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

AUG 10 2007

In response refer to:
2006/05595

Kevin J. Roukey
Chief, Central California/Nevada Section
U.S. Army Engineer District, Sacramento
1325 J Street
Sacramento, California 95814-2922

Dear Mr. Roukey:

This document transmits NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Enclosure 1) based on our review of eight critical levee erosion repair projects proposed by the California Department of Water Resources (CDWR) in the Sacramento River Flood Control project, and their effects on Federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), and their designated critical habitat in accordance with section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). This biological opinion also includes a section 7(a)(2) analysis of project related effects on the threatened Southern distinct population segment (DPS) of North American green sturgeon (*Acipenser medirostris*).

The proposed levee repairs are pursuant to Governor Schwarzenegger's February 24, 2006, emergency proclamation for California's levee system. The Governor's proclamation ordered the emergency repair of levees to prevent the imminent loss of human property and life. As a result, the U.S. Army Corps of Engineers (Corps) and the CDWR constructed 33 critical levee erosion repair projects during the summer of 2006. Routine levee inspections conducted during the summer of 2006, revealed 24 additional critical levee erosion sites that need immediate repairs to prevent the imminent loss of human property and life. The Corps will construct 14 of the repairs and CDWR will repair the other 10. NMFS analyzed the 14 Corps-led projects in a December 22, 2006, biological opinion. This biological opinion addresses 8 of the CDWR-led levee repairs. The remaining two CDWR repairs are in the early planning stages and will be addressed in a separate consultation.

Your request for formal consultation was received on November 6, 2006. Because of the imminent threat to human life and property, the Corps and CDWR proposed an Action Plan and Alternative Consultation Procedure to expedite the design, environmental review, and construction of these sites while avoiding an irreversible or irretrievable commitment of resources, pursuant to section 7(d) of the ESA. The Action Plan and Alternative Consultation Procedures were developed to provide NMFS with the information necessary to complete the ESA section 7 consultation, and Magnuson-Stevens Conservation and Management Act (MSA)

Essential Fish Habitat (EFH) consultation, concurrent with the levee repair actions. Therefore, NMFS first initiated formal consultation on November 7, 2006. On February 23, 2007, NMFS requested additional information and notified the Corps that the consultation would be initiated upon receipt this information. The additional information was received on March 16, 2007, and NMFS re-initiated consultation on March 28, 2007.

This biological opinion is based on information provided in the March 16, 2007, revised final biological assessment for CDWR-led sites. The biological opinion also is based on design drawings for all projects, information provided at Interagency Flood Management Collaborative Program meetings, and site visits and discussions held with representatives of CDWR, NMFS, U.S. Fish and Wildlife Service (USFWS), the California Department of Fish and Game (CDFG), the Corps, the URS Corporation, and Ayres and Associates. A complete administrative record of this consultation is on file at the NMFS Sacramento Field Office.

Based on the best available scientific and commercial information, the biological opinion concludes that these projects are not likely to jeopardize the above species or adversely modify designated critical habitat. NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to minimize incidental take associated with project actions. The listing of the Southern DPS of North American green sturgeon became effective on July 7, 2006, and some or all of the ESA section 9(a)(1) prohibitions against take will become effective upon the future issuance of protective regulations under section 4(d). Because there are no section 9(a)(1) prohibitions at this time, the incidental take statement, as it pertains to the Southern DPS of North American green sturgeon does not become effective until the issuance of a final 4(d) regulation, as appropriate.

Also enclosed are EFH Conservation Recommendations for Pacific salmon as required by the MSA as amended (16 U.S.C. 1801 *et seq.;* Enclosure 2). This document concludes that the eight CDWR-led critical levee erosion repair projects will adversely affect the EFH of Pacific Salmon in the action area and adopts certain of the terms and conditions of the incidental take statement and the ESA Conservation Recommendations of the biological opinion as the EFH Conservation Recommendations.

Section 305(b)4(B) of the MSA requires that the Corps 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 Corps 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 Corps 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.

If you have any questions regarding this correspondence please contact Mr. Howard Brown in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814. Mr. Brown may be reached by telephone at (916) 930-3608 or by Fax at (916) 930-3629.

Sincerely,

Rodney R McInnis

Rodney R. McInnis
Regional Administrator

Enclosures (2)

cc: Copy to file: 151422SWR2006SA00659
NMFS-PRD, Long Beach, CA
Patti Johnson and Frank Piccola, COE, 1325 J St. Sacramento, CA 95814
Mike Inamine, Deborah Condon, and Paul Sandhu, CDWR, 1416 9th Street, P.O. Box 942836, Sacramento, CA 94236-0001
EJ Kofford, URS Corporation, Crown Corporate Center, 2870 Gateway Oaks, Suite 150, Sacramento, CA 95833
General Manager, The Reclamation Board, 1416 9th St. Sacramento, CA 95833
Susan Moore, Doug Weinrich, and Kim Turner, USFWS, 2800 Cottage Way, #W-2605, Sacramento, CA 95825
Gary Hobgood, CDFG, 1701 Nimbus Road, Suite A, Rancho Cordova, CA 95670

Enclosure 1

BIOLOGICAL OPINION

ACTION AGENCY:	United States Army Corps of Engineers Sacramento District
ACTIVITY:	Eight California Department of Water Resources Critical Levee Erosion Repairs
CONSULTATION CONDUCTED BY:	NOAA's National Marine Fisheries Service, Southwest Region
FILE NUMBER:	151422SWR2005SA00659
DATE ISSUED:	AUG 10 2007

I. CONSULTATION HISTORY

On February 24, 2006, Governor Arnold Schwarzenegger issued an emergency proclamation for California's levee system. The proclamation focused on the imminent threat of 24 critical levee erosion sites located in Colusa, Sacramento, Solano, Sutter, Yolo, and Yuba counties.

On June 21, 2006, NMFS issued a biological opinion for the construction of 29 critical levee repair projects.

On September 15, 2006, the Corps requested an amendment to the June 21, 2006, biological opinion to construct 4 additional critical sites.

On October 18, 2006, NMFS issued an amended biological opinion in response to the Corp's September 15, request.

On November 2, and 3, 2006, the URS corporation led NMFS, USFWS, and CDFG on site visits to the proposed project area and provided all available project information, including preliminary project cross sections. NMFS, USFWS, and CDFG provided preliminary recommendations for design considerations and integrated conservation measures to minimize impacts to protected natural resources.

On November 6, 2006, The Corps requested section 7 consultation for eight CDWR-led critical levee erosion repair projects. This request included an Action Plan and Alternative Consultation Procedure to expedite the design, environmental review, and construction of these sites while avoiding an irreversible or irretrievable commitment of resources, pursuant to section 7(d) of the ESA.

On November 7, 2006, NMFS initiated formal section 7 consultation for eight CDWR-led critical levee erosion repair projects. Consultation was initiated at this time due to the imminent threat to human life and property. The Corps and CDWR proposed an Action Plan and Alternative Consultation Procedure to expedite the design, environmental review, and construction of these sites while avoiding an irreversible or irretrievable commitment of resources, pursuant to section 7(d) of the ESA. The Action Plan and Alternative Consultation Procedures were developed to provide NMFS with the information necessary to complete the ESA section 7 consultation, and Magnuson-Stevens Conservation and Management Act (MSA) Essential Fish Habitat (EFH) consultation, concurrent with the levee repair actions.

On November 9, 2006, the Corps held a technical team meeting to discuss issues from field reviews.

On November 16, 2006, the Corps held a technical team meeting to provide draft final project designs.

On December 4, the URS Corporation provided NMFS with a draft biological assessment (BA) for the CDWR 2006 critical levee repair projects.

On December 12, 2006, NMFS provided CDWR and the URS Corporation with comments on the draft BA.

On January 2, 2007, the URS Corporation provided NMFS with a final biological assessment.

On January 23, 2007, the URS Corporation held a meeting with NMFS, the USFWS, and CDFG to discuss Phase 2 project designs. The purpose of the meeting was to develop Phase 2 design approaches that avoid, minimize, or compensate for project-related impacts. Habitat modeling conducted to date indicated the need for additional conservation measures to compensate for potential project-related effects to aquatic species of special concern. As a result, the URS Corporation, and CDWR demonstrated an interest to improve the modeled habitat conditions, and proposed another revision to the Action Plan and Alternative Consultation Procedures. According to the revised schedule, CDWR planned to provide NMFS with final project description on February 2, 2007, and NMFS expected to issue a draft biological opinion on February 16, 2007, and a final on February 28, 2007.

On February 23, 2007, NMFS had not received an updated project description, and issued a letter requesting additional information. In this letter, NMFS identified the specific information needs that would be required to fully analyze the effects of the proposed action.

On March 16, 2007, CDWR and the URS Corporation provided NMFS with a revised project description for Phase 2 construction actions at 6 sites, and revised modeling information to reflect species responses to the proposed design changes.

On March 28, 2007, NMFS notified CDWR that it had received the information necessary to fully analyze the effects of the proposed action, and would complete the biological opinion.

On April 6, 2007, CDWR and NMFS met to discuss the draft terms and conditions for the biological opinion.

This biological opinion is based on information provided in the March 16, 2007, revised BA; discussions held with CDWR, the URS Corporation, the Corps, USFWS, and CDFG; field reviews of the erosion sites; Standard Assessment Method (SAM) analyses; and engineering designs. A complete administrative record of this consultation is on file at the NMFS Sacramento Area Office.

