an organism because they interfere with metabolic functions by inhibiting key enzyme activity in metabolic pathways, decrease neurological function, degrade cardiovascular output, and act as mutagens, teratogens or carcinogens in exposed organisms (Rand *et al*. 1995, Goyer 1996). For listed species, these effects may occur directly to the listed fish or to its prey base, which reduces the forage base available to the listed species.

In the aquatic environment, most anthropogenic chemicals and waste materials including toxic organic and inorganic chemicals eventually accumulate in sediment (Ingersoll 1995). Direct exposure to contaminated sediments may cause deleterious effects to listed salmonids or the threatened green sturgeon. This may occur if a fish swims through a plume of the resuspended sediments or rests on contaminated substrate and absorbs the toxic compounds through one of several routes: dermal contact, ingestion, or uptake across the gills. Elevated contaminant levels may be found in localized “hot spots” where discharge occurs or where river currents deposit sediment loads. Sediment contaminant levels can thus be significantly higher than the overlying water column concentrations (EPA 1994). However, the more likely route of exposure to salmonids or sturgeon is through the food chain, when the fish feed on organisms that are contaminated with toxic compounds. Prey species become contaminated either by feeding on the detritus associated with the sediments or dwelling in the sediment itself. Therefore, the degree of exposure to the salmonids and green sturgeon depends on their trophic level and the amount of contaminated forage base they consume. Response of salmonids and green sturgeon to contaminated sediments is similar to water borne exposures.

Low DO levels frequently are observed in the portion of the Stockton deep water ship channel (DWSC) extending from Channel Point, downstream to Turner and Columbia Cuts. Over a 5-year period, starting in August 2000, a DO meter has recorded channel DO levels at Rough and Ready Island (Dock 20 of the West Complex). Over the course of this time period, there have been 297 days in which violations of the 5 mg/L DO criteria for the protection of aquatic life in the San Joaquin River between Channel Point and Turner and Columbia Cuts have occurred during the September through May migratory period for salmonids in the San Joaquin River. The data derived from the California Data Exchange Center files indicate that DO depressions occur during all migratory months, with significant events occurring from November through March when listed Central Valley steelhead adults and smolts would be utilizing this portion of the San Joaquin River as a migratory corridor.

Potential factors that contribute to these DO depressions are reduced river flows through the ship channel, released ammonia from the City of Stockton Wastewater Treatment Plant, upstream contributions of organic materials (*e.g.*, algal loads, nutrients, agricultural discharges) and the increased volume of the dredged ship channel. During the winter and early spring emigration period, increased ammonia concentrations in the discharges from the City of Stockton Waste Water Treatment Facility lowers the DO in the adjacent DWSC near the West Complex. In addition to the adverse effects of the lowered DO on salmonid physiology, ammonia is in itself toxic to salmonids at low concentrations. Likewise, adult fish migrating upstream will encounter lowered DO in the DWSC as they move upstream in the fall and early winter due to low flows and excessive algal and nutrient loads coming downstream from the upper San Joaquin River watershed. Levels of DO below 5 mg/L have been reported as delaying or blocking fall-run Chinook salmon in studies conducted by Hallock *et al.* (1970).

6. Hatchery Operations and Practices

Five hatcheries currently produce Chinook salmon in the Central Valley and four of these also produce steelhead. Releasing large numbers of hatchery fish can pose a threat to wild Chinook salmon and steelhead stocks through genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs in the Central Valley primarily are caused by straying of hatchery fish and the subsequent interbreeding of hatchery fish with wild fish. In the CV, practices such as transferring eggs between hatcheries and trucking smolts to distant sites for release contribute to elevated straying levels (US Department of the Interior 1999). For example, the primary steelhead broodstock at Nimbus Hatchery on the American River originated from the Eel River basin. One of the recommendations in the Joint Hatchery Review Report (NMFS and CDFG 2001) was to identify and designate new sources of steelhead brood stock to replace the current Eel River origin brood stock.

Hatchery practices as well as spatial and temporal overlaps of habitat use and spawning activity between spring- and fall-run fish have led to the hybridization and homogenization of some subpopulations (CDFG 1998). As early as the 1960s, Slater (1963) observed that early fall- and spring-run Chinook salmon were competing for spawning sites in the Sacramento River below Keswick Dam, and speculated that the two runs may have hybridized. The FRFH spring-run

Chinook salmon have been documented as straying throughout the Central Valley for many years (CDFG 1998), and in many cases have been recovered from the spawning grounds of fall-run Chinook salmon, an indication that FRFH spring-run Chinook salmon may exhibit fall-run life history characteristics. Although the degree of hybridization has not been comprehensively determined, it is clear that the populations of spring-run Chinook salmon spawning in the Feather River and counted at RBDD contain hybridized fish.

The management of hatcheries, such as Nimbus Hatchery and FRFH, can directly impact spring-run Chinook salmon and steelhead populations by oversaturating the natural carrying capacity of the limited habitat available below dams. In the case of the Feather River, significant redd superimposition occurs in-river due to hatchery overproduction and the inability to physically separate spring- and fall-run Chinook salmon adults. This concurrent spawning has led to hybridization between the spring- and fall-run Chinook salmon in the Feather River. At Nimbus Hatchery, operating Folsom Dam to meet temperature requirements for returning hatchery fall-run Chinook salmon often limits the amount of water available for steelhead spawning and rearing the rest of the year.

The increase in Central Valley hatchery production has reversed the composition of the steelhead population, from 88 percent naturally-produced fish in the 1950s (McEwan 2001) to an estimated 23 to 37 percent naturally-produced fish currently (Nobriga and Cadrett 2003). The increase in hatchery steelhead production proportionate to the wild population has reduced the viability of the wild steelhead populations, increased the use of out-of-basin stocks for hatchery production, and increased straying (NMFS and CDFG 2001). Thus, the ability of natural populations to successfully reproduce and continue their genetic integrity likely has been diminished.

The relatively low number of spawners needed to sustain a hatchery population can result in high harvest-to-escapements ratios in waters where fishing regulations are set according to hatchery population. This can lead to over-exploitation and reduction in the size of wild populations existing in the same system as hatchery populations due to incidental bycatch (McEwan 2001).

Hatcheries also can have some positive effects on salmonid populations. Artificial propagation has been shown to be effective in bolstering the numbers of naturally spawning fish in the short term under specific scenarios. Artificial propagation programs can also aid in conserving genetic resources and guarding against catastrophic loss of naturally spawned populations at critically low abundance levels, as was the case with the Sacramento River winter-run Chinook salmon population during the 1990s. However, relative abundance is only one component of a viable salmonid population.

7. Over Utilization

a. Ocean Commercial and Sport Harvest – Chinook Salmon and Steelhead

Extensive ocean recreational and commercial troll fisheries for Chinook salmon exist along the Northern and Central California coast, and an inland recreational fishery exists in the Central Valley for Chinook salmon and steelhead. Ocean harvest of Central Valley Chinook salmon is estimated using an abundance index, called the Central Valley Index (CVI) harvest index. The

CVI is the sum of the ocean fishery Chinook salmon harvested south of Point Arena (where 85 percent of Central Valley Chinook salmon are caught), plus the Central Valley adult Chinook salmon escapement. The CVI harvest index is the ocean harvest landed south of Point Arena divided by the CVI. CWT returns indicate that Central Valley salmon congregate off the California coast between Point Arena and Morro Bay.

Ocean fisheries have affected the age structure of CV spring-run Chinook salmon through targeting large fish for many years and reducing the numbers of 4- and 5-year-old fish (CDFG 1998). As a result of very low returns of fall-run Chinook salmon to the Central Valley in 2007 and 2008, there was a complete closure of commercial and recreational ocean Chinook salmon fishery in 2008 and 2009, respectively. However, contrary to expectations, even with the 2 years of ocean fishery closures, the CV spring-run Chinook salmon population continues to decline. Ocean harvest rates of CV spring-run Chinook salmon are thought to be a function of the CVI (Good *et al*. 2005). Harvest rates of CV spring-run Chinook salmon ranged from 0.55 to nearly 0.80 between 1970 and 1995 when harvest rates were adjusted for the protection of Sacramento River winter-run Chinook salmon. The drop in the CVI in 2001 as a result of high fall-run escapement to 0.27 also reduced harvest of CV spring-run Chinook salmon. There is essentially no ocean harvest of CCV steelhead.

b. Inland Sport Harvest –Chinook Salmon and Steelhead

In-river recreational fisheries historically have taken CV spring-run Chinook salmon throughout the species' range. During the summer, holding adult CV spring-run Chinook salmon are easily targeted by anglers when they congregate in large pools. Poaching also occurs at fish ladders, and other areas where adults congregate; however, the significance of poaching on the adult population is unknown. Specific regulations for the protection of CV spring-run Chinook salmon in Mill, Deer, Butte, and Big Chico creeks and the Yuba River have been added to the existing CDFG regulations. The current regulations, including those developed for Sacramento River winter-run Chinook salmon provide some level of protection for spring-run fish (CDFG 1998).

There is little information on CCV steelhead harvest rates in California. Hallock *et al.* (1961) estimated that harvest rates for Sacramento River steelhead from the 1953-1954 through 1958-1959 seasons ranged from 25.1 percent to 45.6 percent assuming a 20 percent non-return rate of tags. The average annual harvest rate of adult steelhead above RBDD for the 3-year period from 1991-1992 through 1993-1994 was 16 percent (McEwan and Jackson 1996). Since 1998, all hatchery steelhead have been marked with an adipose fin clip allowing anglers to distinguish hatchery and wild steelhead. Current regulations restrict anglers from keeping unmarked steelhead in Central Valley streams. Overall, this regulation has greatly increased protection of naturally produced adult steelhead; however, the total number of CCV steelhead contacted might be a significant fraction of basin-wide escapement, and even low catch-and-release mortality may pose a problem for wild populations (Good *et al*. 2005).

c. Commercial harvest of White Sturgeon and Bycatch of Green Sturgeon

Commercial harvest of white sturgeon results in the incidental bycatch of green sturgeon primarily along the Oregon and Washington coasts and within their coastal estuaries. Oregon and Washington have recently prohibited the retention of green sturgeon in their waters for commercial and recreational fisheries. Adams *et al*. (2002) reported harvest of green sturgeon from California, Oregon, and Washington between 1985 and 2001. Total captures of green sturgeon in the Columbia River Estuary by commercial means ranged from 240 fish per year to 6,000. Catches in Willapa Bay and Grays Harbor by commercial means combined ranged from 9 fish to 2,494 fish per year. Emmett *et al*. (1991) indicated that averages of 4.7 to 15.9 tons of green sturgeon were landed annually in Grays Harbor and Willapa Bay respectively. Overall, captures appeared to be dropping through the years; however, this could be related to changing fishing regulations. Adams *et al*. (2002) also reported sport fishing captures in California, Oregon, and Washington. Within the San Francisco Estuary, green sturgeon are captured by sport fisherman targeting the more desirable white sturgeon, particularly in San Pablo and Suisun bays (Emmett *et al*. 1991). Sport fishing in the Columbia River, Willapa Bay, and Grays Harbor captured from 22 to 553 fish per year between 1985 and 2001. Again, it appears sport fishing captures are dropping through time; however, it is not known if this is a result of abundance, changed fishing regulations, or other factors. Based on new research by Israel (2006) and past tagged fish returns reported by CDFG (2002), a high proportion of green sturgeon present in the Columbia River, Willapa Bay, and Grays Harbor (as much as 80 percent in the Columbia River) may be Southern DPS North American green sturgeon. This indicates a potential threat to the Southern DPS North American green sturgeon population. Beamesderfer *et al.* (2007) estimated that green sturgeon will be vulnerable to slot limits (outside of California) for approximately 14 years of their life span. Fishing gear mortality presents an additional risk to the long-lived sturgeon species such as the green sturgeon (Boreman 1997). Although sturgeon are relatively hardy and generally survive being hooked, their long life makes them vulnerable to repeated hooking encounters, which leads to an overall significant hooking mortality rate over their lifetime. An adult green sturgeon may not become sexually mature until they are 13 to 18 years of age for males (152-185cm), and 16 to 27 years of age for females (165-202 cm, Van Eenennaam *et al.* 2006). Even though slot limits "protect" a significant proportion of the life history of green sturgeon from harvest, they do not protect them from fishing pressure.

Green sturgeon are caught incidentally by sport fisherman targeting the more highly desired white sturgeon within the Delta waterways and the Sacramento River. New regulations which went into effect in March 2007, reduced the slot limit of sturgeon from 72 inches to 66 inches, and limit the retention of white sturgeon to one fish per day with a total of 3 fish retained per year. In addition, a non-transferable sturgeon punch card with tags must be obtained by each angler fishing for sturgeon. All sturgeon caught must be recorded on the card, including those released. All green sturgeon must be released unharmed and recorded on the sturgeon punch card by the angler.

Poaching rates of green sturgeon in the Central Valley are unknown; however, catches of sturgeon occur during all years, especially during wet years. Unfortunately, there is no catch, effort, and stock size data for this fishery which precludes making exploitation estimates (USFWS 1995a). Areas just downstream of Thermalito Afterbay outlet and Cox's Spillway, and several barriers impeding migration on the Feather River may be areas of high adult mortality from increased fishing effort and poaching. The small population of sturgeon inhabiting the San Joaquin River (believed to be currently comprised of only white sturgeon) experiences heavy fishing pressure, particularly regarding illegal snagging and it may be more than the population can support (USFWS 1995a).