II. DESCRIPTION OF THE PROPOSED ACTION

During February 2006, as a result of imminent threat of catastrophic levee failure, Governor Arnold Schwarzenegger declared a state of emergency for the California Levee system and ordered the immediate repair of critical levee erosion sites in the Sacramento River Flood Control Project (SRFCP), in Colusa, Sacramento, Solano, Sutter, Yolo, and Yuba counties to prevent the imminent loss of human life and property. The SRFCP consists of approximately 980 miles of levees, plus overflow weirs, pumping plants, and bypass channels that protect urban and agricultural lands in the Sacramento Valley and the Sacramento-San Joaquin River Delta (Delta).

The U.S. Army Corps of Engineers (Corps) proposes to permit CDWR to take all necessary actions to stabilize eight critical levee erosion sites along the Sacramento River, Sutter Slough, and the Bear River. The erosion sites are located are designated by distance in miles from the mouth of the water body, and either the right (R) or the left (L) bank. The convention for right and left bank designation is "as facing downstream;" therefore RM 70.7L is located 70.7 miles from the mouth, on the left bank as one faces downstream. Projects are located on the Sacramento River at RMs 70.7R, 71.7 R, 73.0R, 99.5R, and 182.0R; along Sutter Slough at RMs 24.8L, 25.4R; and the Bear River at RM 1.2L. Project locations are shown on Figure 1, and Appendix A, Figure 1.

The purpose of the action is to restore eroded levees so that they can reliably protect life and property while protecting and mitigating adverse effects to environmental resources. The proposed action will re-establish levee profiles; halt erosion; minimize loss of riparian vegetation; prevent the eventual loss of nearshore aquatic habitat that likely would occur without the action; replace lost and damaged vegetation and instream woody material (IWM) onsite, and provide additional compensation for project-related effects, if needed.

All sites were selected based on a comprehensive erosion site evaluation prepared by Ayres and Associates (2006) for the Corps. The evaluation was made based on field surveys and quantitative ranking of characteristics, such as bank slope, bench width, length and location of erosion, radius of curvature, bank stability, dynamic geomorphology, vegetation cover, tree hazards, soil type, water velocity, wave action, economic factors, human use, seepage potential, and tidal fluctuation. Although the engineering and environmental solutions for each of these sites will differ somewhat, the types of erosion sites, the locations of the sites, the environmental resources of the sites, and the types of repair and restoration methods will be similar.

A. Project Description

The proposed action is to place rock revetment along the waterside slope of each erosion site, and replace or install environmental features to replace or enhance habitat for several Federally listed threatened or endangered fish species. Project locations are shown on Figure 1, and Appendix A, Figure 1.

The bank protection measures generally would consist of: (1) reinforcement of the river bank with rock riprap; (2) placement of rock on top of the toe riprap to create a bench that slopes at a 10:1 ratio to the water; (3) placement of soil on the bench and along the upper slope; (4) anchoring IWM along the waterside edge of the bench, on the bench surface, and on the bank slope to enhance fish habitat; and (5) planting the bench and the upper slope with vegetation to increase bank protection and establish riparian habitat.

The bank protection projects will repair bank and levee erosion and replace or install riparian and shaded riverine aquatic (SRA) habitat. Generally, this will be accomplished by incorporating rock benches, that serve as buffers against extreme toe scour and shear stress while providing space for planting riparian vegetation and creating a platform to support aquatic habitat features. This design, which has been employed along the lower Sacramento and American Rivers, and the recently-constructed critical levee erosion repairs, will protect existing SRA habitat and create elements of natural SRA habitat that otherwise would be lost as a result of project construction activities and continued erosion.

The bench design functions to repair existing scour, to provide a buffer against extreme toe scour, to develop a surface and soil for plantings, and to provide shallow-water habitat for juvenile fish rearing and refugia. Benches will be constructed that slope toward the water, generally between the average spring and summer water surface elevation (WSEL). Benches will include IWM, a variable shoreline, and riparian vegetation that will mimic the ecosystem functions of natural floodplain habitat, except that it will not contain natural erodable substrate.

Benches generally are designed to be seasonally inundated by average winter and spring flows. During normal water years, benches are likely to be inundated from January through March. During high flow years, benches may be inundated as early as November to as late as July. During low flow years, benches may not be inundated at all. Benches typically will not be inundated during the summer and fall months, and will not be inundated under any flow scenario from the beginning of July through mid-November.

The roughness factor associated with grown-out plantings will reduce both flow velocities and shear stress against the bank. The bench will provide a platform to anchor added IWM structures for fish habitat, and will vary in height to provide seasonally flooded areas and velocity refugia at a variety of flow conditions.

Living and dead IWM would be placed along the sites to create diverse fish habitat features and refugia. Downstream from Sacramento RM 30, IWM will only be placed to the extent that it fully replaces what existed prior to construction. Upstream from Sacramento RM 30, IWM will be placed along the sites to ensure that there is functioning IWM along 40 to 80 percent of the project shoreline length at average summer and spring shoreline elevations. Individual pieces of IWM will be approximately 15 feet long, and 10 feet wide, and will retain limbs and root wads, to the extent feasible, for maximum habitat value. Willow fascine bundles will be installed with IWM placed at the average summer WSEL.

Standing and fallen trees at the project sites would be protected in place to the maximum extent possible, and all disturbed areas would be protected with erosion control measures such as hydro seeding and plug plantings. Where necessary, clearing of smaller vegetation from the levee slope would be accomplished using small equipment and/or hand tools. Native trees over 4-inches diameter at breast height (dbh) will not be removed, except where it is infeasible to retain them. Trees greater than 4-inches dbh will be protected by placing erosion control fabric or lumber around the trunk. This design is intended to let the lumber decay and provide room for growth, thereby delaying or preventing the girdling of the trees by rock. Some pruning of trees may be required during the construction phase. If IWM is removed to install bank protection features, it will be anchored back in place and incorporated into supplemental IWM installation. Exotic species may be removed, and the area replanted with native species appropriate for the location and elevation on an acre-for-acre basis.

Riparian trees and shrubs would be planted along the project sites starting at elevations from 1 foot to 4 feet above mean August WSEL. Vegetation generally will be planted on three-to twenty-foot centers, in three to four zones. Planting plans vary by sight and location of project features in relation to the size and slope of the levee. A typical planting schedule is shown in Appendix A, Figure 2. Large container plants will be placed in large rock voids. Live pole cuttings and container plantings of appropriate native species will be included in the palette for plantings at each site. All plant propagation materials will be collected from areas adjacent to the project site or from riparian habitats in the Sacramento Valley at sites within a 50-mile radius of the project site. A nursery experienced with native plant collection and propagation will grow container stock. Plants will be collected in a way that results in minimal impacts on the source plants and surrounding habitat.

Construction is schedule to occur in two phases. Phase 1 will place rock revetment at the sites, to reduce the potential for the imminent failure of the levee system. Phase 2 will place additional rock revetment and will install project conservation measures designed to minimize project-related impacts to Federally listed species.

Construction equipment and materials will access the sites from the Sacramento River and from levee roads. Barges have limited access above RM 70 because of shallow water. For sites downstream from or near Sacramento RM 70, including Sutter Slough RMs 24.8L, 25.4R, barges can be used to access the site. For sites upstream of RM 70, including Bear RM 1.2L, construction will be from the landside using levee tops, benches, or adjacent agricultural areas for staging and laydown areas. Construction materials, including rock revetment and fill material, will be hauled from a commercial or previously permitted site.

At sites accessible by barge, the contractor will construct the levee repair sites primarily from cranes mounted on barges. The contractor will first place rock revetment from the rock toe up to an elevation above the August WSEL. Then the contractor will begin placing rock fill into the void space to above the water line. Contractors will use earthfill to fill in the area from the WSEL to +4 feet. Existing IWM will be left in place where feasible and covered by rock revetment. Once construction of the bench is completed, the contractor will begin placing fill materials and installing the IWM and plantings on the sites.

Incorporation of environmental features that restore riparian and SRA habitat is a key aspect of the proposed action. As a result, off-site compensation and/or mitigation for impacts on these types of habitats from project construction activities will be implemented only to the extent that the project design does not fully offset these impacts.

Overall, the project would reinforce approximately 11,540 linear feet (lf) of shoreline. The area above the mean summer water level will be covered with soil and planted with riparian vegetation. Several thousand lf of IWM will be placed at summer and spring water elevations. Exact amounts are subject to minor change. If project lengths increase, the application of conservation measures will be extended accordingly. Detailed project descriptions of all 8 sites are listed below:

1. <u>Project Activities at Sacramento RM 70.7R</u>

The bank protection measures at Sacramento RM 70.7R will consist of:

- Reinforcement of the bank slope and toe with a total of 640 linear feet of rock revetment approximately 10 feet thick between the elevations of minus 5 feet and 30 feet National Geodetic Vertical Datum (NGVD) over a total area of 65,700 square feet (1.51 acres). NGVD are geodetic reference points that are used to translate landmark positions based on their elevation location. NGVD reference points may vary by region and do not necessarily indicate an elevation in relation to sea level.
- Placement of a 1-foot-thick layer of non-engineered fill varying from 10 feet to 13 feet NGVD on top of the rock revetment and covering an area of 5,500 square feet (0.13 acres).
- Placement of approximately 400 linear feet (sum of the linear extent of IWM that will be placed at the mean February WSEL and the mean August WSEL) of IWM for aquatic habitat and bank stabilization.

- Planting of vegetation starting at an elevation of 9.5 feet to 38 feet NGVD and extending to the top of the bank to provide bank stabilization and riparian habitat.

Approximately 26,500 cubic yards of rock revetment will be placed along the embankment and will extend up to 40 feet out into the river from the newly constructed riverbank at the mean summer water level. Approximately 30,000 square feet (0.69 acres) of this rock-covered area will be below the mean summer water line. Approximately 200 cubic yards of fill (a mixture of sand and silt suitable for plant growth) will be placed on top of the rock revetment and may be covered with a biodegradable coir fabric to prevent soil loss during the first high water (before vegetation has established). Upon completion, the bank slopes at the site will be 3H:1V (measured from the toe of the bank to an elevation of 30 feet NGVD) with a bench at 10 feet to 13 feet NGVD (sloping area total 56,000 square feet or 1.29 acres).

The landscape plan will include planting fascine bundles as close as possible to the mean August WSEL to provide instream vegetation and shoreline shading from 1 year to 5 years following repairs. Riparian trees and shrubs will be planted along the site starting at 9.5 feet to 38 feet NGVD and extending to the top of the bank.

IWM will be embedded into or chained onto the levee slope to provide bank protection and aquatic habitat during winter and spring flows. The IWM will be approximately 15 feet long and 10 feet wide, and will retain limbs and root wad (to the extent feasible) for maximum habitat value. IWM will be embedded at an average spacing of one unit per 24 linear feet of streambank (i.e., IWM will occupy approximately 40 percent of the linear extent of bank at both the mean August WSEL and the mean February WSEL). Occasionally IWM will be clustered in tight groups of approximately three individual units. Fifty-five units will be imbedded into the slope approximately 2 feet below August mean WSEL. Fifty-five units will be anchored on the riparian bench. One hundred ten units will be embedded into the slope just below the February mean WSEL. The IWM will be positioned at a 20-degree to 25-degree angle to the bank pointing downstream, or as directed by the engineer.

2. Project Activities at Sacramento RM 71.7R

The bank protection measures at Sacramento RM 71.7R will consist of:

- Reinforcement of the bank slope and toe with a total of 1,000 linear feet of rock revetment approximately 10 feet thick between the elevations of minus 15 feet and 30 feet NGVD over a total area of 107,500 square feet (2.47 acre);
- Placement of a 1-foot-thick layer of non-engineered fill varying from 10 feet to 13 feet NGVD on top of the rock revetment and covering an area of 8,000 square feet (0.18 acre);
- Placement of approximately 1,200 linear feet (sum of the linear extent of IWM that will be placed at the mean February WSEL and the mean August WSEL) of IWM for aquatic habitat and bank stabilization; and

- Planting of vegetation starting at an elevation of 9.5 feet to 38 feet NGVD and extending to the top of the bank to provide bank stabilization and riparian habitat.

Approximately 28,000 cubic yards of rock revetment will be placed along the embankment and will extend up to 50 feet out into the river from the newly constructed riverbank at mean summer water level. Approximately 59,000 square feet (1.35 acres) of this rock-covered area will be below the mean summer water line. Approximately 220 cubic yards of fill (a mixture of sand and silt suitable for plant growth) will be placed on top of the rock revetment and may be covered with a biodegradable coir fabric to prevent soil loss during the first high water (before vegetation has established). Upon completion, the bank slopes at the two work sites will be 3H:1V (measured from the toe of the bank to an elevation of 30 NGVD) with a bench at 10 feet to 13 feet NGVD (sloping area total 89,000 square feet or 2.04 acre).

Riparian trees and shrubs will be planted along the site starting at 9.5 feet to 38 feet NGVD and extending to the top of the bank. Large potted plants will be installed in larger rock voids. Standing trees >4 inches dbh will be protected in place, and all disturbed areas will be restored with erosion control measures. The landscape plan will include planting vegetation as close as possible to the mean August WSEL to provide instream vegetation and shoreline shading from 1 year to 5 years following repairs.

IWM will be embedded into or chained onto the levee slope to provide bank protection and aquatic habitat during winter and spring flows. The IWM will be approximately 15 feet long and 10 feet wide, and will retain limbs and root wad (to the extent feasible) for maximum habitat value. IWM will be embedded at an average spacing of one unit per 12 linear feet of streambank (*i.e.*, IWM will occupy approximately 80 percent of the linear extent of bank at both the mean August WSEL and the mean February WSEL). Occasionally IWM will be clustered in tight groups of approximately three individual units. Forty-five units will be imbedded into the slope approximately 2 feet below August mean WSEL. Forty-five units will be anchored on the riparian bench. Ninety units will be embedded into the slope just below the February mean WSEL. The IWM will be positioned at a 20-degree to 25-degree angle to the bank pointing downstream, or as directed by the engineer.

3. <u>Project Activities at Sacramento RM 73.0R</u>

The bank protection measures at Sacramento 73.0R will consist of:

- Reinforcement of the bank toe with a total of 500 linear feet of rock revetment approximately 10 feet thick between the elevations of minus 20 feet and 30 feet NGVD over a total area of 44,000 square feet (1.01 acres);
- Placement of a 1-foot-thick layer of non-engineered fill varying from 10 feet to 13 feet NGVD on top of the rock revetment and covering an area of 3,000 square feet (0.07 acre);

- Placement of approximately 540 linear feet (sum of the linear extent of IWM that will be placed at the mean February WSEL and the mean August WSEL) of IWM for aquatic habitat and bank stabilization; and
- Planting of vegetation starting at an elevation of 9.5 feet to 38 feet NGVD and extending to the top of the bank to provide bank stabilization and riparian habitat.

Approximately 14,000 cubic yards of rock revetment will be placed along the embankment and will extend up to 60 feet out into the river from the newly constructed riverbank at mean summer water level. Approximately 23,000 square feet (0.53 acres) of this rock-covered area will be below the mean summer water line. Approximately 110 cubic yards of fill (a mixture of sand and silt suitable for plant growth) will be placed on top of the rock revetment and may be covered with a biodegradable coir fabric to prevent soil loss during the first high water (before vegetation has established). Upon completion, the bank slopes at the site will be 3H:1V (measured from the toe of the bank to an elevation of 30 feet NGVD) with a bench at 10 feet to 13 feet NGVD (sloping area total 38,000 square feet or 0.87 acres).

The landscape plan will include planting vegetation as close as possible to the mean August WSEL to provide instream vegetation and shoreline shading from 1 year to 5 years following repairs. Riparian trees and shrubs will be planted along the site starting at 9.5 feet to 38 feet NGVD and extending to the top of the bank. Large potted plants will be installed in larger rock voids. Standing trees ≥4 inches dbh will be protected in place, and all disturbed areas will be restored with erosion control measures.

IWM will be embedded into the levee slope to provide bank protection and aquatic habitat during winter and spring flows. The IWM will be approximately 15 feet long and 10 feet wide, and will retain limbs and root wad (to the extent feasible) for maximum habitat value. IWM will be embedded at an average spacing of one unit per 10 linear feet of streambank (i.e., IWM will occupy approximately 80 percent of the linear extent of bank at both the mean August WSEL and the mean February WSEL). Occasionally IWM will be clustered in tight groups of approximately three individual units. Twenty-five units will be imbedded into the slope approximately 2 feet below August mean WSEL. Twenty-five units will be anchored on the riparian bench. Fifty units will be embedded into the slope just below the February mean WSEL. The IWM will be positioned at a 20-degree to 25-degree angle to the bank pointing downstream, or as directed by the engineer.

4. <u>Project Activities at Sacramento RM 99.5R</u>

The bank protection measures at Sacramento RM 99.5R will consist of:

- Reinforcement of the bank toe with a total of 1,000 linear feet of rock revetment approximately 18 feet thick between the elevations of minus 22 feet and 38 feet NGVD over a total area of 217,000 square feet (4.98 acres);

- Placement of approximately 800 linear feet (sum of the linear extent of IWM that will be placed at the mean February WSEL and the mean August WSEL) of IWM for aquatic habitat and bank stabilization; and
- Planting of vegetation starting at an elevation of 14 feet to 40 feet NGVD and extending to the top of the bank to provide bank stabilization and riparian habitat.

Approximately 27,219 cubic yards of rock revetment will be placed along the embankment and will extend up to 67 feet out into the river from the newly constructed riverbank at mean summer water level. Approximately 65,338 square feet (1.58 acres) of this rock-covered area will be below the mean summer water line. Approximately 1,945 cubic yards of fill (a mixture of sand and silt suitable for plant growth) will be placed on top of the rock revetment and may be covered with a biodegradable coir fabric to prevent soil loss during the first high water (before vegetation has established). Upon completion, the bank slopes at the site will be 1.5H:1V (measured from the toe of the bank to an elevation of 10 NGVD) with a bench sloping from 8 feet to 10 feet NGVD (sloping area total 15,500 square feet or 0.36 acres).

Riparian trees and shrubs will be planted along the site starting at 14 feet to 40 feet NGVD and extending to the top of the bank. Large potted plants will be installed in larger rock voids. Standing trees ≥4 inches dbh will be protected in place, and all disturbed areas will be restored with erosion control measures.