8. Disease and Predation

Infectious disease is one of many factors that influence adult and juvenile salmonid survival. Salmonids are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment (NMFS 1996a,b, 1998). Specific diseases such as bacterial kidney disease, C*eratomyxosis shasta* (C-shasta), Columnaris Disease, furunculosis, infectious hematopoietic necrosis, redmouth and black spot disease, whirling disease, and erythrocytic inclusion body syndrome are known, among others, to affect steelhead and Chinook salmon (NMFS 1996a,b, 1998). Very little current or historical information exists to quantify changes in infection levels and mortality rates attributable to these diseases; however, studies have shown that wild fish tend to be less susceptible to pathogens than are hatchery-reared fish. Nevertheless, wild salmonids may contract diseases that are spread through the water column (*i.e.*, waterborne pathogens) as well as through interbreeding with infected hatchery fish. The stress of being released into the wild from a controlled hatchery environment frequently causes latent infections to convert into a more pathological state, and increases the potential of transmission from hatchery reared fish to wild stocks within the same waters.

Accelerated predation also may be a factor in the decline of Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon, and to a lesser degree CCV steelhead. 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 both disorient juvenile salmonids and attract predators (Stevens 1961, Decato 1978, Vogel *et al.* 1988, Garcia 1989).

On the mainstem Sacramento River, high rates of predation were known to occur at the RBDD, Anderson-Cottonwood Irrigation District's (ACID) diversion dam, GCID's diversion facility, areas where rock revetment has replaced natural river bank vegetation, and at South Delta water diversion structures (*e*.g., Clifton Court Forebay; CDFG 1998). Predation at RBDD on juvenile winter-run Chinook salmon was believed to be higher than normal due to flow dynamics associated with the operation of this structure. Due to their small size, early emigrating winter-run Chinook salmon were very susceptible to predation in Lake Red Bluff when the RBDD gates remain closed in summer and early fall. In passing the dam, juveniles are subject to conditions which greatly disorient them, making them highly susceptible to predation by fish or birds. Sacramento pikeminnow (*Ptychocheilus grandis*) and striped bass congregate below the dam and prey on juvenile salmon in the tail waters. The Sacramento pikeminnow is a species native to the Sacramento River basin and has co-evolved with the anadromous salmonids in this system. However, rearing conditions in the Sacramento River today (*e.g.*, warm water, low-irregular flow, standing water, and water diversions) compared to its natural state and function decades ago in the pre-dam era, are more conducive to warm water species such as Sacramento pikeminnow and striped bass than to native salmonids. Tucker *et al.* (1998) reported that predation during the summer months by Sacramento pikeminnow on juvenile salmonids increased to 66 percent of the total weight of stomach contents in the predatory pikeminnow.

Striped bass showed a strong preference for juvenile salmonids as prey during this study. This research also indicated that the percent frequency of occurrence for juvenile salmonids nearly equaled other fish species in the stomach contents of the predatory fish. Tucker *et al.* (2003) showed the temporal distribution for these two predators in the RBDD area were directly related to RBDD operations (predators congregated when the dam gates were in, and dispersed when the gates were removed). As of 2012, with the construction of the pumping plant, the RBDD will no longer operate with the gates down, and predation at this site is expected to no longer be a problem area.

USFWS found that more predatory fish were found at rock revetment bank protection sites between Chico Landing and Red Bluff than at sites with naturally eroding banks (Michny and Hampton 1984). From October 1976 to November 1993, CDFG conducted 10 mark/recapture studies at the SWP's Clifton Court Forebay to estimate pre-screen losses using hatchery-reared juvenile Chinook salmon. Pre-screen losses ranged from 69 percent to 99 percent. Predation by striped bass is thought to be the primary cause of the loss (Gingras 1997, DWR 2009).

Predation on juvenile salmonids has increased as a result of water development activities which have created ideal habitats for predators and non-native invasive species (NIS). Turbulent conditions near dam bypasses, turbine outfalls, water conveyances, and spillways disorient juvenile salmonid migrants and increase their predator avoidance response time, thus improving predator success. Increased exposure to predators has also resulted from reduced water flow through reservoirs; a condition which has increased juvenile travel time. Other locations in the Central Valley where predation is of concern include flood bypasses, post-release sites for salmonids salvaged at the CVP and SWP Fish Facilities, and the SMSCG. Predation on salmon by striped bass and Sacramento pikeminnow at salvage release sites in the Delta and lower Sacramento River has been documented (Orsi 1967, Pickard *et al.* 1982); however, accurate predation rates at these sites are difficult to determine. CDFG conducted predation studies from 1987 to 1993 at the SMSCG to determine if the structure attracts and concentrates predators. The dominant predator species at the SMSCG was striped bass, and the remains of juvenile Chinook salmon were identified in their stomach contents (Edwards *et al.* 1996, Tillman *et al.* 1996, NMFS 1997).

Avian predation on fish contributes to the loss of migrating juvenile salmonids by constraining natural and artificial production. Fish-eating birds that occur in the CV include great blue herons (*Ardea herodias*), gulls (*Larus* spp.), osprey (*Pandion haliaetus*), common mergansers (*Mergus merganser*), American white pelicans (*Pelecanus erythrorhynchos*), double-crested cormorants (*Phalacrocorax* spp.), Caspian terns (*Sterna caspia*), belted kingfishers (*Ceryle alcyon*), black-crowned night herons (*Nycticorax nycticorax*), Forster's terns (*Sterna forsteri*), hooded mergansers (*Lophodytes cucullatus*), and bald eagles (*Haliaeetus leucocephalus*) (Stephenson and Fast 2005). These birds have high metabolic rates and require large quantities of food relative to their body size.

Mammals can also be an important source of predation on salmonids within the California Central Valley. Predators such as river otters (*Lontra canadensis*), raccoons (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and western spotted skunk (*Spilogale gracilis*) are common. Other mammals that take salmonid include: badger (*Taxidea taxus*), bobcat (*Lynx rufus*), coyote

(*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), long-tailed weasel (*Mustela frenata*), mink (*Mustela vison*), mountain lion (*Felis concolor*), red fox (*Vulpes vulpes*), and ringtail (*Bassariscus astutus*). These animals, especially river otters, are capable of removing large numbers of salmon and trout from the aquatic habitat (Dolloff 1993). Mammals have the potential to consume large numbers of salmonids, but generally scavenge post-spawned salmon. In the marine environment, pinnipeds, including harbor seals (*Phoca vitulina*), California sea lions (*Zalophus californianus*), and Steller's sea lions (*Eumetopia jubatus*) are the primary marine mammals preying on salmonids (Spence *et al*. 1996). Pacific striped dolphin (*Lagenorhynchus obliquidens*) and killer whale (*Orcinus orca*) can also prey on adult salmonids in the nearshore marine environment, and at times become locally important. Although harbor seal and sea lion predation primarily is confined to the marine and estuarine environments, they are known to travel well into freshwater after migrating fish and have frequently been encountered in the Delta and the lower portions of the Sacramento and San Joaquin rivers. All of these predators are opportunists, searching out locations where juveniles and adults are most vulnerable, such as the large water diversions in the South Delta.

9. Environmental Variation

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al*. 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal Oscillation. In addition, large-scale climatic regime shifts, such as the El Nino condition, appear to change productivity levels over large expanses of the Pacific Ocean. A further confounding effect is the fluctuation between drought and wet conditions in the basins of the American west. During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years, which reduced inflows to watersheds up and down the west coast.

"El Niño" is an environmental condition often cited as a cause for the decline of West Coast salmonids (NMFS 1996b). El Niño is an unusual warming of the Pacific Ocean off South America and is caused by atmospheric changes in the tropical Pacific Ocean (Southern Oscillation-ENSO) resulting in reductions or reversals of the normal trade wind circulation patterns. The El Niño ocean conditions are characterized by anomalous warm sea surface temperatures and changes to coastal currents and upwelling patterns. Principal ecosystem alterations include decreased primary and secondary productivity in affected regions and changes in prey and predator species distributions. Cold-water species are displaced towards higher latitudes or move into deeper, cooler water, and their habitat niches occupied by species tolerant of warmer water that move upwards from the lower latitudes with the warm water tongue.

A key factor affecting many West Coast stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival in the ocean is driven largely by events occurring between ocean entry and recruitment to a sub-adult life stage.

10. Ecosystem Restoration

In 2010, the California legislature created the Delta Stewardship Council made up of diverse community representatives and water interests. The Delta Stewardship Council is the successor to the California Bay-Delta Authority and CALFED Bay-Delta Program. The Delta Stewardship Council must adopt and implement a comprehensive management plan for the Sacramento-San Joaquin Delta, which is called "The Delta Plan" and must be implemented by January 2012 as mandated by the Delta Reform Act of 2009.

Two programs included under the Delta Stewardship Council ; the Ecosystem Restoration Program (ERP) and the EWA, were created to improve conditions for fish, including listed salmonids, in the Central Valley (CALFED 2000). 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 steelhead and 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 CBDA-ERP Program have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and 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. Similar habitat restoration is imminent adjacent to Suisun Marsh (*i.e.*, at the confluence of Montezuma Slough and the Sacramento River) as part of the Montezuma Wetlands project, which is intended to provide for commercial disposal of material dredged from San Francisco Bay in conjunction with tidal wetland restoration.

A sub-program of the ERP called the Environmental Water Program (EWP) has been established to support ERP projects through enhancement of instream flows that are biologically and ecologically significant in anadromous reaches of priority streams controlled by dams. This program is in the development stage and the benefits to listed salmonids are not yet clear.

The EWA is designed to provide water at critical times to meet ESA requirements and incidental take limits without water supply impacts to other users, particularly South of Delta water users. In early 2001, the EWA released 290 thousand acre feet of water from San Luis Reservoir at key times to offset reductions in South Delta pumping implemented to protect winter-run Chinook salmon, delta smelt, and splittail. However, the benefit derived by this action to winter-run Chinook salmon in terms of number of fish saved was very small. The anticipated benefits to other Delta fisheries from the use of the EWA water are much higher than those benefits ascribed to listed salmonids by the EWA release. Under the long term operations of the CVP and SWP, EWA assets have declined to 48 thousand acre feet after carriage water costs.

a. Central Valley Project Improvement Act

The Central Valley Project Improvement Act (CVPIA), implemented in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the

CVP. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward recovery of all 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 the Interior's ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for spring-run Chinook salmon and steelhead by maintaining or increasing instream flows in Butte and Mill creeks and the San Joaquin River at critical times.

b. Iron Mountain Mine Remediation

Environmental Protection Agency's Iron Mountain Mine remediation involves the removal of toxic metals in acidic mine drainage from the Spring Creek Watershed with a state-of-the-art lime neutralization plant. Contaminant loading into the Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990s (US Bureau of Reclamation 2004). Decreasing the heavy metal contaminants that enter the Sacramento River should increase the survival of salmonid eggs and juveniles. However, during periods of heavy rainfall upstream of the Iron Mountain Mine, the US Bureau of Reclamation substantially increases Sacramento River flows in order to dilute heavy metal contaminants being spilled from the Spring Creek debris dam. This rapid change in flows can cause juvenile salmonids to become stranded or isolated in side channels below Keswick Dam.

c. State Water Project Delta Pumping Plant Fish Protection Agreement (Four-Pumps Agreement)

The Four Pumps Agreement Program has approved about $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreement inception in 1986. Four Pumps projects that benefit spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer creeks; enhanced law enforcement efforts from San Francisco Bay 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 (US Bureau of Reclamation 2004).

11. <u>Non-Native Invasive Species</u>

As currently seen in the San Francisco estuary, non-invasive species (NIS) can alter the natural food webs that existed prior to their introduction. Perhaps the most significant example is illustrated by the Asiatic freshwater clams *Corbicula fluminea* and *Potamocorbula amurensis*. The arrival of these clams in the estuary disrupted the normal benthic community structure and depressed phytoplankton levels in the estuary due to the highly efficient filter feeding of the introduced clams (Cohen and Moyle 2004). The decline in the levels of phytoplankton reduces the population levels of zooplankton that feed upon them, and hence reduces the forage base available to salmonids transiting the Delta and San Francisco estuary which feed either upon the zooplankton directly or their mature forms. This lack of forage base can adversely impact the health and physiological condition of these salmonids as they emigrate through the Delta region to the Pacific Ocean.

Attempts to control the NIS also can adversely impact the health and well-being of salmonids within the affected water systems. For example, the control programs for the invasive water hyacinth (*Eichhornia crassipes*) and Brazilian waterweed (*Egeria densa*) plants in the Delta must balance the toxicity of the herbicides applied to control the plants to the probability of exposure to listed salmonids during herbicide application. In addition, the control of the nuisance plants have certain physical parameters that must be accounted for in the treatment protocols, particularly the decrease in DO resulting from the decomposing vegetable matter left by plants that have died.

12. Summary

For Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead, the construction of high dams for hydropower, flood control, and water supply resulted in the loss of vast amounts of upstream habitat (*i.e.*, approximately 80 percent, or a minimum linear estimate of over 1,000 stream miles), and often resulted in precipitous declines in affected salmonid populations. For example, the completion of Friant Dam in 1947 has been linked with the extirpation of spring-run Chinook salmon in the San Joaquin River upstream of the Merced River within just a few years. The reduced populations that remain below Central Valley dams are forced to spawn in lower elevation tailwater habitats of the mainstem rivers and tributaries that were previously not used for this purpose. This habitat is entirely dependent on managing reservoir releases to maintain cool water temperatures suitable for spawning, and/or rearing of salmonids. This requirement has been difficult to achieve in all water year types and for all life stages of affected salmonid species. Steelhead, in particular, seem to require the qualities of small tributary habitat similar to what they historically used for spawning; habitat that is largely unavailable to them under the current water management scenario. All salmonid species considered in this consultation have been adversely affected by the production of hatchery fish associated with the mitigation for the habitat lost to dam construction (*e.g.*, from genetic impacts, increased competition, exposure to novel diseases, *etc*.).

Land-use activities have significantly altered fish habitat quantity and quality for Chinook salmon and steelhead through alteration of streambank and channel morphology; alteration of ambient water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of LWM; and removal of riparian vegetation resulting in increased streambank erosion. Human-induced habitat changes, such as: alteration of natural flow regimes; installation of bank revetment; and building structures such as dams, bridges, water diversions, piers, and wharves, often provide conditions that both disorient juvenile salmonids and attract predators. Harvest activities, ocean productivity, and drought conditions provide added stressors to listed salmonid populations. In contrast, various ecosystem restoration activities have contributed to improved conditions for listed salmonids (*e.g.*, various fish screens). However, some important restoration activities (*e.g.*, Battle Creek Restoration Project) have not yet been completed and benefits to listed salmonids from the EWA have been less than anticipated.