IWM will be embedded into the levee slope to provide bank protection and aquatic habitat during winter and spring flows. The IWM will be approximately 15 feet long and 10 feet wide, and will retain limbs and root wad (to the extent feasible) for maximum habitat value. IWM will be embedded at an average spacing of one unit per 10 linear feet of streambank (i.e., IWM will occupy approximately 40 percent of the linear extent of bank at both the mean August WSEL and the mean February WSEL). Occasionally IWM will be clustered in tight groups of approximately three individual units. Seventy-eight units will be imbedded into the slope approximately 2 feet below August mean WSEL. Seventy-eight units will be anchored on the riparian bench. One hundred fifty-five units will be embedded into the slope just below the February mean WSEL. The IWM will be positioned at a 20-degree to 25-degree angle to the bank pointing downstream, or as directed by the engineer.

5. <u>Project Activities at Sacramento RM 182.0R</u>

The bank protection measures at Sacramento RM 182.0R will consist of:

- Reinforcement of the bank toe with a total of 4,450 linear feet of rock revetment 5-10 feet thick between the elevations of 72 feet and 109 feet NGVD for the northern section and 79 to 107 feet for the southern section, over a total area of 230,000 square feet (5.1 acre);
- Placement of approximately 3,640 linear feet (sum of the linear extent of IWM that will be placed at the mean February WSEL and the mean August WSEL) of IWM for aquatic habitat and bank stabilization; and

- Planting of vegetation starting at an elevation of 94 feet NGVD and extending to the top of the bank to provide bank stabilization and riparian habitat.

Approximately 100,000 cubic yards of rock revetment will be placed along the embankment and will extend up to 29 feet to 40 feet out into the river from the newly constructed riverbank at mean summer water level. Approximately 139,100 square feet (3.2 acre) of this rock-covered area will be below the mean summer water line. Approximately 11,000 cubic yards of fill (a mixture of sand and silt suitable for plant growth) will be placed on top of the rock revetment and may be covered with a biodegradable coir fabric to prevent soil loss during the first high water (before vegetation has established). Upon completion, the bank slopes at the sites will be 1.5H:1V (measured from the toe of the bank to an elevation of 114 NGVD) with a bench sloping from 2 percent (sloping area total 49,500 square feet or 1.14 acres).

Riparian trees and shrubs will be planted along the site starting at 94 feet to 120 feet NGVD and extending to the top of the bank. Large potted plants will be installed in larger rock voids. Standing trees ≥4 inches dbh will be protected in place, and all disturbed areas will be restored with erosion control measures.

IWM will be embedded into the levee slope to provide bank protection and aquatic habitat during winter and spring flows. The IWM will be approximately 15 feet long and 10 feet wide, and will retain limbs and root wad (to the extent feasible) for maximum habitat value. IWM will occupy approximately 40 percent of the linear extent of bank at both the mean August WSEL and the mean February WSEL. One hundred eighty six units will be embedded into the slope approximately 6 inches below August mean WSEL. One hundred eleven units will be anchored at the February WSEL. The lower level IWM will be positioned at a 20-degree angle to the bank pointing downstream, or as directed by the engineer. The upper level will be parallel to the bank, or as directed by the engineer.

6. Project Activities at Sutter Slough RM 24.8L

The bank protection measures at Sutter Slough RM 24.8L will consist of:

- Reinforcement of the bank toe with a total of 1,500 linear feet of rock revetment approximately 4 feet thick between the elevations of minus 18 feet and 17 feet NGVD over a total area of 140,000 square feet (3.21 acre);
- Placement of a 1-foot-thick layer of non-engineered fill varying from 5 feet to 17 feet NGVD on top of the rock revetment and covering an area of 70,000 square feet (1.61 acres);
- Placement of approximately 1,300 linear feet (sum of the linear extent of willow fascine bundles that will be placed at the mean February WSEL and the mean August WSEL) of willow fascine bundles for aquatic habitat and bank stabilization; and
- Planting of vegetation starting at an elevation of and extending to the top of the bank to provide bank stabilization and riparian habitat.

Approximately 27,000 cubic yards of rock revetment will be placed along the embankment and will extend up to 45 feet out into the river from the newly constructed riverbank at mean summer water level. Approximately 63,000 square feet (1.45 acres) of this rock-covered area will be below the mean summer water line. Approximately 2,600 cubic yards of fill (a mixture of sand and silt suitable for plant growth) will be placed on top of the rock revetment and may be covered with a biodegradable coir fabric to prevent soil loss during the first high water (before vegetation has established). Upon completion, the bank slopes at the site will be 3H:1V (measured from the toe of the bank to an elevation of 10 NGVD) with a level bench at 6 feet NGVD (sloping area total 117,000 square feet or 2.69 acres).

Several measures will be incorporated into repair designs to increase the quality of Delta smelt habitat. The mean elevation of the rock berm on the waterside of the riparian bench will be set at approximately 1 foot above the mean August WSEL. Elevation undulations, in approximately 300-foot long wavelengths, will occur along the entire length of the riparian bench. The elevational range of the undulations will be from 1 foot above the mean August WSEL to 4 feet above the mean August WSEL. The landscape plan will include planting vegetation as close as possible to the mean August WSEL to provide instream vegetation and shoreline shading from 1 year to 5 years following repairs. Suitable plant species could include bulrush, sedge, or rush planted in 5 inch to 6 inch diameter peat pots spaced 3 feet apart and installed in the interstitial spaces within the rock slope protection.

Riparian trees and shrubs will be planted along the site starting at 5 feet to 17 feet NGVD and extending to the top of the bank. Large potted plants will be installed in larger rock voids. Standing trees ≥4 inches dbh will be protected in place, and all disturbed areas will be restored with erosion control measures. Willow fascine bundles will be embedded into the levee slope to provide bank protection and aquatic habitat during winter and spring flows. The bundles will be equally spaced along both the mean February WSEL and the mean August WSEL (or as close to the waterline as practical), and arranged to provide for maximum habitat value. The bundles will be embedded into the levee slope such that the cut ends are in contact with the underlying soil or bedding rock. Occasionally, bundles will be clustered in tight groups consisting of many units. Units will be imbedded into the slope approximately 2 feet below August mean WSEL, and just below the February mean WSEL. The bundles will be positioned at a 20-degree to 25-degree angle to the bank, or as directed by the engineer.

7. Project Activities at Sutter Slough RM 25.4R

The bank protection measures at Sutter Slough RM 25.4R will consist of:

- Reinforcement of the bank toe with a total of 1,100 linear feet of rock revetment approximately 5 feet thick between the elevations of minus 16 feet and 17 feet NGVD over a total area of 102,000 square feet (2.57 acres);
- Placement of a 1-foot-thick layer of non-engineered fill varying from 5 feet to 18 feet NGVD on top of the rock revetment and covering an area of 50,000 square feet (1.15 acres);

- Placement of approximately 950 linear feet (sum of the linear extent of willow fascine bundles that will be placed at the mean February WSEL and the mean August WSEL) of willow fascine bundles for aquatic habitat and bank stabilization; and
- Planting of vegetation starting at an elevation of 5 feet to 17 feet NGVD and extending to the top of the bank to provide bank stabilization and riparian habitat.

Approximately 27,000 cubic yards of rock revetment will be placed along the embankment and will extend up to 45 feet out into the river from the newly constructed riverbank at mean summer water level. Approximately 45,000 square feet (1.03 acre) of this rock-covered area will be below the mean summer water line. Approximately 2,000 cubic yards of fill (a mixture of sand and silt suitable for plant growth) will be placed on top of the rock revetment and may be covered with a biodegradable coir fabric to prevent soil loss during the first high water (before vegetation has established). Upon completion, the bank slopes at the site will be 3H:1V (measured from the toe of the bank to an elevation of 17 NGVD) with a level bench at 6 feet NGVD (sloping area total 99,000 square feet or 2.27 acres).

Several measures will be incorporated into repair designs to increase the quality of Delta smelt habitat. The mean elevation of the rock berm on the waterside of the riparian bench will be set at approximately 1 foot above the mean August WSEL. Elevation undulations, in approximately 300-foot long wavelengths, will occur along the entire length of the riparian bench. The elevational range of the undulations will be from 1 foot above the mean August WSEL to 4 feet above the mean August WSEL. The landscape plan will include planting vegetation as close as possible to the mean August WSEL to provide instream vegetation and shoreline shading from 1 year to 5 years following repairs. Suitable plant species could include bulrush, sedge, or rush planted in 5 inch to 6 inch diameter peat pots spaced 3 feet apart and installed in the interstitial spaces within the rock.

Riparian trees and shrubs will be planted along the site starting at 5 feet to 17 feet NGVD and extending to the top of the bank. Large potted plants will be installed in larger rock voids. Standing trees ≥4 inches dbh will be protected in place, and all disturbed areas will be restored with erosion control measures.

Fascine bundles will be embedded into the levee slope to provide bank protection and aquatic habitat during winter and spring flows. Fascine bundles will be equally spaced along both the mean February WSEL and the mean August WSEL (or as close to the waterline as practical), and arranged to provide for maximum habitat value. The bundles will be embedded into the levee slope such that the cut ends are in contact with the underlying soil or bedding rock. Occasionally, bundles will be clustered in tight groups consisting of many units. Units will be imbedded into the slope approximately 2 feet below August mean WSEL, and just below the February mean WSEL. The bundles will be positioned at a 20-degree to 25-degree angle to the bank, or as directed by the engineer.

8. Project Activities at Bear RM 1.2L

The bank protection measures at Bear RM 1.2L will consist of:

- Reinforcement of the bank toe with a total of approximately 1,250 linear feet of rock revetment approximately 5 feet thick between the elevations of 20 feet and 62 feet NGVD, over a total area of 159,000 square feet (3.65 acres);
- Placement of approximately 1,000 linear feet (sum of the linear extent of IWM that will be placed at the mean February WSEL and the mean August WSEL) of IWM for aquatic habitat and bank stabilization; and
- Planting of vegetation starting at an elevation of 26 feet to 33 feet NGVD and extending to the top of the bank to provide bank stabilization and riparian habitat.

Approximately 51,038 cubic yards of rock revetment will be placed along the embankment. The rock revetment will extend up to 30 feet out into the river from the newly constructed riverbank at mean summer water level. Approximately 15,300 square feet (0.35 acres) of this rock-covered area will be below the mean summer water line. Upon completion, the bank slopes on the waterside of the levee will be 1.5H:1V (1.5 horizontal to 1 vertical, measured from the toe of the launch rock to the existing bench around an elevation of 45 feet NGVD) and transition to 2H:1V above the existing bench to the levee crest. The bank slope on the landside of the levee will be 3H:1V from the existing ground elevation (approximately 31 feet NGVD) to the existing levee crest (approximately 62 feet NGVD).

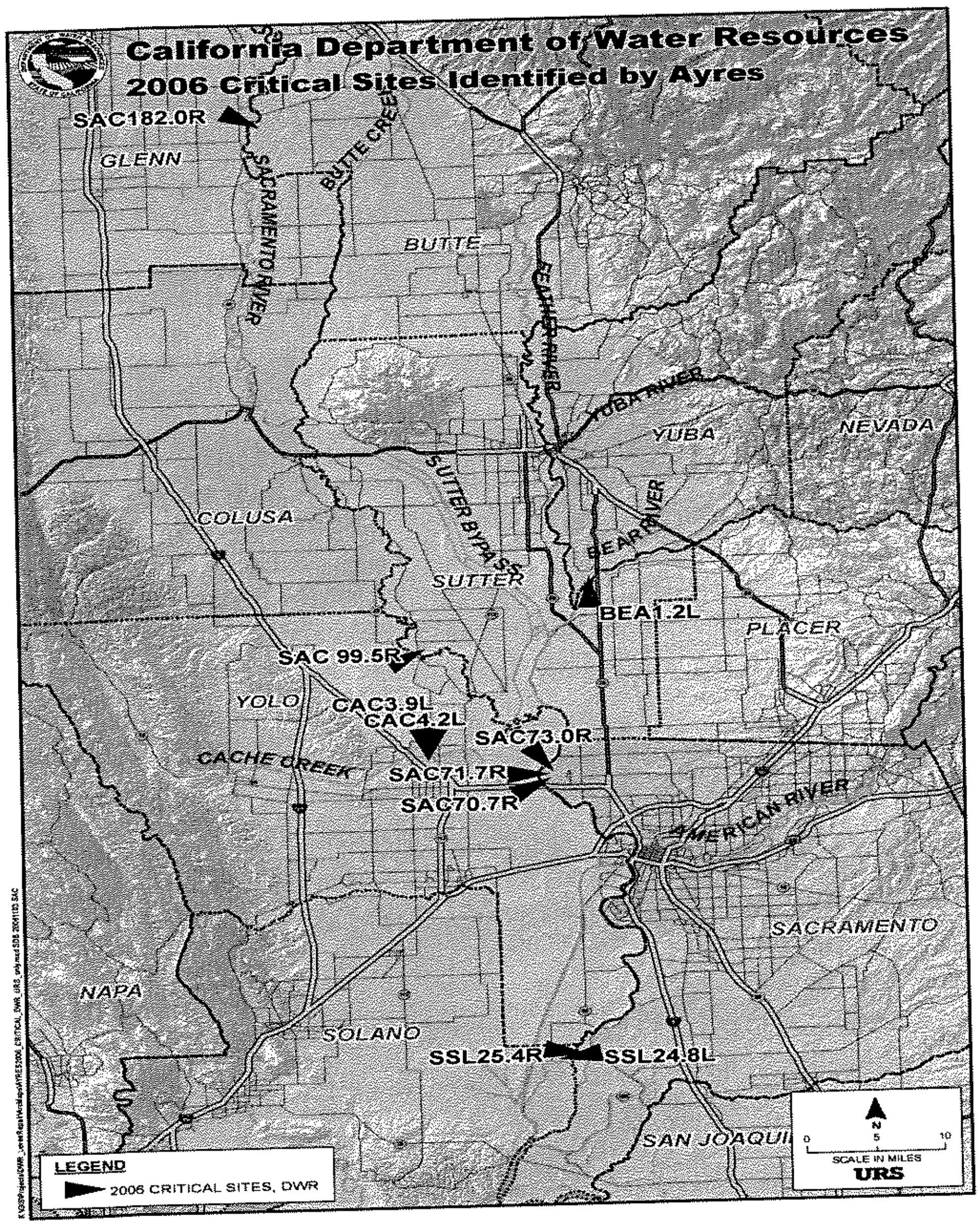
Riparian trees and shrubs will be planted along the site starting at 26 feet to 33 feet NGVD and extending to the top of the bank. Large potted plants will be installed in larger rock voids. Standing trees ≥4 inches dbh will be protected in place, and all disturbed areas will be restored with erosion control measures.

IWM will be embedded into the levee slope or chained onto the levee slope to provide bank protection and aquatic habitat during winter and summer flows. The IWM will be approximately 15 feet long and 10 feet wide, and will retain limbs and root wad (to the extent feasible) for maximum habitat value. IWM will be embedded at an average spacing of 1 unit per 24 linear feet of streambank (i.e., IWM will occupy approximately 40 percent of the linear extent of bank at both the mean August WSEL and the mean February WSEL). Sixty units will be imbedded into the slope approximately 2 feet below the August mean WSEL. Sixty units will be anchored on the riparian bench. One hundred twenty units will be embedded into the slope just below the February mean WSEL. The IWM will be positioned at a 20-degree to 25-degree angle to the bank pointing downstream, or as directed by the engineer.

B. Construction Schedule and Periods

Construction will occur in 2 phases. Phase 1 is expected to occur from November 15, 2006 through spring of 2007. Phase 2, will begin as soon as possible following Phase I, and will continue until conservation measures, including riparian plantings, are fully installed. This currently is expected to be by the end of summer 2007. Construction on dry land may occur in months prior to or following this period. Construction primarily is scheduled to occur during daylight hours. Construction activities may be temporarily suspended due to high flows or rain.

Figure 1. Map of the action area and 8 critical levee erosion repair sites. Two sites on this map, CAC3.9L, and CAC 4.2L are not part of the proposed action.



C. Project Operation and Maintenance

Operation and Maintenance (O&M) activities that may be necessary for three to five years to maintain the flood control and environmental values at the site include removing invasive vegetation determined to be detrimental to the success of the project, pruning and watering planted vegetation to promote optimal growth, replacing vegetation plantings, monitoring navigational hazards, and placing fill and rock revetment if the site is damaged during high flow events or vandalism.

Maintenance of conservation measures will be conducted to the extent necessary to ensure that the overall long-term habitat effects of the project are positive, as determined by the SAM. This approach will adaptively manage project conservation measures based on SAM modeling, monitoring, and professional judgment. Once established, the riparian vegetation is expected to be self-maintaining. Annual placement of the bank protection material would require no more than 600 cubic yards of material per site, per year. If more than 600 cubic yards per site need to be placed in any year, the operating and maintaining agency would consult separately with NMFS through the Corps regulatory division.

In coordination with Federal and State resource agencies, any in-water work would be conducted during appropriate time periods to avoid adverse impacts to fish. The current proposed in-water work window is August 1 to November 30.

CDWR will, within 12 months of the onset of construction of the proposed bank protection actions prepare a detailed O&M plan for the bank protection actions and any additional or off-site mitigation that may be required. CDWR shall at a minimum take yearly photos of the sites in two locations (*i.e.*, upstream, downstream) to document site performance. The O&M plan will ensure that riparian vegetation and anchored IWM are maintained and, pending the results of monitoring, adaptively managed (modified) to ensure their mitigation value. If O&M activities identify new technologies to enhance habitat values for federally listed fish species, they will be considered for wider application to other eroding sites in the project area. Should the anchored IWM features prove harmful to any Federally listed species, or should they be deemed a potential hazard to recreation or navigation, CDWR will request USFWS and NMFS to consider allowing non-maintenance or removal.

D. Proposed Minimization and Conservation Measures

1. <u>Off-site Conservation Measures</u>

CDWR proposes that the project will be fully self-compensating (no off-site compensation will be needed). However, the final SAM analysis or other evaluations may identify the need for off-site compensation. In that event, if it is not possible to implement the SAM or another method of compensation agreed to by the interagency working group (IWG) agencies, the following default compensation measures will apply.

Mitigation, in the form of a setback levee or other fluvial-function-restoring measure, will be implemented to the extent that the on-site features do not fully offset the project impacts. Such mitigation will create a floodplain or erodible area (as applicable) that is no less than five times as large as the bank area that currently exists between the existing edge of water at the mean summer water level and the existing projected levee section at mean summer water level. Currently, this area is assumed to be the maximum potential extent of lateral river migration (i.e., river functioning potential) that will be lost as a result of the proposed levee repairs. Other more accurate or representative methods of quantifying this river functioning potential and determining appropriate compensation may be developed in the future before implementation of the off-site mitigation.