Similar to the listed salmonids, the Southern DPS of North American green sturgeon have been negatively impacted by hydroelectric and water storage operations in the Central Valley which ultimately affect the hydrology and accesibility of Central Valley rivers and streams to anadromous fish. Anthropogenic manipulations of the aquatic habitat, such as dredging, bank stabilization, and waste water discharges have also degraded the quality of the Central Valley's waterways for green sturgeon.

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 process" (50 CFR 402.02). The action area encompasses the upper Sacramento River and associated floodplains and riparian areas at and adjacent to RM 36, the lateral 350 feet of the Sacramento River, from 600 feet upstream of the proposed Jellys Ferry Bridge construction area to 600 feet downstream of the project site. This area was selected because it represents the upstream and lateral extents of anticipated acoustic effects from pile driving, and downstream extent of anticipated effects related to increases in suspended sediment and turbidity. As discussed in Section II above, the total square foot area project footprint estimate for in-water work during construction is 12,125 sq ft.

1. <u>Status of Listed Species and Critical Habitat within the Action Area</u>

The action area provides adult spawning and juvenile rearing habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead. Nearly all of the adult and juvenile life stages of these fish that spawn upstream of RBDD migrate through the action area. Due to the life history timing of winter- and spring-run Chinook salmon, steelhead and North American green sturgeon, it is possible for one or more of the following life stages to be present within the action area throughout the year: adult migrants, spawners, incubating eggs, or rearing and emigrating juveniles.

a. Status of the Species in the Action Area

(1) Sacramento River Winter-run Chinook Salmon. CDFW conducts frequent aerial redd surveys of the upper Sacramento River from Princeton Ferry to Keswick Dam throughout the year. Records were examined for the reaches extending from Jellys Ferry upstream to Battle Creek, and from Jellys Ferry Bridge downstream to the Bend Ferry Bridge, for the period from 2001 through 2014. These surveys indicate that the action area is within the spawning range of winter- and spring-run Chinook salmon, however, they suggest that limited spawning occurs within the action area. Since 2001, little winter-run Chinook salmon spawning has occurred (less than 2%) within these two reaches of the upper Sacramento River (from Battle Creek, RM 31, to Bend Ferry Bridge, RM 45) with the exception of 2007 when four redds upstream, and two redds downstream were observed, and in 2001 when two redds upstream and eight redds downstream were observed (CDFW 2014, unpublished data).

The USFWS (Poytress *et al.* 2014) conducts extensive rotary screw trap monitoring immediately downstream of the project area. Monitoring results from 2002 to 2012 show that juvenile emigration at the project site should occur between late July and late November (Figure 3).

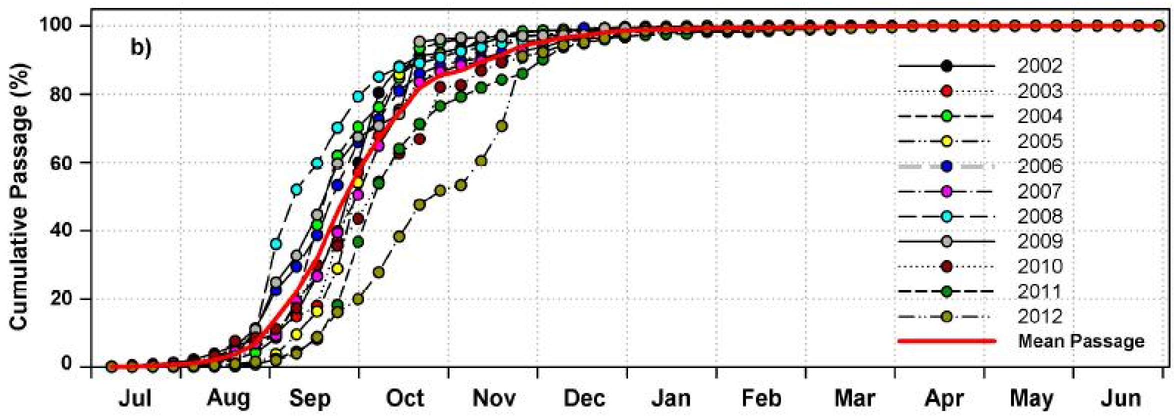

Figure 3. Juvenile winter-run Chinook salmon emigration past Red Bluff Diversion Dam (immediately downstream of the project area).

***(2) Central Valley Spring-run Chinook Salmon**.*

Most spring-run Chinook salmon, spawn in tributaries to the Sacramento River (Butte, Mill, Deer creeks) will not be affected by the proposed project, but there are small populations located upstream of the action are in Clear and Battle creeks and some spawning is thought to occur in the mainstem Sacramento River as indicated by early spawning observations of Chinook salmon near the City of Redding. CV spring-run Chinook salmon redds have been observed in the two monitoring reaches upstream and downstream of the project area in years 2007, 2006, 2005, 2002, and 2001; ranging from one redd, to 22 redds (25% of total redds).

The USFWS (Poytress *et al.,* 2014) conducts extensive rotary screw trap monitoring immediately downstream of the project area. Monitoring results from 2002 to 2012 show that juvenile emigration at the project site should occur between October and mid-April (Figure 4).

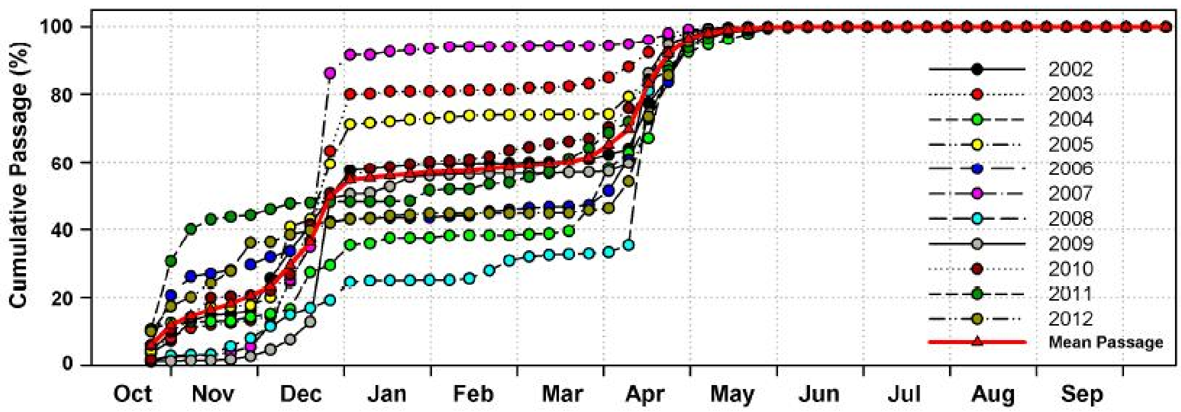

Figure 4. Juvenile spring-run Chinook salmon emigration past Red Bluff Diversion Dam (immediately downstream of the project area).

(3) Central Valley Steelhead. CCV steelhead populations currently spawn in tributaries to the Sacramento and San Joaquin rivers. The proportion of steelhead in this DPS that migrate through the action area is unknown, but spawning is primarily expected to occur in Clear, Cow and Battle creeks, and in the mainstem Sacramento River near the City of Redding. Some spawning also occurs in other smaller Redding area streams. Adult steelhead may be present throughout the action area from June through March, with the peak occurring between August and October (Bailey 1954, Hallock *et al.* 1957). Juvenile steelhead emigrate through the Sacramento River late fall to spring. The majority of juvenile steelhead emigrate as yearlings and are assumed to primarily utilize the center of the channel rather than the shoreline. Central Valley steelhead and/or rainbow trout redds have been observed within the action area during aerial redd surveys, although these redds have not been counted or documented (Killam 2005).

The USFWS (Poytress *et al.,* 2014) conducts extensive rotary screw trap monitoring immediately downstream of the project area. Monitoring results from 2002 to 2012 show that juvenile emigration at the project site should occur between April and October (Figure 5).

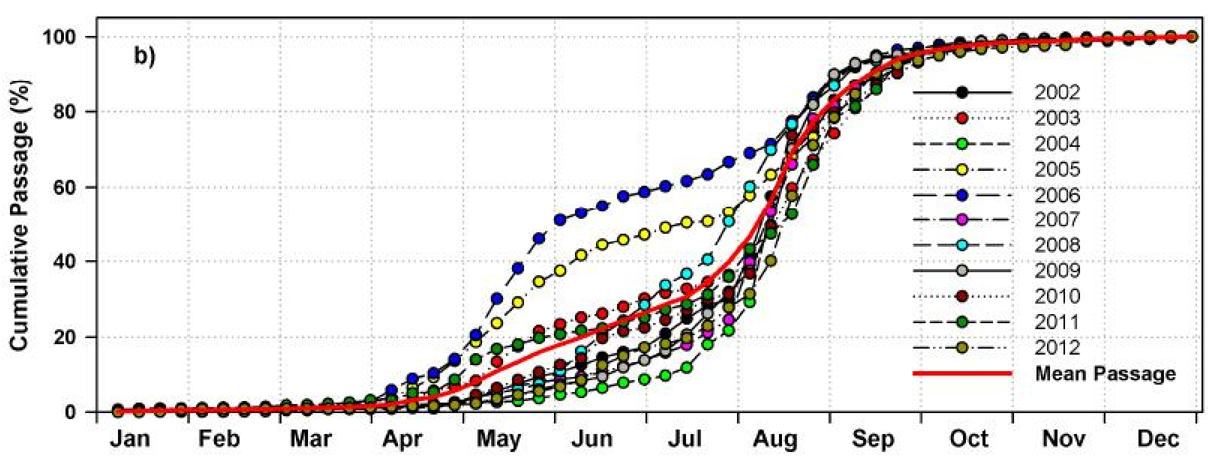

Figure 5. Juvenile *O. mykiss* emigration past Red Bluff Diversion Dam (immediately downstream of the project area).

(4) Southern DPS of North American Green Sturgeon. The spawning population of the Southern DPS of North American green sturgeon is currently restricted to the Sacramento River below Keswick Dam, and is composed of a single breeding population, thus the entire population of adults and juveniles that spawn or hatch upstream of RBDD must pass through the action area. Adult spawning population estimates in the upper Sacramento River, using sibling based genetics, indicates 10-28 spawners per year between 2002-2006 (Israel and May 2010). Newly hatched juvenile green sturgeon are captured each summer in the rotary screw traps which sample the water coming out of RBDD (Gaines and Martin 2002) providing firm evidence that spawning occurs upstream of RBDD. Young green sturgeon appear to rear for the first one to two months in the Sacramento River (California Department of Fish and Game 2002). Juvenile green sturgeon appear in USFWS rotary screw traps at RBDD from May through August (Poytess et al 2010) and at lengths ranging from 24 to 31 mm fork length, indicating they are approximately two weeks old (California Department of Fish and Game 2002, U.S. Fish and Wildlife Service 2002). Starting in 2012, the RBDD gates have remained permanently open, allowing anadromous fish such as green sturgeon unrestricted passage at Red Bluff all year long, and it may be reasonably expected that this should bolster the population's productivity by removing a major barrier to migration/passage.

The USFWS (Poytress *et al.,* 2014) conducts extensive rotary screw trap monitoring immediately downstream of the project area. Monitoring results from 2003 to 2012 show that juvenile emigration at the project site should occur between May and August (Figure 6).

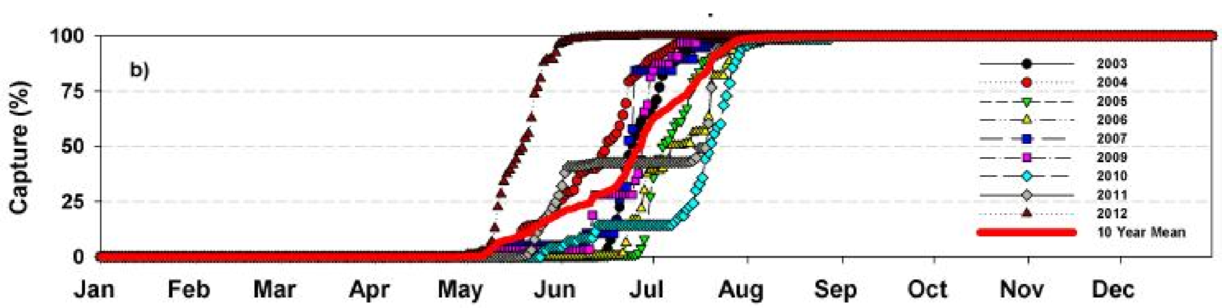

Figure 6. Juvenile green sturgeon emigration past Red Bluff Diversion Dam (immediately downstream of the project area).

b. Status of Critical Habitat in the Action Area

(1) Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, and Central Valley Steelhead. The action area is within designated critical habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead. 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 as adult and juvenile migration and juvenile rearing, and some limited spawning. As described in Section III above, the current condition of critical habitat for the listed salmonids has become impaired and has degraded in quality compared to historical conditions. The result has been the reduction in quantity and quality of several essential elements of migration and rearing habitat required by juveniles to grow and survive. In spite of the degraded condition of this habitat, it remains extremely important to the survival of the listed salmonids because its entire length is used for extended periods of time by a large proportion of all federally-listed anadromous salmonid species that spawn in the upper Sacramento River and its tributaries above RBDD.

(2) Southern DPS of North American Green Sturgeon. The action area is within designated critical habitat for the Southern DPS of North American green sturgeon. North American green sturgeon holding habitat consists of the bottoms of deep pools where velocities are lowest, often in off-channel coves or low-gradient reaches of the main channel (Erickson *et al.* 2002).

The diversions in the action area are a potential threat to the Southern DPS of North American green sturgeon. Larval green sturgeon are likely susceptible to entrainment primarily from benthic water diversion facilities during the first 5 days of development and susceptible to diversion entrainment from facilities drawing water from the bottom and top of the water column starting at day 6. Reduced flows in the action area likely affect year class strength of the Southern DPS of North American green sturgeon as increased flows have been found to improve year class strength. Various land-use activities in the action area, such as urbanization and agricultural encroachment, have resulted in habitat simplification. Runoff from residential and industrial areas also contributes to water quality degradation (CRWQCB-Central Valley Region 1998). Urban stormwater runoff contains pesticides, oil, grease, heavy metals, polycyclic aromatic hydrocarbons, other organics and nutrients (CRWQCB-Central Valley Region 1998) that contaminate drainage waters and destroy aquatic life necessary for green sturgeon survival (NMFS 1996c). In addition, juvenile and adult green sturgeon are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges in the action area.

The action area is utilized by larvae and post-larvae and to a lesser extent, juvenile Southern DPS of North American green sturgeon for rearing and migration purposes. Although it is believed that larvae and post-larvae as well as juveniles primarily are benthically oriented (with the exception of the post-larvae nocturnal swim-up believed to be a dispersal mechanism), channelization downstream of the action area has resulted in a loss of ecosystem properties (USFWS 2000, Sweeney *et al.* 2004). Channelization results in reduced food supply (aquatic invertebrates) and reduced pollutant processing, organic matter processing, and nitrogen uptake (Sweeney *et al.* 2004).

2. <u>Factors Affecting Listed Species and Critical Habitat within the Action Area</u>

Many of the range-wide factors affecting the species are discussed in Section II of this BO, and are considered the same in the action area. This section will focus on the specific factors in the action area that are more relevant to the proposed project.

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 residential and industrial areas also contributes to water quality degradation [California Regional Water Quality Control Board (CRWQCB)-Central Valley Region 1998]. Urban stormwater runoff contains pesticides, oil, grease, heavy metals, polycyclic aromatic hydrocarbons, other organics and nutrients (CRWQCB-Central Valley Region 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. Increased predation as a result of habitat changes in the action area, such as the alteration of natural flow regimes and the installation of bank revetment structures, is likely a factor in the decline of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead.

Ongoing improvements to the upper reaches of the Sacramento River, including gravel augmentation, screening of diversions, and riparian habitat restoration, are expected to further improve conditions for anadromous fish and critical habitat, but the incremental benefit of these actions is not yet known. Even with these improvements, some problems persist that may affect anadromous fish and reduce the quality of the PCEs of critical habitat within the action area. Some of the remaining problems include major fall and winter flow reductions causing dewatering of redds, potential competition and genetic introgression between spring- and fall-run Chinook salmon due to overlapping spawning habitats, and degraded rearing conditions in the river due to a lack of mature riparian habitat.

The frequency of acid mine drainage exceeding target levels below Keswick Dam has decreased over the last 10 years; however, exceedences of dissolved copper targets have occurred during each of the last 6 years, and metal concentrations remain high enough to have sublethal effects on adult fish and lethal effects on eggs and larvae (CRWQCB 2001). Although acid mine drainage has, over the years, reduced the number of Chinook salmon and steelhead within the action area, recent remedial actions at Iron Mountain Mine are thought to have curtailed the direct poisoning of listed species.

Fall flow reductions have been found to negatively impact PCEs for salmonid spawning by causing extensive redd dewatering throughout the Sacramento River spawning areas (Killam 2002). The largest reductions have been occurring in early to mid-November, following the peak in water demand for rice decomposition. While reductions in this time period primarily impact fall-run Chinook salmon, they also have the potential to impact late spawning spring-run Chinook salmon and early spawning steelhead.

The construction of Shasta and Keswick Dams, and the resultant exclusion of spring-run Chinook salmon from their historic upper Sacramento River spawning habitat has forced mainstem-spawning spring-run Chinook salmon to spawn in the middle reaches of the river (between Keswick and Red Bluff dams) in areas easily accessible to fall-run Chinook salmon. Because spring-run Chinook salmon hold over the summer and spawn during a similar time period as do fall-run Chinook salmon (September through October depending on habitat conditions), there is a potential for the two species to have negative interactions such as competition for prime spawning sites, superimposition of redds in the same location, and genetic introgression caused by individuals of the different races spawning together and creating crossed progeny.

3. <u>Importance of the Action Area to the Survival and Recovery of Listed Species</u>

Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the southern DPS of North American green sturgeon are expected to continue to utilize the action area as a migratory corridor and for spawning and/or rearing. Despite its relatively small size, the value of the action area as a migratory corridor, and its suitability as spawning and rearing habitat, make it an important node of habitat for the survival and recovery of local populations of listed species. Because the action area is within the most important habitat available to winter-run Chinook salmon, the continuity and connectivity of the action area to the rest of their habitat is important for the survival and recovery of that ESU.

The information that is available on green sturgeon indicates that, as with winter-run Chinook salmon, the mainstem Sacramento River may be the last viable spawning habitat for the Southern DPS of North American green sturgeon (NMFS 2005). Because of similarities in their migration and spawn timing, it is likely that many of the same factors affecting winter-run Chinook salmon are also significant to green sturgeon. Because the action area is within the most important habitat available to the Southern DPS of North American green sturgeon, the continuity and connectivity of the action area to the rest of their habitat is important for the survival and recovery of that DPS.

Although the habitat within the action area may be important for the survival and recovery of local and upstream populations of spring-run Chinook salmon, the primary abundance of spring-run Chinook salmon is in streams and rivers downstream of the action area, which means that the value of the habitat within the action area may not be as essential for the survival and recovery of spring-run Chinook salmon as it is for winter- run and green sturgeon.

The CCV steelhead DPS' dependence on the action area is intermediate between that of winter-run and spring-run Chinook salmon. Like spring-run Chinook salmon, a significant proportion of the CCV steelhead DPS spawn downstream of the action area, in tributaries, although their population numbers are more evenly distributed upstream and downstream of RBDD than are spring-run Chinook salmon, and large spawning populations in the mainstem Sacramento River and Battle Creek/Coleman National Fish Hatchery depend on the action area during both upstream and downstream migration and rearing.

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 BO assesses the effects of the proposed Project on NMFS' listed fish and their designated critical habitat (Caltrans 2013). The Project is likely to adversely affect endangered Sacramento River winter-run Chinook salmon, threatened CV spring-run Chinook salmon, threatened CCV steelhead, threatened North American green sturgeon and their designated critical habitats through the removal and demolition of the existing bridge, sedimentation/turbidity, fish rescue, and pile driving activities. In the *Description of the Proposed Action* section of this BO, NMFS provided an overview of the action. In the *Status of the Species* and *Environmental Baseline* sections of this BO, 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). 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 generally approaches "jeopardy" analyses in a series of steps. First, NMFS evaluates the available evidence to identify direct and indirect physical, chemical, and biotic effects of the proposed actions (these effects include direct impacts to a species habitat; modifications to something in the species' environment - such as 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 disruptive noises). Once NMFS has identified the effects of the action, the available evidence is evaluated to identify a species' likelihood and extent of exposure to any adverse effects caused by the action (*i.e.* the extent of spatial and temporal overlap between the species and the effects of the action). Once NMFS has identified the level of exposure that a species will have to the effects of the action, the available evidence is evaluated to identify the species' probable response, including physical and behavioral reactions, to these effects. These responses then will be assessed to determine if they can reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; or decreasing the age at which individuals stop reproducing). The available evidence is then used 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.

1. Information Available for the Assessment

To conduct the assessment, NMFS examined a variety of sources. Detailed background information on the status of the species and critical habitat has been published in a number of documents including peer reviewed scientific journals, primary reference materials, governmental and non-governmental reports, the biological assessment for this project, and project meeting notes. Additional information investigating the effects of the project's actions on the listed species in question, their anticipated response to these actions, and the environmental consequences of the actions as a whole was obtained from the aforementioned resources. For information that has been taken directly from published, citable documents, those citations have been referenced in the text and listed at the end of this document.

B. Assessment

The proposed Project includes actions that may adversely affect several life stages of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and green sturgeon. Adverse effects to these species and their habitat may result from changes in water quality from bridge construction, acoustic effects associated with pile driving, and the potential handling of fish from fish salvage operations. The project includes integrated design features to avoid and minimize many of these potential impacts. Below, Table 8 describes the proportion that each species may be affected by the project during the in-water work.

Table 8. Juvenile listed fish exposure to Project effects during in-water work period: May 1 to August 15.

Species Outmigrating	Proportion passing RBDD	Dates exposed to project effects
Winter-run Chinook salmon	Less than 5 percent	August 1- August 15
Spring-run Chinook salmon	Less than 5 percent	May 1 – May 15
Steelhead	Approximately 50 percent	May 1 – August 15
Green Sturgeon	All	May 1 – August 15

Source: Poytress *et al.* 2014

1. <u>Gravel placement work pads</u>

Placement of the gravel pad could result in injury or death to juveniles if they are unable to avoid the falling gravel. In addition, temporary impacts will potentially occur during the time period the gravel work pads will be in place, which will result in approximately 0.95 ac loss of riverine habitat that could be used for migration and/or rearing. This riverine habitat will be unavailable during construction. The temporary loss of this habitat, and specifically its location on either bank, will require migrating fish to move into the middle of the river in order to pass through the approximately 200-foot opening between the pads, which could result in migration delays.

Pacific Hydrologic, Inc. determined that maximum water velocities through the opening would be approximately 7.8 ft/s at a flow rate of 50,000 cfs, which was used as a maximum flow rate since it has only been exceeded once in the last 15 years (Caltrans 2013). Per Bell (1986), typical cruising speeds for adult Chinook salmon range up to 4 ft/s, while typical sustained speeds range up to 10 ft/s, and darting speeds range up to 22 ft/s. The length of the 200-foot wide opening will be approximately 125 feet, based on the width of the temporary work pads. Consequently, adult Chinook salmon passing through the opening would need to maintain a speed of 7.8 ft/s for approximately 125 feet. Since typical sustained speeds (*i.e.*, high speed for several minutes) for this species range up to 10 ft/s, maintaining a speed of 7.8 ft/s for 125 feet would be well within the range for this species and would not result in adverse effects to its migration activities.

After construction is complete, the bottom one foot of the gravel pads will remain in place to avoid impacts to the river bottom. This is a potential beneficial effect as it may result in some increased spawning habitat.

2. Anti-spawning mats

The installation of anti-spawning mats is to keep winter- and spring-run Chinook salmon from spawning near the construction site, and will minimize potential impacts to incubating eggs. Installation will be between March 1 and April 15, prior to the start of in-water work, will result in the loss of approximately 0.08 ac of potential spring- and winter-run Chinook salmon spawning habitat, until the mats are removed between November 1 to 30. This loss of habitat will be for one spawning season only. Migrating fish can utilize other areas of suitable spawning habitat until the mats are removed.

3. Sedimentation and Turbidity

Construction related disturbance (*i.e.* placement of piles, gravel pads, and anti-spawning mats) to soils, vegetation, and the streambed within the Project limits will temporarily increase sedimentation and turbidity in the Sacramento River. A prolonged increase in sedimentation and turbidity affects the growth, survival, and reproductive success of aquatic species. High levels of suspended sediment reduces the ability of listed fish to feed and respire, resulting in increased stress levels and reduced growth rates, and a reduced tolerance to fish diseases and toxicants (Waters 1995).

NMFS anticipates that some local increases in turbidity and suspended sediment above baseline levels will result from in-water construction activities. Indirect effects resulting from the proposed project may include potential water quality impacts following construction until graded areas have re-vegetated. NMFS expects these water quality impacts to be minor, short term increases in turbidity and sedimentation and only lasting the duration of the project. Water quality impacts are unlikely to affect migrating adults to the extent of injuring them, but may injure some juvenile fish, which are smaller and less mobile, and are actively feeding and growing, by temporarily disrupting normal behaviors that are essential to growth and survival. Increased sedimentation and turbidity resulting from project construction will be temporary and limited to a small portion of the river during construction activities. The BMPs incorporated into the project plans will further minimize turbidity effects to listed fish in the project construction area.

Responses of salmonids to elevated levels of suspended sediments often fall into three major categories: physiological effects, behavioral effects, and habitat effects (Bash *et al.* 2001). The severity of the effect is a function of concentration and duration (Newcombe and MacDonald 1991; Newcombe and Jensen 1996) so that low concentrations and long exposure periods are frequently as deleterious as short exposures to high concentrations of suspended sediments. A review by Lloyd (1987) indicated that several behavioral characteristics of salmonids can be altered by even relatively small changes in turbidity (10 to 50 Nephelometric Turbidity Units [NTUs]). Salmonids exposed to slight to moderate increases in turbidity exhibited avoidance, loss of station in the stream, reduced feeding rates and reduced use of overhead cover. Short-term increases in turbidity and suspended sediment may disrupt feeding activities of fish or result in temporary displacement from preferred habitats. Numerous studies show that suspended sediment and turbidity levels moderately elevated above natural background values can result in non-lethal detrimental effects to salmonids. Suspended sediment affects salmonids by decreasing reproductive success, reducing feeding success and growth, causing avoidance of rearing habitats, and disrupting migration cues (Bash *et al.* 2001). Sigler *et al.* (1984 *in* Bjornn and Reiser 1991) found that prolonged turbidity between 25 and 50 NTUs reduced growth of juvenile coho salmon and steelhead. MacDonald *et al.* (1991) found that the ability of salmon to find and capture food is impaired at turbidities from 25 to 70 NTUs. Reaction distances of *O. mykiss* to prey were reduced with increases of turbidity of only 15 NTUs over an ambient level of 4 to 6 NTUs in experimental stream channels (Barrett *et al.* 1992). Bisson and Bilby (1982) reported that juvenile coho salmon avoid turbidities exceeding 70 NTUs. Increased turbidity, used as an indicator of increased suspended sediments, also is correlated with a decline in primary productivity, a decline in the abundance of periphyton, and reductions in the abundance and diversity of invertebrate fauna in the affected area (Lloyd 1987; Newcombe and MacDonald 1991). Increased sediment delivery can also fill interstitial substrate spaces and reduce cover for juvenile fish (Platts *et. al.* 1979) and abundance and availability of aquatic invertebrates for food (Bjornn and Reiser 1991).