For any setback levee or other measure implemented at a site that already has a vegetated bench, SRA cover, IWM, and/or other high-value aquatic habitat features, the IWG will evaluate the relative degree of river functioning that will be restored at the mitigation site. USFWS and NMFS will use such information to determine the credit (toward achieving the required river-functioning potential) that will be granted for the setback levee or other measure. The highest priority for off-site mitigation credit will be granted for currently rock-revetted sites where high potential exists for restoration of floodplain area, fluvial functioning, and IWM input.
The setback levees (or other measures) floodplain or erosion area will include habitat features intended to maximize aquatic benefits for federally listed fish species, including (as applicable) Delta smelt and the three listed salmonids that occur in the project area. Site design may be limited by various engineering and hydraulic constraints, but will incorporate at least one of the following features: a shallow, frequently inundated, vegetated floodplain with an open canopy; a less frequently inundated area including significant SRA cover, a more closed canopy, and high structural diversity; significant occurrence of IWM recruitment; and/or active erosion of banks. The setback levees (or other measures) engineered (expected or anticipated) project life will equal or exceed that of the design life of the repair. Hydraulic modeling, or other means acceptable to the agencies, may be used to determine the project life for setback levees (or other measures).

Implementation of the setback levee or other measure must incorporate avoidance, minimization, and conservation measures sufficient to offset the adverse effects on all listed species under USFWS, NMFS, and CDFG jurisdiction. The setback levees (or other measures) may be constructed, and rock revetment may be removed, at any suitable location within the mainstem of the lower Sacramento River (not tributary streams or distributary sloughs) within the project area, and upstream as far as RM 243.0. The setback levees (or other measures) and removal of rock revetment may occur, if consistent with Corps policy and all other regulatory considerations, on Federal and non-Federal levees and at other sites.

2. Additional Avoidance, Minimization, and Conservation Measures

Another project objective is to avoid and minimize environmental impacts during construction. Therefore, the following measures will be incorporated into the project:

- CDWR will consult with USFWS, NMFS, CDFG, and the Corps to identify resources and appropriate avoidance and minimization measures;

- Biological resources in the project vicinity will be identified by pre-surveying the site;

- Construction access roads and laydown areas will be sited away from sensitive resources to the extent feasible;

- Elderberry shrubs, the obligate host plant of the federally protected VELB, will be fenced off and avoided;

- Covering stockpiles and watering roads will control fugitive dust from construction; and

- All construction personnel will receive environmental awareness education.

- A final SAM analysis will be conducted after Phase 2. If this final SAM analysis, or other evaluations indicated uncompensated habitat impacts, CDWR will pursue further conservation measures.

- Construction materials stockpiling, such as portable equipment, vehicles, and supplies, including chemicals, will be restricted to the designated construction staging areas and barges, exclusive of any riparian and wetlands areas.

- Erosion control measures preventing soil or sediment from entering the river will be implemented, monitored for effectiveness, and maintained throughout the construction operations.

- CDWR will continue to implement a six-part process to review and approve tree removals. Consistent with the streambed alteration agreement, vegetation removal will be minimized. Consistent with the plans and specifications for the projects, all trees over 4 inches dbh will be protected unless authorized for removal through the six-part process. The parts consist of the contractor proposing a list of trees that are requested for removal. The list of trees is reviewed by the site engineer to determine if leaving the trees would result in an insufficient repair (e.g., interfere with the structural integrity of the levee) or review the arborists recommendation that the tree is unsafe. The environmental monitor is provided an opportunity to investigate whether any active nests or protected birds are using the tree, but otherwise the environmental permits require that no trees be removed. The engineer provides written concurrence for removal for those trees that are allowed to be removed.

- All litter, debris, unused materials, equipment, and supplies will be removed daily from any areas below the ordinary high water line and deposited at an appropriate disposal or storage site.

- Any spills of hazardous materials will be cleaned up immediately and reported to the resource agencies within 24 hours. Any such spills, and the success of the efforts to clean them up, also will be reported in post-construction compliance reports.

- A representative will be appointed by CDWR to act as the point-of-contact for any CDWR employee, contractor, or contractor employee who might incidentally take a living (or find a dead, injured, or entrapped) threatened or endangered species during Project construction and operations. The representative will be identified to the employees and contractors during an all-employee education program conducted by CDWR relative to the various Federally listed species that may be encountered on the construction sites.

- If requested by the resource agencies, during or upon completion of construction activities, CDWR's biologist/environmental manager or contractor will accompany USFWS or NMFS personnel on an on-site, post construction inspection tour to review Project impacts and mitigation success.

- The intake for any water pump needed for the construction process will be screened to NMFS salmonid-screening specifications.

- A CDWR representative will work closely with the contractor(s) through all construction stages to ensure that any living native riparian vegetation or IWM within vegetation-clearing zones that can be avoided reasonably, without compromising basic engineering design and safety, is avoided and left undisturbed to the extent feasible.

- Exotic species may be removed, and the area replanted with native species appropriate for the location and elevation on an acre-for-acre basis, without the need for any additional mitigation for such removal.

- A vegetation-monitoring plan, reviewed in advance by the resource agencies and covering all areas where any woody riparian vegetation is to be replanted, will be instituted for 5 years after construction.

- O&M requirements prepared by CDWR for the proposed levee repair sites will contain measures to ensure the maintenance of the benches and anchored IWM features for at least three years, or until new, live riparian vegetation has become established at which point those measures need no longer be maintained. Language providing such assurance(s) will be provided to the resource agencies for review and concurrence before formal O&M documents are finalized by CDWR, and written evidence of the acceptance of this assurance language by the local maintaining agency or district will be provided to the resource agencies.

- The efficacy of minimization features (*i.e.*, plantings in rock revetment, planting bench, and anchored IWM) will be studied for five years following construction. The study will include IWM input and retention, sediment and organic matter retention and storage, and habitat creation. CDWR or their agents will prepare annual reports that include specific information pertaining to each of the five monitoring elements (riparian, overhead SRA cover, instream SRA cover, and VELB habitat) at the project sites. The reports will include information about all equipment and techniques used for monitoring purposes. Annual reports will be submitted to USFWS, NMFS, and CDFG by August 1 of each monitoring year.

- The effectiveness of the setback levee (or other mitigation measure), as well as that of any engineered mitigation technology, will be evaluated through monitoring designed by the IWG. Findings of this monitoring may be used in future levee repair designs.

- Identify all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, and plant species in the potentially affected project areas.

- Minimize effects by altering engineering design to avoid potential direct and indirect effects.

- Incorporate sensitive habitat information into project bid specifications.

- Fence sensitive habitats with orange construction fencing or similar material.

- Incorporate into project bid specifications requirements for contractors to avoid identified sensitive habitats.

- Minimize native vegetation removal to the extent feasible, and leave as much existing IWM in place as possible, anchoring the IWM in place with rock.

- Use a plant palate, developed in coordination with USFWS and NMFS, which specifies the appropriate species to be used for replanting.

- Protect trees to be surrounded by rock with appropriate measures, such as geotextile fabric, to reduce the risk of girdling the trees.

- Perform only minimal grubbing or contouring of the sites.

- Ensure all fill materials are placed with minimal excavation or movement of existing materials on site.

- Ensure all clearing, pruning, and trimming of vegetation are supervised by a qualified biologist to ensure these activities have a minimal effect on natural resources.

- Monitor effects of construction activities on natural resources.

F. Monitoring

On May 26, 2006, CDWR submitted a monitoring plan for the resource agencies to review. Once approved, the monitoring plan will be implemented at each site. Monitoring is necessary to ensure that the vegetated benches and IWM structures are functioning as projected to the benefit of federally listed fish species. CDWR or the local Reclamation District will submit a yearly report of monitoring results for the repair sites to the resource agencies by August 1 of each year. Monitoring will be conducted until the projected benefits of mitigation actions to Federally listed fish species can be either substantially confirmed or discounted.

F. 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). The action area, for the purposes of this biological opinion includes the Sacramento River from RM 182.0 downstream to RM 0, including Sutter Slough from RM 25.4 downstream to the confluence with the Sacramento River, and the Bear River, downstream to the Feather River's confluence with the Sacramento River at Verona. This area was selected because it represents the upstream and downstream extent of anticipated project actions, including potential off-site compensation actions.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

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

Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
endangered (June 28, 2005, 70 FR 37160)
Sacramento River winter-run Chinook salmon designated critical habitat
(June 16, 1993, 58 FR 33212)
Central Valley spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
threatened (June 28, 2005, 70 FR 37160)
Central Valley spring-run Chinook salmon designated critical habitat
(September 2, 2005, 70 FR 52488)
Central Valley steelhead DPS (*Oncorhynchus mykiss*)
threatened (December 22, 2005)

Central Valley steelhead designated critical habitat
(September 2, 2005, 70 FR 52488)
Southern DPS of North American green sturgeon (*Acipenser medirostris*)
threatened (April 7, 2006, 70 FR 17386)

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

1. Chinook Salmon

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

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

Information on the migration rates of Chinook salmon in freshwater is scant and primarily comes from the Columbia River basin where information regarding migration behavior is needed to assess the effects of dams on travel times and passage (Matter *et al.* 2003). Keefer *et al.* (2004) found migration rates of Chinook salmon ranging from approximately 10 kilometers (km) per day to greater than 35 km per day and to be primarily correlated with date, and secondarily with discharge, year, and reach, in the Columbia River basin. Matter *et al.* (2003) documented migration rates of adult Chinook salmon ranging from 29 to 32 km per day in the Snake River. Adult Chinook salmon inserted with sonic tags and tracked throughout the Delta and lower Sacramento and San Joaquin rivers were observed exhibiting substantial upstream and downstream movement in a random fashion while migrating upstream (California Bay-Delta

Authority (CALFED) 2001) several days at a time. Adult salmonids migrating upstream are assumed to make greater use of pool and mid-channel habitat than channel margins (Stillwater Sciences 2004), particularly larger salmon such as Chinook, as described by Hughes (2004). Adults are thought to exhibit crepuscular behavior during their upstream migrations; meaning that they primarily are active during twilight hours. Recent hydroacoustic monitoring conducted by LGL Environmental Research Associates showed peak upstream movement of adult CV spring-run Chinook salmon in lower Mill Creek, a tributary to the Sacramento River, occurring the in the four hour period before sunrise and again after sunset.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools (USFWS 1995). Upon emergence, fry swim or are displaced downstream (Healey 1991). Similar to adult movement, juvenile salmonid downstream movement is crepuscular. Documents and data provided to NMFS in support of ESA section 10 research permit applications depicts that the daily migration of juveniles passing RBDD is highest in the four hour period prior to sunrise (Martin *et al.* 2001). Once started downstream, fry may continue downstream to the estuary and rear, or may take up residence in the stream for a period of time from weeks to a year (Healey 1991).

Fry then seek nearshore habitats containing beneficial aspects such as riparian vegetation and associated substrates important for providing aquatic and terrestrial invertebrates, predator avoidance, and slower velocities for resting (NMFS 1996). The benefits of shallow water habitats for salmonid rearing also have recently been realized as shallow water habitat has been found to be more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Meyer 1979, Healey 1980). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, MacFarlane and Norton 2001, Sommer *et al.* 2001).

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

Juvenile Chinook salmon migration rates vary considerably presumably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al.* (1982) found fry Chinook salmon to travel as fast as 30 km per day in the Sacramento River and Sommer *et al.*

(2001) found rates ranging from approximately 0.5 miles up to more than 6 miles per day in the Yolo Bypass. As Chinook salmon begin the smoltification stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healey 1980, Levy and Northcote 1981).

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

a. *Sacramento River Winter-run Chinook Salmon*

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

Sacramento River winter-run Chinook salmon adults enter the Sacramento River basin between December and July; the peak occurring in March (Table 2; Yoshiyama *et al.* 1998, Moyle 2002). Spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick Dam and Red Bluff Diversion Dam (RBDD) (Vogel and Marine 1991). The majority of Sacramento River winter-run Chinook salmon spawners are 3 years old.

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

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

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

a) Adult

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

b) Juvenile

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

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

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

Historical Sacramento River winter-run Chinook salmon population estimates, which included males and femaless, were as high as near 100,000 fish in the 1960s, but declined to under 200 fish in the 1990s (Good *et al.* 2005). Population estimates in 2003 (8,218), 2004 (7,701), and 2005 (15,730) show a recent increase in the population size (California Department of Fish and Game [CDFG] Grandtab, February 2005, letter titled "Winter-run Chinook Salmon Escapement Estimates for 2005" from CDFG to NMFS, January 13, 2006) and a 3-year average of 10,550. The 2005 run was the highest since the listing. Overall, abundance measures suggest that the abundance is increasing (Good *et al.* 2005). Two current methods are utilized to estimate the juvenile production of Sacramento River winter-run Chinook salmon: the Juvenile Production Estimate (JPE) method, and the Juvenile Production Index (JPI) method (Gaines and Poytress 2004). Gaines and Poytress (2004) estimated the juvenile population of Sacramento River winter-run Chinook salmon exiting the upper Sacramento River at RBDD to be 3,707,916 juveniles per year using the JPI method between the years 1995 and 2003 (excluding 2000 and 2001). Using the JPE method, they estimated an average of 3,857,036 juveniles exiting the upper Sacramento River at RBDD between the years of 1996 and 2003 (Gaines and Poytress 2004). Averaging these 2 estimates yields an estimated population size of 3,782,476.

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

Lindley *et al.* (2007), in their framework for assessing the viability of Chinook salmon and steelhead in the Sacramento-San Joaquin basin, concluded that the population of winter-run Chinook salmon that spawns below Keswick dam satisfies low-risk criteria for population size, population decline, but increasing hatchery influence is concern that puts the population at a moderate risk of extinction. Furthermore, the Lindley *et al.* (2007) point out that an ESU represented by a single population at moderate risk, is at a high risk of extinction over the long term.

b. *Central Valley Spring-run Chinook Salmon*

NMFS listed the Central Valley spring-run Chinook salmon (CV spring-run Chinook salmon) ESU as threatened on September 16, 1999 (64 FR 50394). In June 2004, NMFS proposed that CV spring-run Chinook salmon remain listed as threatened (69 FR 33102). This proposal was based on the recognition that although CV spring-run Chinook salmon productivity trends are positive, the ESU continues to face risks from having a limited number of remaining populations (*i.e.*, 3 existing populations from an estimated 17 historical populations), a limited geographic distribution, and potential hybridization with Feather River Hatchery (FRH) spring-run Chinook salmon, which until recently were not included in the ESU and are genetically divergent from other populations in Mill, Deer, and Butte Creeks. On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of CV spring-run Chinook salmon as threatened (70 FR 37160). This decision also included the FRH spring-run Chinook salmon population as part of the CV spring-run Chinook salmon ESU. Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005 (70 FR 52488).

Adult CV spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River between March and September, primarily in May and June (Table 3; Yoshiyama *et al.* 1998, Moyle 2002). Lindley *et al.* (2006a) indicates adult CV spring-run Chinook salmon enter native tributaries from the Sacramento River primarily between mid April and mid June. Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al.* 1998).

Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year (YOY) or as juveniles or yearlings. The modal size of fry migrants at approximately 40 mm between December and April in Mill, Butte, and Deer Creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al.* 2006a). Studies in Butte Creek (Ward *et al.* 2002, 2003, McReynolds *et al.* 2005) found the majority of 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 (YOY) migration and an earlier yearling migration (Lindley *et al.* 2006a).

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

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

Table 3. 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

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

(b) Juvenile

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

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

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

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

Lindley *et al.* concluded that Butte and Deer Creek fish are at low risk of extinction, satisfying viability criteria for population size, decline/growth rate, hatchery influence, and catastrophe. The Mill Creek population is at a low to moderate risk, satisfying some, but not all viability criteria. The Feather and Yuba River populations as data deficient and did not assess their viability. However, because the existing CV spring-run Chinook salmon populations are spatially confined to relatively few remaining streams in only one of four historic diversity groups, the ESU remains vulnerable to catastrophic disturbance, it remains at a moderate to high risk of extinction.

2. Central Valley Steelhead

Central Valley steelhead (CV steelhead) were originally listed as threatened on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento and San Joaquin River basins in California's Central Valley. In June 2004, NMFS proposed that CV spring-run Chinook salmon remain listed as threatened (69 FR 33102). On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of CV steelhead as threatened (70 FR 37160). This decision also included the Coleman National Fish Hatchery and FRH steelhead populations. These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for CV steelhead on September 2, 2005 (70 FR 52488).

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

CV steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April with peaks from January though March in small streams and tributaries where cool, well oxygenated water is available year-round (Hallock *et al.* 1961, McEwan and Jackson 1996) (Table 4). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapolov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams.

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

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

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating CV steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Juvenile CV steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002).

Some may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall. Nobriga and Cadrett (2003) also have verified these temporal findings based on analysis of captures at Chipps Island, Suisun Bay.