4. Fish Salvage

Per the Project Description outlined in Section II above, 3/32-inch wire mesh with wood template or rock weight will be attached to the bottom of the CIDH pile casings to form a cone shape prior to the casings being lowered to the river bottom during in-water construction. The wire mesh will prevent any fish from being trapped during the installation of the CIDH pile temporary casings. Therefore, no fish rescues are anticipated. However, the fish salvage plan safeguard measure (No. 12 on page 12) will be followed should the wire mesh on the bottom of the CIDH casing be damaged while being lowered into the water, which may result in salmonids or sturgeon getting trapped. Although this is unlikely, it has occurred at other Caltrans bridge construction sites, and since Sacramento River flows near the project area (Bends Ferry Road Bridge; RM 45) are fairly swift and in excess of 7,300 cfs (Caltrans 2013), there is the potential for this to occur.

5. Fish Passage

Per the Project Description outlined in Section II above, the project will construct temporary gravel work pads on each bank and leave an approximate 200-foot opening between the pads. Not only will the gravel pads reduce the number of driven piles required for the construction access trestles and falsework support, they will allow for unimpeded passage for fish migrating through the project area during all in-water work construction activities (Caltrans 2013). If the opening is less than 200-feet, or water level drops during construction, adult salmonids may have difficulty passing the work area. A biologist will ensure passage remains open at all times.

6. Harm to Fish as a result of Accidental Hazardous Materials and Chemical Spills

Construction related activities could potentially impair water quality should hazardous chemicals (e.g. fuels and petroleum-based lubricants) or other construction materials enter the Sacramento River. Construction-related chemical spills could potentially affect fish and aquatic resources by causing physiological stress, reducing biodiversity, altering primary and secondary production, interfering with fish passage, and causing direct mortality. However, implementation of avoidance and minimization measures described in Section II of this BO will minimize and avoid potential for exposure to hazardous chemicals.

7. Pile Driving and Underwater Sound Pressure

a. Impacts on Fish

The underwater sound pressure waves that have the potential to adversely affect listed anadromous fish species originate from the contact of the hammer with the top of the steel pile. The impact of the hammer on the top of the steel pile causes a wave to travel down the pile and causes the pile to resonate radially and longitudinally like a gigantic bell. Most of the acoustic energy is a result of the outward expansion and inward contraction of the walls of the steel pipe pile as the compression wave moves down the pile from the hammer to the end of the pile buried in the riverbed and/or floodplain. Water is virtually incompressible and the outward movement of the pipe pile (by a fraction of an inch) followed by the pile walls pulling back inward to their original shape, sends an underwater pressure wave propagating outward from the pile in all directions. The steel pipe pile resonates sending out a succession of waves even as it is pushed several inches deeper into the riverbed.

Fish may be injured or killed when exposed to high underwater sound pressure levels (SPL) generated by steel piles installed with impact hammers. Pathologies to fish tissue associated with very high SPLs are collectively known as *barotraumas*. Barotraumas may occur as a result of exposure to drastic changes in underwater pressure. A common type of barotrauma is rupturing of the swim bladder; other injuries may occur such as hemorrhaging and rupture of internal organs. Death can be instantaneous, occur within minutes after exposure, or occur several days later. Gisiner (1998) reports swim bladders of fish can perforate and hemorrhage when exposed to blast and high-energy impulse noise underwater. If the swim bladder bursts and the air escapes from the body cavity or is forced out of the pneumatic duct, the fish may sink to the bottom. If the swim bladder bursts but the air stays inside the body cavity, the fish is likely to stay afloat but have some difficulty in maneuvering or maintaining orientation in the water column. With salmonids, the swim bladder routinely expands and contracts as they swim near the surface or swim in deeper water near the bottom. At high sound pressure levels of pile driving, the swim bladder may rapidly and repeatedly expand and contract, hammering the internal organs that cannot move away since they are bound by the vertebral column above and the abdominal muscles and skin that hold the internal organs in place below the swim bladder (Gaspin 1975). This pneumatic pounding may result in the rupture of capillaries in the internal organs as indicated by observed blood in the abdominal cavity, and maceration of the kidney tissues. The pneumatic duct, which connects the swim bladder with the esophagus, may not make a significant difference in the vulnerability of the salmonids since it is so small relative to the volume of the swim bladder (Gaspin 1975). Green sturgeon are likely to suffer similar effects to those of salmonids since they possess similar anatomy and physiology (*e.g.,* physostomous swim bladder).

Fish can also die when exposed to lower sound pressure levels if exposed for longer periods of time. Hastings (1995) found death rates of 50 percent and 56 percent for gouramis (*Trichogaster sp*.) when exposed to continuous sounds at 192 dB (re: 1 μPa) at 400 Hz and 198 dB (re: 1 μPa) at 150 Hz, respectively, and 25 percent for goldfish (*Carassius auratus*) when exposed to sounds of 204 dB (re: 1 μPa) at 250 Hz for two hours or less. Hastings (1995) also reported that acoustic "stunning," a potentially lethal effect resulting in a physiological shutdown of body functions, immobilized gourami within eight to thirty minutes of exposure to the aforementioned sounds.

High SPLs can also result in a temporary threshold shift in hearing sensitivity or auditory damage to fish (Carslon *et al*. 2007). Structural damage to the fish inner ear by intense sound has been examined by Enger (1981) and Hastings *et al.* (1995, 1996) with scanning electron microscopy. Hastings *et al.* (1996) found destruction of sensory cells in the inner ears of oscars (*Astronotus ocellatus*) four days after being exposed to continuous sound for one hour at 180 dB (re:1 μPa) at 300 Hz. Hastings (1995) also reported that 13 out of 34 goldfish exposed for two hours to SPLs ranging from 192 to 204 dB (re:1 μPa) at either 250 or 500 Hz experienced equilibrium problems that included swimming backwards and/or upside down and wobbling from side to side. These fish recovered within one day suggesting that the damage was not permanent. This fish behavior could have been caused by post-traumatic vertigo (lack of balance and dizziness caused by a problem in the inner ear) similar to that experienced by humans after a severe blow to the body or head.

Additional detrimental effects to fish from loud sounds include stress, increasing risk of mortality by reducing predator avoidance capability, and interfering with communication necessary for navigation and reproduction. Scholik and Yan (2001) reported temporary threshold shifts for fathead minnows (*Pimephales promelas*) exposed to 24 hours of white noise with a bandwidth of 300 – 4000 Hz and overall sound pressure level of only 142 dB (re:1 μPa). Their results indicated that the effects could last longer than 14 days. Even if threshold shifts do not occur, loud sounds can mask the ability of aquatic animals to hear their environment, thus increasing their vulnerability to predators or ability avoid areas that may pose safety risks and possibly affect migration behavior.

Pile driving and the resulting underwater sound pressure may result in "agitation" of salmonids indicated by a change in swimming behavior, such as detected by Shin (1995) with salmonids, or "alarm" detected by McCauley *et al.* (2003). Salmonids and may exhibit a startle response to the first few strikes of a pile. The startle response is a quick burst of swimming that may be involved in avoidance of predators (Popper 1997). A fish that exhibits a startle response may not necessarily be injured, but it is exhibiting behavior that suggests it perceives a stimulus indicating potential danger in its immediate environment. However, fish do not exhibit a startle response every time they experience a strong hydroacoustic stimulus. From the recent pile driving studies along the west coast, biologists have observed that fish may startle and swim away from the stimulus at the start of pile driving, but that they observed the fish to recover, and in some cases turn around and pass by the area of impact multiple times (M. Molnar, pers.

comm. with J. Meyer NMFS 2011). Thus a ramping up of the hammer during the initial phase of pile driving is not necessarily a suitable or reliable fish avoidance or minimization measure as has been proposed in some pile driving projects.

A study in Puget Sound, Washington suggests that pile driving operations disrupt juvenile salmon behavior (Feist *et al*. 1992). Though no underwater sound measurements are available from that study, comparisons between juvenile salmon schooling behavior in areas subjected to pile driving/construction and other areas where there was no pile driving/construction indicate that there were fewer schools of fish in the pile-driving areas than in the non-pile driving areas. The results are not conclusive but there is a suggestion that pile-driving operations may result in a disruption in the normal migratory behavior of the salmon in that study, though the mechanisms salmon may use for avoiding the area are not understood at this time.

NMFS currently uses a dual metric criteria to assess onset of injury for fish exposed to pile driving sounds (FHWG 2008). Specifically, this includes a single strike peak SPL of 206 dB (re: 1 μPa) and an accumulated SEL of 187 dB (re: 1 μPa^2-sec) for fish equal to or greater than 2 grams or 183 dB (re: 1 μPa^2sec) for fish less than 2 grams. If either threshold is exceeded, then physical injury is assumed to occur. There is uncertainty as to the behavioral response of fish exposed to high levels of underwater sound produced when driving piles in or near water. Based on the information currently available and until new data indicate otherwise, NMFS believes a 150 dB root-mean-square pressure (RMS) threshold for behavioral responses for salmonids and green sturgeon is appropriate.

b. Assessment of Project Pile Driving Effects

Effects on an individual fish during pile driving construction activities will be dependent on a number of variables, including:

1. Size and force of the hammer strike; (summarize)

2. Location of fish from the pile;

3. Site specific sound propagation characteristics;

4. Size of the fish;

5. Species of fish;

6. Presence and type of a swim bladder;

7. Physical condition of the fish; and

8. Effectiveness of bubble curtain and/or other sound pressure attenuation technology.

As stated above, a dual metric criteria of 206 dB (re: 1 μPa) peak SPL for any single strike and a cumulative sound exposure level (cSEL) of 187 dB (re: 1 μPa^2-sec) and/or 183 dB (re: 1 μPa^2-

sec) are currently used by NMFS and Caltrans as thresholds to correlate physical injury to fish two grams or larger, and fish less than two grams (respectively) in size from underwater sound produced during the installation of piles with impact hammers. As distance from the pile increases, transmission loss reduces sound pressure levels and the potential harmful effects to fish also decrease. Disturbance and noise associated with construction at the pile driving site may also startle fish and result in some dispersion from the action area.

Water depth at the pile driving site (the upper reaches of the Sacramento River) will also influence the rate of sound attenuation. In deep water areas high sound pressure waves are likely to travel further out into water column than they would otherwise travel if encapsulated within an air bubble curtain, or conducted within a dewatered cofferdam, thereby resulting in adverse impacts to salmonids and green sturgeon over a larger area. In contrast, within shallow water, attenuation rates are likely to be higher thereby reducing the area where adverse effects are expected.

Based on proposed construction activities, the effects of noise on fish would be primarily limited to avoidance behavior in response to movements, vibrations, and noise caused by construction personnel and equipment operating in or adjacent to the Sacramento River. Additional effects may include physiological stress, physical injury (including hearing loss), and mortality. For the project, all of the structural piles for the temporary falsework/working trestle piles would be driven in place by impact hammer methodology (Table 9).

As noted above in Section II, 12-inch, thick-walled H piles will be driven (using an impact hammer) into the river bottom to construct the two temporary trestles (50 piles each, 100 piles total), finger piers (30 piles total), and to support the temporary falsework (100 piles total). The Technical Guidance for Assessment and Mitigation of Hydroacoustic Effects of Pile Driving on Fish (Guidance; Caltrans 2009) provides data for 12-inch, thick-walled H piles driven into place with an impact hammer at depths of approximately 5 m (16.4 ft) and less than 5 m (16.4 ft). As stated previously the depth of the Sacramento River in the project area during the work period is typically between 6 to 10 feet (i.e., less than 5 m/16.4 ft). Consequently, it is estimated that driving H piles for the temporary trestle and temporary falsework will result in maximum peak sound levels of 190 dB, SEL of 160 dB, and RMS of 175 dB. All referenced data is based on measurements at a distance of 10 m (32.8 ft) from the pile driving. Table 9 shows the expected underwater noise levels for this project.

Caltrans estimates the peak SPL calculated for a 12-inch pile is 190 dB for this project. They estimate a single-strike SEL of 160 dB, and an RMS of 175 dB. Estimation of the cumulative SEL requires an estimate of the duration of pile driving activities in a single day. The project estimates that 6 piles would be driven per day (12 hours) during in-water pile driving operations and on land.

NMFS has analyzed the effects of the proposed pile driving for the permanent and temporary structures necessary for construction of the project, including the proposed avoidance and minimization measures. As a result, NMFS does not anticipate SPLs, SELs and RMS values to be exceeded beyond the following distances surrounding each pile during each construction phase, for fish greater than or equal to 2 grams and less than 2 grams:

- For un-attenuated temporary trestle piles (12-inch steel piles), 206 dB peak SPL at 2 m, 187 dB cSEL at 26 m, 183 cSEL at 32 m, and 150 dB RMS at 178 m;
- For un-attenuated temporary falsework piles (12-inch steel piles), 206 dB peak SPL at 2 m, 187 dB cSEL at 26 m, 183 cSEL at 32 m, and 150 dB RMS at 178 m.

Table 9. Jellys Ferry Bridge Replacement Project Pile Driving Data

Pile Name	Pile Type	Driver Type	Number of strikes/pile	Strikes/day	Reference Distance (m)	Attenuation (dB)	Peak (dB)	SEL (dB)	RMS (dB)	Distance (m) to threshold			
										Peak dB	Cumulative SEL dB		RMS dB
											Fish >2 g	Fish < 2 g	
										206 dB	187 dB	183 dB	150 dB
Temporary Trestle (including finger piles)	12” steel H-piles	Impact	550	3300	10	0	190	160	175	2	26	32	178
Temporary Falsework	12” steel H-piles	Impact	550	3300	10	0	190	160	175	2	26	32	178

Caltrans 2009. Technical guidance manual for the assessment of the hydroacoustic effects of pile driving on fish. Sacramento, CA.

As distance from the pile increases, SPLs decrease and the potential harmful effects to fish also decrease. Hence the distance to reach the 150 dB RMS corresponding to sub-injurious sound levels (*i.e.* non-lethal, behavioral responses), is not expected to extend beyond 178 m (356 m diameter) from the action area for any pile driving event. This larger area defines the total area of impact expected from pile driving for the entire duration of bridge replacement activities.

The maximum area where fish may be injured or killed during impact hammering of the 12-inch steel piles is 32 m (64 m diameter), corresponding to the cumulative SEL threshold of 183 dB. Further away from the piles, to a distance of 178 m (356 m diameter), corresponding to the 150 dB RMS threshold, fish behavior may be adversely affected. Since no fish are expected to be holding within these areas during un-attenuated pile driving of the 12-inch piles (this reach of the upper Sacramento River is largely used by listed fish as a migratory corridor) no attenuation devices will be implemented.

Based on these computations, peak SPLs generated by pile driving activities will be nearly within established thresholds for the protection of fish. However, cumulative SPLs sufficient to cause injury to fish would occur within 32 meters of the of pile driving activities. These areas are considered the maximum radius of the potential impact zone for injury or mortality.

NMFS anticipates that juvenile salmonids and green sturgeon located within 32 meters of piles driven with an impact hammer may suffer physical injury or mortality from exposure to high underwater sound levels. This is the distance expected to reach the cSEL threshold of 183 dB. Beyond 32 meters, extending 178 meters from the pile corresponding with the 150 dB RMS, salmonids and sturgeon may exhibit behavioral responses. These disruptions to normal behavioral patterns could result in decreased feeding opportunities, loss of shelter from predators, or dispersal from suitable rearing habitat which may contribute to a reduced growth rate. Disruption of these behaviors may also lead to increased predation if fish become disoriented or concentrated in areas with high predator densities. However, the likelihood for these effects to occur will be minimized since pile driving will occur during the day, and most fish passage is expected to occur at night. Additionally, fish will have a minimum width of 200 feet of river (between the gravel pads) when migrating up or downstream, and are expected to avoid the disturbance-side of the creek when passing. This will minimize the majority of the impact to a non-lethal level. The May 1 through August 15 in-water work window will further minimize the extent of the impacts on listed anadromous fish by avoiding the peaks of juvenile migration periods.

The startling or agitation of juvenile and adult salmonids and green sturgeon may temporarily disrupt normal behaviors (such as feeding, sheltering, and migrating) that are essential to growth and survival. Injury is caused when disrupting these behaviors increases the likelihood that individual fish will face increased competition for food and space, and experience reduced growth rates or possibly weight loss. Disruption of these behaviors may also result in the death of some individuals due to increased predation if fish are disoriented or concentrated in areas with high predator densities. Disruption of behaviors may occur between May 1 and August 15 of both construction years, especially during the first year during weekday daylight operation hours of pile driving. Because of their nocturnal migratory behavior, daily migration delays are expected only to impact the portion of each species that migrates during daylight hours. Therefore, salmonids and sturgeon will still be exposed during the daytime. Adult CCV steelhead, CV spring-run Chinook, Sacramento River winter-run Chinook salmon, and green sturgeon that are migrating upstream may be startled or exhibit other behavioral responses during pile driving, resulting in daily migration delays of up to eight hours by holding downstream of the bridge until the pile driving stops. These migration delays are not expected to injure adults because adult fish commonly hold in deep pools while migrating upstream, and will likely wait until the daytime disturbance subsides before passing upstream.

In summary, NMFS anticipates that pile driving will be detectable to salmonids and green sturgeon up to 32 meters from the source, which may result in injury or death. In addition, from 178 meters, the sounds generated may harass juvenile salmonids and sturgeon causing temporary disruption of normal behaviors such as feeding, sheltering, and migrating that may contribute to reduced or negative growth. Disruption of these behaviors may also lead to increased predation if fish become disoriented or concentrated in areas with high predator densities. These effects should be small because pile driving will occur during the day, enabling unhindered fish passage at night during peak migration times. The minimum 200 feet width of river for passage at the project site will allow for safe passage (outside of 32 meters) on the opposite bank of the disturbance. The May 1 through August 15 work window will further minimize the extent of the impacts on listed anadromous fish by avoiding the peaks of juvenile migration periods.

8. Effects on Designated Critical Habitat Primary Constituent Elements (PCEs)

Project construction will result in permanent and temporary effects to both SRA habitat and riverine habitat in the upper Sacramento River. In turn, this will affect critical habitat for listed species migrating, rearing, and holding in the area.

The Project may result in improved spawning within the action area due to the addition of 0.95 ac of spawning gravel following removal of the temporary gravel work pads (i.e., leaving the bottom 1 foot of gravel), which will offset the permanent loss of 0.01 ac of riverine habitat.

Within the action area, the relevant PCEs for salmonids and sturgeon include food resources, water flow, water quality, migratory corridors, water depth, and streambed quality (related to spawning habitat). The Project is unlikely to demonstrably affect, within the action area, rearing habitat or food resources or their availability for salmonids. The migratory corridor for listed salmonids and green sturgeon will be temporarily affected, as will potential spawning habitat for salmonids. Impacts to the migration corridor are only expected to be short-term, and unimpeded passage will be open throughout construction.

a. Effects on Shaded Riverine Aquatic Habitat (SRA)

SRA habitat generally includes the woody vegetation and cover structures associated with "natural" banks that function to provide shade; sediment, nutrient, and chemical regulation; stream bank stability; input of woody debris and leaves that provide cover and serve as substrates for food-producing invertebrates. Permanent loss of SRA habitat, totaling 2.09 ac, shall be compensated at a 3:1 ratio (Table 10). Accordingly, 6.27 ac of riparian floodplain forest (RFF) credits will be purchased at the Fremont Landing Conservation Bank (FLCB), or other NMFS-approved conservation bank, to compensate for the loss of 2.09 ac of SRA resulting from implementation of the project.

Permanent effects to shaded riparian aquatic (SRA) habitat, consisting of valley oak riparian totaling 2.09 acres (ac), will occur during construction of the new bridge since it will be located on a different alignment than the existing bridge. The permanent loss of the SRA habitat will decrease shading over the river. However, the new bridge will be substantially wider than the existing bridge (37 feet versus 21 feet) and will provide more shading area, which will minimize the effects from the loss of SRA.

b. Effects of Sediment on Critical Habitat

The project will also result in the permanent loss of approximately 0.01 ac of riverine or critical habitat for listed fish during construction of the two bridge support columns (Table 10). BMPs are incorporated into the project to minimize turbidity effects to critical habitat. The creation of 0.95 ac of new spawning habitat following removal of the temporary gravel work pads (i.e., leaving the bottom 1 foot of gravel) will offset the permanent loss of 0.01 ac of riverine habitat.

Effects on critical habitats can also reduce fisheries habitat quality by increasing sedimentation. Sedimentation can decrease or reduce spawning habitat as well as rearing habitat. Increased sedimentation, especially in low valley streams, can smother incubating embryos and emergent fry. Increased sedimentation can seal gravel and decrease inter-gravel water flow reducing inter-gravel dissolved oxygen concentrations and result in high biological oxygen demand (BOD). Increased turbidity, especially caused by fine inorganic particles, increase drift of macroinvertebrates. Aquatic invertebrate communities may change as a result of sedimentation or turbidity, which in turn could affect salmonid prey items. In addition, suspended materials in slow moving waters can increase absorption of solar energy near the surface causing the heated upper layers to stratify reducing the dispersion of dissolved oxygen and nutrients to lower depths.

Table 10. Summary of Impacts and Proposed Mitigation

Habitat Type	Impact Type		
	Permanent	Temporary	Proposed Mitigation
Spawning	----	0.08	Bottom one foot of work pad to remain; create 0.95 ac of spawning habitat
Riverine (critical habitat)	0.01	0.95	Bottom one foot of work pad to remain; create 0.95 ac of spawning habitat
Riparian	2.09	----	Purchase credits from a NMFS-approved off-site bank at 3:1 ratio, total of 6.27 ac of riparian mitigation
Totals	2.10	1.03	

Due to the extended level of higher base flows in the upper Sacramento River, it is anticipated that, with regard to the potential effects described in this section, the effects of suspended sediment that may lead to sedimentation in the project action area will be insignificant because most, if not all of the suspended sediment will dissipate quickly or be diluted substantially by the high base flows (8,770 cfs late summer flow in September; Caltrans 2013) in the upper Sacramento River and moved downstream making the effects insignificant.

c. Freshwater Migratory Corridor

Safe and unobstructed migratory pathways are necessary for adult salmonids and sturgeon to migrate to and from spawning habitats, and for larval and juveniles to migrate downstream from spawning/rearing habitats within freshwater rivers to rearing habitats within the estuaries. The main migratory corridor in the upper Saramento River will not be blocked at any time during project implementation so Sacramento River winter-run Chinook salmon, CCV steelhead, CV spring-run Chinook salmon and green sturgeon using the area to migrate upstream and downstream in the project action area in this reach of the upper Sacramento River to feed or rest, should not be affected and the effects of the project on the PCE of migratory corridors for all listed species is insignificant. Fish that use the action area as a migratory corridor will be able to continue using the channel during and after construction of the proposed action.

d. Freshwater spawning and rearing habitat

Freshwater rearing habitat provides water quantity, quality, and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility. Rearing habitat condition is strongly affected by habitat complexity, food supply, and presence of predators of juvenile salmonids and green sturgeon. Freshwater rearing habitats have a high intrinsic value to salmonids, as the juvenile life stages are dependent on the function of this habitat for successful survival and recruitment.

To reiterate, the loss of spawning habitat due to the placement of anti-spawning mats will be temporary in nature. Migrating fish can utilize other areas of suitable habitat until the mats are removed. As a result of removing the work pads, 0.95 ac of additional spawning habitat will be available to listed fish as the bottom foot of the work pad will remain in river. The project would not result in a permanent direct loss of spawning habitat, but would temporarily make small areas unavailable for spawning during the in-water construction period.

CV spring-run Chinook salmon juveniles would have outmigrated by the time construction begins and during the in-channel construction period. The proposed action would not result in a permanent direct loss of CCV steelhead and green sturgeon rearing habitat, but would temporarily make small areas unavailable for rearing during construction. These short-term temporary instream disturbances (physical equipment, turbidity, etc.) would likely result in the displacement of fish from their habitat to downstream areas. However, there is suitable rearing habitat for salmonids and sturgeon below the action area and above the RBDD.
Based on the expected behavioral response of juveniles to relocate and the condition of the habitat there, any juveniles that are removed during potential fish salvage activities and displaced downstream, are expected to find adequate cover and food and not suffer any diminishment in their fitness from relocation. Through changes to the particle size distribution in the channel bed and increases to the mobility of the geomorphic landscape of the streambed through localized changes in channel hydraulics; these actions will ultimately improve and increase the availability of suitable salmonid and sturgeon rearing habitat in the action area having a beneficial effect.

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.

A. Agricultural Practices

Agricultural practices may negatively affect riparian and wetland habitats through upland modifications that lead to increased siltation or reductions in water flow in stream channels flowing into the action area, including the Sacramento River and Delta. Grazing activities from livestock 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 receiving waters. Increased water temperatures can result when agricultural water exposed to warm summer air temperatures is returned to the Yuba River as agricultural return flow. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect salmonid reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

B. Global 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 likely will 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.

Sea levels are expected to rise by 0.5 to 1.0 meters in the northeastern Pacific coasts in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g*., salt marsh, riverine, mud flats) affecting salmonid PCEs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions, and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Summer droughts along the South Coast and in the interior of the northwest Pacific coastlines will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to overtake native fish species and impact predator-prey relationships (Peterson and Kitchell 2001, Stachowicz *et al.* 2002).

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. 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 could 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 Oroville, it could potentially rise above thermal tolerances for juvenile and adult salmonids (*i.e.* Sacramento River winter-run Chinook salmon and CV steelhead) that must hold below the dam over the summer and fall periods. Within the context of the period over which the project is scheduled to take place, however, the effects of global climate change are unlikely to result in any perceptible declines to the overall health or distribution of the listed populations of anadromous fish within the action area that are the subject of this consultation; therefore, the project effects and climate change are not expected to aggregate.

VII. INTEGRATION AND SYNTHESIS

This section integrates the current conditions described in the *Environmental Baseline* section with the effects of the project and the cumulative effects of future actions. The purpose of this synthesis is to develop an understanding of the likely short-term and long-term responses of listed species and critical habitat to the proposed project.

A. Summary of Current Conditions and Environmental Baseline

The *Status of Species and Critical Habitat* and *Environmental Baseline* sections show that past and present impacts to the Feather River, Sacramento and San Joaquin River basins and the Delta have caused significant salmonid and green sturgeon habitat loss, fragmentation and degradation. This has reduced the quality and quantity of freshwater rearing sites and the migratory corridors within the lower valley floor reaches of the Sacramento and San Joaquin Rivers and the Delta region for these listed species. Additional loss of freshwater spawning sites, rearing sites, and migratory corridors have also occurred upstream in the upper main stem and tributaries of the Sacramento and San Joaquin River basins.

Anthropogenic activities in Central Valley watersheds have contributed substantially to declines in Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and Southern DPS of Northern green sturgeon populations. Access to upper elevation watersheds in the Sacramento River basin have been severely curtailed for spring-run Chinook salmon and steelhead by the construction of large dams on the foothill sections of the valley's major tributaries. These rim dams effectively block access of anadromous fish, including salmonids and sturgeon to the entire watershed above the dams since effective fish ways and ladders are non-existent at this time. Construction of large dams on the major tributaries found in the San Joaquin River basin led to the extirpation of the CV spring-run Chinook salmon populations found in the basin's watersheds. The last self-sustaining population of spring-run Chinook salmon in the San Joaquin River basin was extirpated by the completion of Friant Dam and the Kern and Friant canals in the late 1940s.

The populations of CV steelhead that historically inhabited these various watersheds have also been severely reduced in number, with only a few small populations remaining in the tailwaters below the dams. The operations of various hydropower projects have reduced the extent of suitable water temperatures for over summering steelhead juveniles to the tailwaters immediately below these dams. In some cases the water temperatures reach incipient lethal temperatures only a few miles downstream of the dams. Alterations in the geometry of the Delta channels, removal of riparian vegetation and shallow water habitat, construction of armored levees for flood protection, changes in river flow created by demands of water diverters (including pre-1914 riparian water right holders, CVP and SWP contractors, and municipal entities), and the influx of contaminants from agricultural and urban dischargers have substantially reduced the functionality of the Central Valley's suitable aquatic habitat.

B. Impacts of the Proposed Action on Sacramento River winter-run Chinook salmon, CV spring-run Chinook Salmon, CCV Steelhead, North American green sturgeon, and their Designated Critical Habitat

NMFS finds that the effects of the proposed action on Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, North American green sturgeon, and their designated critical habitats will include a temporary increase in suspended sediment and turbidity, a short-term reduction of SRA habitat, harassment, injury or death, and possible predation-related mortality of individuals from pile driving, and harassment, injury and potential mortality of individuals entrained or salvaged from construction activities. With the exception of loss of SRA habitat, the May 1 to August 15 in water work window during the first construction season and the late March to mid-August in water work window during the second season will avoid in-water work during peak juvenile outmigration periods. In addition, the installation of anti-spawning mats between March 1 and April 15 during the first construction season will assist in avoiding effects to winter- and spring-run Chinook salmon that could utilize the small area of spawning habitat located downstream of the bridge.

The most likely effects to listed salmonids and sturgeon resulting from the proposed action are harassment of juvenile winter-run and spring-run Chinook salmon, CCV steelhead, and green sturgeon resulting from the noise of pile driving, and potential entrainment of juveniles from construction activities. Pile driving may result in injury or death to outmigrating juveniles that pass within the 32 m zone of impact. Pile driving is also expected to result in temporary disruptions in the feeding, sheltering, and migratory behavior of adult and juvenile salmon and steelhead and green sturgeon for fish passing outside of the 32 m zone of impact. This disruption could potentially result in reduced growth and increased susceptibility to predation. Adults are not expected to be injured or result in lethal take as they may only experience temporary migration delays that should not prevent successful spawning. Pile driving is also not expected to prevent salmonids and sturgeon from passing upstream or downstream because pile driving will not be continuous through the day, and will not occur at night, when the majority of fish migrate. Pile driving effects will be minimized by avoiding the peak migration periods of most of the listed anadromous salmonids.

Based on species exposure to in-water work described in Table 8 above, there is some likelihood for winter-run Chinook salmon juveniles to begin outmigrating in early August (less than 5 percent). However, in recent years spawning has begun later, which would result in later outmigration. Spawning monitoring for 2014 has indicated a later spawning timing as well (CDFW 2014, unpublished data). For this reason, we expect very few winter-run Chinook salmon to be outmigrating during this time. Spring-run Chinook salmon's tail end of outmigration past RBDD is in May (Poytress *et al* 2014). Most years have observed zero passage in May, but a few years (e.g. 2004) have observed as many as five percent that are passing RBDD. However, numbers passing the project area are expected to be very low, and effect to the ESU is expected to be minimal since the majority of spring-run Chinook salmon production occurs downstream of the project. CCV steelhead outmigration timing peaks during the in-water work window (50 percent passing), but numbers are likely low with the contribution of only a few major tributaries upstream. Additionally, Coleman National Fish Hatchery steelhead releases, which are upstream of the project area, do not overlap with the project construction dates. Green sturgeon outmigration occurs during the in-water work window; however the majority of spawning occurs downstream of the action area, so very few fish are expected to pass the project area.

Death as a result of entrainment is expected to be minimized by salvaging and relocating fish away from the project site, if necessary. A low mortality rate of juveniles (<10 percent) is expected to result from fish salvage.

Turbidity changes that are within the CVRWQCB standards may result in sudden localized turbidity increases that could injure juvenile salmonids and sturgeon by temporarily impairing their migration, rearing, feeding, or sheltering behavior. Project-related turbidity increases may also contribute to the susceptibility of juvenile salmonids and sturgeon to increased predation. Turbidity related injury and predation will be minimized by implementing the avoidance and contingency measures of the SWPPP, and by scheduling in-water work to avoid peak migration periods of listed anadromous salmonids and sturgeon.

The permanent loss of 2.09 ac of riparian vegetation will result in a small reduction of near shore cover and food production until the vegetation in the disturbed areas is re-established (five to ten years). The purchase of 6.27 ac of RFF credits at FLCB, or other NMFS-approved conservation bank, will compensate for the loss of 2.09 ac of SRA resulting from the implementation of the project. Because of the diverse habitat conditions in the action area, and other forms of cover and food production available to salmon and steelhead within the action area, the loss of 2.09 ac of vegetation is not expected to significantly impair the essential behavioral patterns of listed anadromous fish and will, therefore, not result in a reduction in numbers.

There will be a permanent loss of approximately 0.01 ac of riverine habitat during construction of the two bridge support columns from the increased size of the bridge columns. In addition, the installation of anti-spawning mats will result in the loss of approximately 0.08 ac of potential spawning habitat. However, the creation of 0.95 ac of new spawning habitat following removal of the temporary gravel work pads will offset the permanent loss of 0.01 ac riverine habitat and temporary loss of 0.08 ac spawning habitat. In turn, this also is not expected to significantly impair essential behavioral patterns of listed anadromous fish and will, therefore, not result in a reduction in numbers.

C. Impacts of the Proposed Action on ESU Survival and Recovery

The adverse effects to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and North American green sturgeon within the action area are not expected to affect the overall survival and recovery of the ESUs. This is largely due to the fact that although construction may cause adverse effects to some listed salmonids, the impacts will avoid the largest proportions of listed anadromous fish that migrate through the action area by limiting in-water work to months that avoid peak migration periods to the best extent practicable. Additionally, most of the effects are not lethal. Construction-related harassment will be temporary and will not impede adult fish from reaching upstream spawning and holding habitat, or juvenile fish from migrating downstream. The project will compensate for permanent losses of riparian habitat through the purchase credits from a NMFS-approved off-site conservation bank at 3:1 ratio, totaling 6.27 ac of riparian mitigation creation. Therefore, it is NMFS' opinion that the potential incremental adverse effects of the proposed project does not increase the extinction risk or jeopardize the recovery of the Sacramento River winter-run Chinook salmon ESU, the CV spring-run Chinook salmon ESU, the CCV steelhead DPS, and the Southern DPS of North American green sturgeon.

VII. CONCLUSION

After reviewing the best scientific and commercial data available, including current status of the species discussed above, the Environmental Baseline for the action area, the cumulative effects of the proposed project, it is NMFS' biological opinion that the project, as proposed, is not likely to jeopardize the continued existence of the aforementioned species.

After reviewing the best available scientific and commercial information, the current status of critical habitat, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is NMFS' biological opinion that the project is not likely to destroy or adversely modify designated critical habitat for the aforementioned species.

VIII. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA 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 the purpose of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by Caltrans so that they become binding conditions of any contracts or permits, as appropriate, for the exemption in section 7(o)(2) to apply. Caltrans has a continuing duty to regulate the activity covered by this incidental take statement. If Caltrans (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant and its contractor(s) to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Caltrans or the applicant must report the progress of the action and its impact on the species to NMFS as specified in the 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, CV spring-run Chinook salmon, CCV steelhead, and North American green sturgeon from impacts directly related to designated critical habitat primary constituent elements, sedimentation and turbidity, pile driving and impairment of essential behavior patterns as a result of these activities, injury or harm related to the placement of gravel work pads and anti-spawning mats, potential fish salvage entrainment and fish passage delays, and the possibility deleterious materials entering the waterway at the project construction site. The incidental take is expected to be in the form of harm, harassment, injury or mortality of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and North American green sturgeon resulting from the installation and removal of temporary and permanent piles during bridge construction. Incidental take is expected to occur for during the in-water work window (May 1 to mid-August) when juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and North American green sturgeon individuals are outmigrating past the site.

Often, NMFS cannot, using the best available information, quantify the anticipated incidental take of individual Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and North American green sturgeon because of the variability and uncertainty associated with the population size of the species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the project area. However, it is possible, in those aspects of a project, to describe the ecological surrogates that will lead to the non-lethal and lethal estimates of take.

1. <u>In-water Construction Activities</u>

Although juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and North American green sturgeon are not expected to be rearing in the action area, the in-water work period is during CCV steelhead and green sturgeon outmigration, as well as the potential for winter- and spring-run Chinook salmon to be outmigrating at a low level.

Gravel Pad Installation: Take in the form of injury or death of juvenile CV spring-run Chinook salmon and CCV steelhead may occur during the placement of the gravel work pads, covering 0.75 ac adjacent to the banks. Based on timing of outmigrating juveniles at RBDD, NMFS estimates that less than five percent of the upper Sacramento River spring-run Chinook salmon production and approximately 20 percent of steelhead production may be outmigrating past the action area during the gravel pad placement. We estimate the actual amount of injury or death to be very low, limited to less than five juvenile spring-run Chinook salmon, and less than 10 juvenile steelhead.

Anti-spawning Mat Installation: Take in the form of harm to spawning winter-run Chinook salmon, and CV spring-run Chinook salmon from the temporary loss of 0.08 acres of spawning habitat as a result of behavior modifications that may cause fish to seek other spawning locations. The harm is not expected to kill fish but may cause some injury if these fish must compete with other fish for the available habitat. However, we estimate the level of take to be very low, at less than two adult winter-run Chinook salmon and less than two adult CV spring-run Chinook salmon.

Fish Salvage: Take in the form of capture of fish that may be entrapped in casings during pile driving activities. Based on entrapment at the Deschutes Bridge Replacement, a recent construction site upstream of the proposed action, no more than 30 juvenile CCV steelhead are expected to be entrapped and captured. Ten percent of fish captured and relocated may be injured or killed.

2. <u>Pile Driving</u>

The analysis of proposed project effects anticipates the installation of all of the structural piles for the temporary trestle and falsework piles will be driven in place by impact hammer methodology (Table 9). Driving with an impact hammer will last up to 12 hours per day. Drilling installation of permanent bridge foundation piles assumes that no underwater noise impact is expected. The temporary trestle and falsework piles will require impact installation of 12-inch steel “H” piles. All piles will be driven during the in-water pile driving work window (for a maximum of 50 days, cumulative) between May 1 and August 15, during daylight hours.

Pile driving with an impact hammer is expected to result in incidental take in the form of injury and mortality to juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and green sturgeon through exposure to temporary high SPLs (> 206 dB peak SPL and 183 or 187 dB SEL) within the water column during the installation of the temporary trestle and falsework piles. The number of salmonids and green sturgeon that may be incidentally taken during activities is expected to be small (see exposure Table 8). NMFS will use the area of sound pressure wave impacts extending into the water column from each pile, and the time period for pile driving as a surrogate for number of fish. Based on the sound pressure analysis (refer to Table 9), peak sound pressures are estimated to be below thresholds for injury and/or mortality of listed fish. Cumulative sound pressures are in excess of the 187 and 183 dB SEL for a distance of 26-32 meters surrounding the piles during temporary pile construction.

For listed salmonids outmigrating within 32 m from the pile during unattenuated pile driving of the 12-inch steel temporary falsework/trestle piles, take would be in the form of injury or mortality. Beyond this distance, extending out to 178 m corresponding with SPLs > 150 dB RMS, take would be in the form of harassment. Fish may exhibit behavioral responses such as agitation or rapid bursts in swimming speeds. If Caltrans’ monitoring indicates that SPLs greater than 206 dB peak (re: 1 μPa), or 187 dB SEL (re: 1 μPa^2sec) and 183 dB SEL (re: 1 μPa 2sec), or 150 dB RMS (re: 1 μPa) extend beyond these distances the amount of incidental take may be exceeded.

The analysis of the effects of the proposed project anticipates that the turbidity levels produced by installation and removal of piles will not exceed those permitted under the project SWPPP and that if turbidity levels approach or exceed the acceptable criteria established by the CVWQRCB, construction activities will be halted until turbidity levels return to within acceptable levels.

If these ecological surrogates are not met and maintained, the proposed project will be considered to have exceeded anticipated take levels, thus requiring Caltrans to coordinate with NMFS within 24 hours on ways to reduce the amount of take down to anticipated levels. Anticipated incidental take will be exceeded if the criteria described above are not met, the Project is not implemented as described in the BA prepared for this project, all conservation measures are not implemented as described in the BA (including successful completion of monitoring and reporting criteria), or the project is not implemented in compliance with the terms and conditions of this incidental take statement. If take is exceeded formal consultation must be reinitiated (50 C.F.R. § 402.16(a)).

B. Effect of Take

NMFS has determined that the aforementioned level of take resulting from the Jellys Ferry Bridge Replacement Project is not likely to jeopardize Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, North American green sturgeon and is not likely to destroy or adversely modify designated critical habitat.

C. Reasonable and Prudent Measures

NMFS has determined that the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the incidental take of listed Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and North American green sturgeon resulting from the Project. These RPMs also would minimize adverse effects on designated critical habitat:

1. Measures shall be taken to minimize incidental take of listed anadromous fish during CIDH pile installation;

2. Measures shall be taken to minimize the effect of temporary and permanent habitat loss of riverine and riparian habitat;

3. Measures shall be taken to minimize the number of piles used and duration of pile driving and its potential impacts on listed salmonids and sturgeon, and to monitor the range and distance of high underwater sound levels generated by pile driving operations;

4. Caltrans shall report any incidence of take to NMFS; and

5. Caltrans shall provide a report of project activities to NMFS by December 31 of each construction year.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, Caltrans must comply with the following terms and conditions, which implement the RPMs described above and outline required reporting and monitoring requirements. These terms and conditions are non-discretionary and must be incorporated as binding conditions of any contracts or permits between Caltrans and their contractors:

(1) Measures shall be taken to minimize incidental take of listed anadromous fish during in water CIDH pile installation;

Conditions: Caltrans shall have a fish biologist prepare a fish salvage plan, in coordination with NMFS to recover any individual salmonids entrapped or entrained during the installation of CIDH piles (refer to Measure No. 12). In addition, Caltrans will submit the plan to NMFS 60 days prior to project initiation for NMFS approval.

(2) Measures shall be taken to minimize the effect of temporary loss of riverine and riparian habitat;

Conditions:

a. Existing vegetation will be protected in place where feasible to provide an effective form of erosion and sediment control as well as watershed protection, landscape beautification, dust control, pollution control, noise reduction, and shade;

b. To control invasive species, all landscaping and re-vegetation will consist of Caltrans approved plants or seed mixes from native, locally adapted species.

c. Caltrans shall monitor and maintain all riparian plantings for five years, and provide irrigation, fertilization and replacement plantings as necessary to ensure full and rapid recovery of disturbed riparian habitat features;

d. Caltrans shall provide NMFS a post-construction field review and yearly field reviews for five years of the proposed project site, to assure conservation measures were adequately implemented and whether additional plantings are needed to establish adequate riparian vegetation. Caltrans should successfully re-vegetate at a rate of at least 80 percent at the project site. The first review should occur the year following construction completion. The field review shall include the following elements:

i. Seasonal surveys to determine adequate cover and plant survival throughout the year is being met;

ii. A survival ratio to ensure planting of new vegetation is implemented during the first five years when necessary; and

iii. Photo point monitoring shots at the established repair site to be used as a tool to determine success and survival rates. The photos shall be taken annually on the same date, as much as practicable.

(3) Measures shall be taken to minimize the number of piles used and duration of pile driving and its potential impacts on listed salmonids and sturgeon, and to monitor the range and distance of high underwater sound levels generated by pile driving operations.

Conditions:

a. Real-time monitoring shall be conducted to ensure that underwater sound levels analyzed in this BO do not exceed the established distances described for pile driving construction. Monitoring shall follow NMFS standard practices of 1-2 hydrophones used, the first being placed at 10 m from the pile, mid-depth in the water column, and the second being placed further away near the isopleth estimated for the cumulative SEL distance;

b. Caltrans shall monitor underwater sound during all impact hammer pile driving activities. If underwater sound exceeds the established thresholds at the distances provided above from the piles being driven, then NMFS must be contacted within 24 hours before continuing to drive additional piles.

c. Caltrans shall submit to NMFS a monitoring and reporting plan that will incorporate provisions to provide daily, monthly, and seasonal summaries of all hydroacoustic monitoring results during the pile driving season for approval at least 60 days prior to the start of construction activities (FHWG 2013). In regards to the daily reports, Caltrans shall submit to NMFS a monitoring report (by close of business of the day following the pile driving activities) that provides real-time data regarding the distance (actual or estimated using propagation models) to the thresholds (187 dB accumulated SEL and 150 dB RMS) stated in this BO to determine adverse effects to listed species. Specifically, the reports shall:

i. Describe the locations of hydroacoustic monitoring stations that were used to document the extent of the underwater sound footprint during pile-driving activities, including the number, location, distances, and depths of hydrophones and associated monitoring equipment;

ii. Include the total number of pile strikes per pile, the interval between strikes, the peak SPL and SEL per strike, and accumulated SEL and 150 dB RMS per day for each hydroacoustic monitor deployed; and

d. Caltrans shall submit to NMFS a final hydroacoustic monitoring summary due 30 days following pile driving events for each temporary and permanent structure required for bridge construction. The reports must provide a review of the daily, monthly, and seasonal monitoring data and process, as well as any problems that were encountered.

(4) Caltrans shall report any incidence of take to NMFS; and

Conditions: Caltrans shall record the date, number, and specific location of all listed fish that are relocated for each construction-related activity in the project area in addition to any direct mortality observed during in-water work and relocation. If a listed species is observed injured or killed by project activities, Caltrans shall contact NMFS within 48 hours at 916-930-3600. Notification shall include species identification, the number of fish, and a description of the action that resulted in take. If possible, dead individuals shall be collected, placed in an airtight bag, and refrigerated with the aforementioned information until further direction is received from NMFS.

(5) Caltrans shall provide a report of project activities to NMFS by December 31 of each construction year;

Conditions: This report shall include a summary description of in-water construction dates and activities, avoidance and minimization measures taken. Updates and reports required by these terms and conditions shall be submitted by December 31 of each year during the construction period to:

Assistant Regional Administrator
California Central Valley Office
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento, CA 95814-4607
FAX: (916) 930-3629
Phone: (916) 930-3600

IX. 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. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS proposes the following conservation recommendations that would avoid or reduce adverse impacts to listed anadromous fish species:

(1) Caltrans should support and promote aquatic and riparian habitat restoration within California's Central Valley, and implement practices that avoid or minimize negative impacts to salmon, steelhead, and sturgeon on all of their project sites within critical habitat.

(2) Caltrans 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 and sturgeon habitat restoration projects within the upper Sacramento River.

(3) Caltrans should provide fiscal and staffing support to anadromous salmonid and sturgeon monitoring programs throughout the Delta to improve the understanding of migration and habitat utilization by salmonids and sturgeon in this region.

(4) Caltrans and other local, State, and Federal agencies should provide training for Caltrans environmental and engineering staff that will assist in avoiding or minimizing the impacts of transportation projects on ESA-listed salmonids, green sturgeon and their habitats.

(5) Caltrans and other local, State, and Federal agencies should include in bid packages to contractors specific requirements for scheduling construction activities that adhere to seasonal work windows in order to avoid principal migration times for listed anadromous fish species.

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

X. REINITIATION NOTICE

This concludes formal consultation on the Jellys Ferry Bridge Replacement project. As provided in 50 CFR §402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

XI. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the California Department of Transportation (Caltrans). Individual copies of this opinion were provided to the Caltrans. This opinion will be posted on the Public Consultation Tracking

System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01, et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the Literature Cited section. The analyses in this opinion and EFH consultation (Enclosure 2) contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, and are consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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Enclosure 2

Magnuson-Stevens Fishery Conservation and Management Act

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS[1]
Jellys Ferry Bridge Replacement Project (Project)

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (U.S.C. 180 *et seq.*), requires that essential fish habitat (EFH) be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NOAA's National Marine Fisheries Service (NMFS) on any activity 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.

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purposes of interpreting the definition of EFH, "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. Freshwater EFH for salmon consists of four major components: spawning and incubation habitat; juvenile rearing habitat; juvenile migration corridors; and adult migration corridors and adult holding habitat (Pacific Fishery Management Council 2003). Important components of EFH for spawning, rearing, and migration include suitable substrate composition; water quality (e.g., DO, nutrients, temperature); water quantity, depth and velocity; channel gradient and stability; food; cover and habitat complexity (e.g., large woody material, pools, channel complexity, aquatic vegetation); space; access and passage; and floodplain and habitat connectivity (Pacific Fishery Management Council 2003). The proposed project site is within the region identified as EFH for Pacific salmon in Amendment 14 of the Pacific Salmon FMPs.

The Pacific Fishery Management Council (PFMC) has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 14 to the Pacific Coast Salmon FMP (PFMC 1999). Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998). Sacramento River winter-run Chinook salmon

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[1]The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) set forth new mandates for NOAA's National Marine Fisheries Service (NMFS) and Federal action agencies to protect important marine and anadromous fish habitat. Federal action agencies which fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding potential adverse effects of their actions on EFH, and respond in writing to NMFS "EFH Conservation Recommendations." The Pacific Fisheries Management Council has identified essential fish habitat (EFH) for the Pacific salmon fishery in Amendment 14 to the Pacific Coast Salmon Fishery Management Plan.

(*Oncorhynchus tshawytscha*), Central Valley (CV) spring-run Chinook salmon (*O. tshawytscha*), and CV fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Pacific Coast Salmon FMP that occur in the Central Valley. CV Fall-run Chinook salmon comprise the largest population of Chinook salmon in the Sacramento River watershed; additionally a smaller CV spring-run Chinook salmon population persists as well. The only existing population of Sacramento River winter-run Chinook salmon is in the Sacramento River watershed as well.

Factors limiting salmon populations in the Sacramento River Watershed include flow conditions affecting juvenile rearing and outmigration, water temperatures and water quality affecting adult immigration, holding, spawning and embryo incubation, and lack of spawning habitat due to sediment transport process being blocked by Keswick Dam, sedimentation affecting embryo incubation, and hybridization between fall-run and spring-run Chinook salmon, affecting genetic integrity.

A. Life History and Habitat Requirements

1. <u>Pacific Salmon</u>

General life history information for CV fall-run Chinook salmon is summarized below. Further detailed information on the other CV Chinook salmon Evolutionarily Significant Units (ESUs) are available in the enclosed biological opinion, the NMFS status review of Chinook salmon from Washington, Idaho, Oregon, and California (Myers *et al.* 1998), and the NMFS proposed rule for listing several ESUs of Chinook salmon (63 FR 11482).

Adult CV fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from July through December and spawn from October through December while adult CV late fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from October to April and spawn from January to April (U.S. Fish and Wildlife Service [USFWS] 1998). Chinook salmon spawning generally occurs in clean loose gravel in swift, relatively shallow riffles, or along the edges of fast runs (NMFS 1997).

Egg incubation occurs from October through March (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and into the San Francisco Bay and its estuarine waters (Kjelson *et al.* 1982). The remaining fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. 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). Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation. These smolts generally spend a very short time in the Delta and estuary before entry into the ocean. Whether entering the Delta or estuary as fry or larger juveniles, CV Chinook salmon depend on passage through the Delta for access to the ocean.

II. PROPOSED ACTION

The purpose of the Jellys Ferry Bridge Replacement Project is to replace the structurally-obsolete and seismically deficient existing bridge structure over the Sacramento River. The project is located on Jellys Ferry Road over the Sacramento River, approximately 9 miles north of Red Bluff and 7.5 miles east of Interstate 5, in northern Tehama County, California. The proposed project consists of three elements; replacement of the existing bridge, realignment of Jellys Ferry Road, and relocation of a portion of the Bureau of Land Management (BLM) recreational facilities.

The proposed bridge replacement project requires the realignment of a portion of Jellys Ferry Road, and temporary and permanent modification of a portion of the adjacent BLM recreational facilities in order to construct the new bridge over the Sacramento River channel. Overflow from the Sacramento River at the Overflow No. 1 location (just north of the existing north abutment) is conveyed through the Sacramento River Bridge while overflow at the Overflow No. 2 location (further to the north of the existing north abutment) would be conveyed through an additional Overflow No. 2 Bridge.

III. EFFECTS OF THE PROPOSED ACTION

The effects of the proposed action on salmonid habitat are described at length in section V. (*Effects of the Action*) of the preceding biological opinion (BO), and generally are expected to apply to Pacific salmon EFH.

Effects to EFH stemming from construction activities that may contribute sediment and increased turbidity will be avoided or minimized by meeting Regional Water Quality Board objectives, Caltrans water pollution specifications, implementing applicable BMPs, staging equipment outside of the riparian corridor, limiting the amount of riparian vegetation removal, and creating a riparian restoration plan at the project site to include the restoration of areas impacted by the project, and will establish a healthy riparian corridor along this reach of the upper Sacramento River.

EFH will be adversely affected by the disturbance of up to 2.09 acres (ac) of riparian vegetation as a result of construction activities. The majority of these impacts are expected to be temporary, as all disturbed areas outside the actual footprint of the new bridge would be restored to preconstruction conditions and any areas of disturbed vegetation will be protected in place where feasible to provide an effective form of erosion and sediment control as well as watershed protection, landscape beautification, dust control, pollution control, noise reduction, and shade. To control invasive species, all landscaping and re-vegetation will consist of Caltrans approved plants or seed mixes from native, locally adapted species. In addition, Caltrans will compensate for the loss of 2.09 ac of riparian vegetation at a 3:1 ratio at an NMFS-approved anadromous fish conservation bank.

These effects to EFH may result in a temporary redistribution of some individuals, primarily migrating and rearing juvenile salmonids, but, due to the temporary nature of these disturbances, the adverse effects that are anticipated to result from the proposed project are not of the type, duration, or magnitude that would be expected to adversely modify EFH to the extent that it could lead to an appreciable reduction in the function and conservation role of the affected habitat. NMFS expects that nearly all of the adverse effects to EFH from this project will be of a short term nature and will not affect any associated Pacific salmon EFH beyond the construction period of the project.

IV. CONCLUSION

Based on our review of the material provided, and the best scientific and commercial information currently available, NMFS has determined that the proposed action would adversely affect EFH for Pacific salmon. However, the proposed action includes adequate measures (described in Enclosure 1 above) to avoid, minimize, or otherwise offset the adverse effects to EFH.

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 BO, NMFS recommends that Terms and Conditions 1-3, as well as the Conservation Recommendations in the preceding BO prepared for the Sacramento River winter-run Chinook salmon ESU, CV spring-run Chinook salmon ESU, CCV steelhead ESU, and North American green sturgeon DPS be adopted as EFH Conservation Recommendations.

Those terms and conditions which require the submittal of reports and status updates can be disregarded for the purposes of this EFH consultation as there is no need to duplicate those submittals.

VI. STATUTORY REQUIREMENTS

Section 305 (b) 4(B) of the MSA requires that the Federal lead agency provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the lead agency for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR 600.920[j]). In the case of a response that is inconsistent with our recommendations, the lead agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreement with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

VII. SUPPLEMENTAL CONSULTATION

Pursuant to 50 CFR 600.920(l), Caltrans must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations.

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