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

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

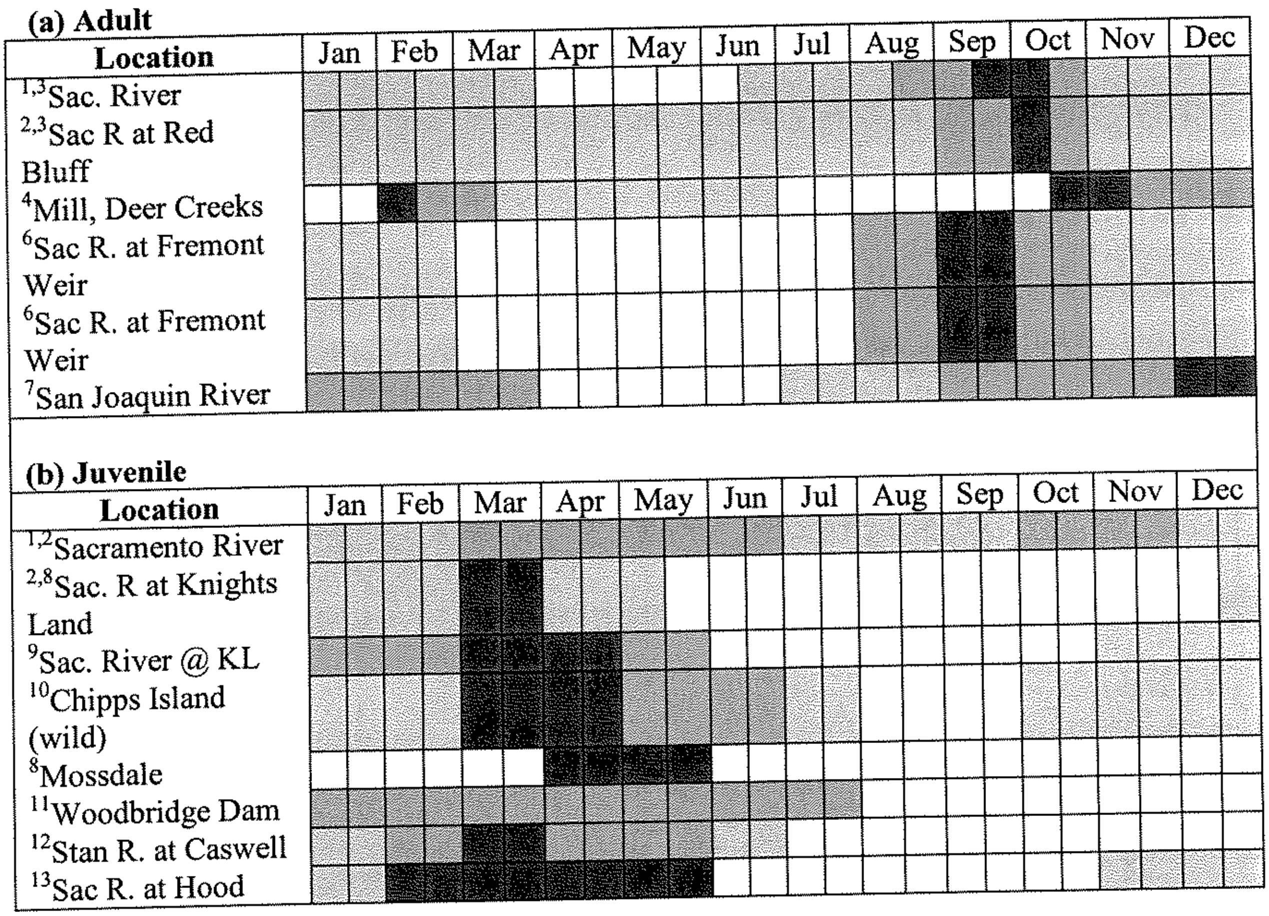
Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather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

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

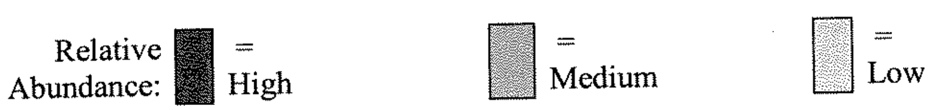
It is possible that naturally-spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced Rivers during fall-run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

Stanislaus River" (Letter from Dean Marston, CDFG, to Madelyn Martinez, NMFS, January 9, 2003). The documented returns on the order of single fish in these tributaries suggest that existing populations of CV steelhead on the Tuolumne, Merced, and lower San Joaquin Rivers are severely depressed.

Table 4. The temporal occurrence of adult (a) and juvenile (b) CV steelhead in the Central Valley. Darker shades indicate months of greatest relative abundance.



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



Lindley *et al.* (2006b) indicated that prior population census estimates completed in the 1990s found the CV 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). CV steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates. The future of CV steelhead is uncertain due to limited data concerning their status. However, Lindlely *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 ESU is at moderate to high risk of extinction.

3. <u>Southern Distinct Population Segment of North American Green Sturgeon</u>

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

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

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

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

New information regarding the migration and habitat use of the Southern DPS of North American green sturgeon has emerged. Lindley (2006c) presents preliminary results of large-scale green sturgeon migration studies. Lindley's analysis verified past population structure delineations based on genetic work and found frequent large-scale migrations of green sturgeon along the Pacific Coast. It appears North American green sturgeon are migrating considerable distances up the Pacific Coast into other estuaries, particularly the Columbia. This information also agrees with the results of green sturgeon tagging studies completed by CDFG where they tagged a total of 233 green sturgeon in the San Pablo Estuary between 1954 and 2001. A total of 17 tagged fish were recovered: 3 in the Sacramento-San Joaquin Estuary, 2 in the Pacific Ocean off of California, and 12 from commercial fisheries off of Oregon and Washington. Eight of the 12 recoveries were in the Columbia Estuary (CDFG 2002).

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

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

Based on the distribution of sturgeon eggs, larva, and juveniles in the Sacramento River, CDFG (2002) indicated that Southern DPS of green sturgeon spawn in late spring and early summer above Hamilton City possibly to Keswick Dam. Adult green sturgeon are believed to spawn every 3 to 5 years and reach sexual maturity only after several years of growth (*i.e.*, 10 to 15 years based on sympatric white sturgeon sexual maturity (CDFG 2002). Adult female green sturgeon produce between 60,000 and 140,000 eggs each reproductive cycle, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al.* 2001). Southern DPS Green sturgeon adults begin their upstream spawning migrations into the San Francisco Bay in March, reach Knights Landing during April, and spawn between March and July (Heublein *et al.* 2006). Peak spawning is believed to occur between April and June (Table 4) and thought to occur in deep turbulent pools (Adams *et al.* 2002). Substrate is likely large cobble but can range from clean sand to bedrock (USFWS 2002). Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length. According to Heublein (2006) all adults leave the Sacramento River prior to September 1.

After approximately 10 days, larvae begin feeding, growing rapidly, and young green sturgeon appear to rear for the first 1 to 2 months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging from 24 to 31 mm fork length (CDFG 2002, USFWS 2002). The mean yearly total length of post-larval green sturgeon captured in rotary screw traps at the RBDD ranged from 26 mm to 34 mm between 1995 and 2000 indicating they are approximately 2 weeks old. The mean yearly total length of post-larval green sturgeon captured in the GCID rotary screw trap, approximatley 30 miles downstream of RBDD ranged from 33 mm to 44 mm between 1997 and 2005 (CDFG, unpublished data) indicating they are approximately 3 weeks old (Van Eenennaam *et al.* 2001).

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

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

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

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

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

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

Table 5. The temporal occurrence of adult (a) larval and post-larval (b) juvenile (c) and coastal migrant (d) Southern DPS of North American green sturgeon. Locations emphasize the Central Valley of California. Darker shades indicate months of greatest relative abundance.

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

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

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

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

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

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

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

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

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

* Fish Facility salvage operations

Relative Abundance: = High = Medium = Low

B. Critical Habitat and Primary Constituent Elements

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

Critical habitat for 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, and the Sacramento River and Delta. Critical Habitat for CV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope Creeks in the Sacramento River basin; and, the San Joaquin River its tributaries, and the Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (70 FR 52488). The bankfull elevation is defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series (Dunne and Leopold 1978, MacDonald *et* al. 1991, Rosgen 1996). Critical habitat for CV spring-run Chinook salmon and steelhead is defined as specific areas that contain the primary constituent elements (PCE) and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for CV spring-run Chinook salmon and CV steelhead, and as physical habitat elements for Sacramento River winter-run Chinook salmon.

1. <u>Spawning Habitat</u>

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. Spawning habitat for CV steelhead is similar in nature to the requirements of Chinook salmon, primarily occurring in reaches directly below dams (*i.e.*, above RBDD on the Sacramento River) throughout the Central Valley. Most remaining natural spawning habitats (those not downstream from large dams) currently are in good condition, with adequate water temperatures, stream flows, and gravel conditions to support successful reproduction. Some areas below dams, especially for steelhead are degraded by fluctuating flow conditions related to water storage and flood management, that scour or strand redds. Spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

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

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of obstruction with water quantity and quality conditions and contain natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility, survival and food supply. Migratory corridors are downstream of the spawning area and include the lower Sacramento River and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams, unscreened or poorly- screened diversions, and degraded water quality. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta and the much of the Sacramento River is not a problem, but problems exist on many tributary streams, and at the RBDD. For juveniles, unscreened or inadequately screen water diversions throughout their migration corridors, and a scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations, and are essential for connecting early rearing habitat with the ocean even the degraded reaches are considered to have a high conservation value to the species. Thus, although much of the migration corridor is in poor condition, it is important to the species.

4. Estuarine Areas

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

C. Factors Affecting the Species and Critical Habitat

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

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

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

a. Modification and Curtailment of Habitat and Range

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

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

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

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

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

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

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

b. *Ecosystem Restoration*

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

Two programs included under CALFED; the Ecosystem Restoration Program (ERP) and the EWA, were created to improve conditions for fish, including listed salmonids, in the Central Valley. Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids and emphasis has been placed in tributary drainages with high potential for CV 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 CALFED-ERP 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.

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

c. *Climate Change*

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

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

2. Critical Habitat for Salmonids

According the NMFS CHART report (2005b) the major categories of habitat-related activities affecting Central Valley salmonids include: (1) irrigation impoundments and withdrawals (2) channel modifications and levee maintenance, (4) the presence and operation of hydroelectric dams, (5) flood control and streambank stabilization, and (6) exotic and invasive species introductions and management. All of these activities affect PCEs via their alteration of one or more of the following: stream hydrology, flow and water-level modification, fish passage, geomorphology and sediment transport, temperature, DO levels, nearshore and aquatic vegetation, soils and nutrients, physical habitat structure and complexity, forage, and predation (Spence *et al.* 1996). According to the NMFS CHART report (2005b), the condition of critical habitat varies throughout the range of the species. Generally, the conservation value of existing spawning habitat ranges from moderate to high quality, with the primary threats including changes to water quality, and spawning gravel composition from rural, suburban, and urban development, forestry, and road construction and maintenance. Downstream, river and estuarine migration and rearing corridors range in condition from poor to high quality depending on location. Tributary migratory and rearing corridors tended to rate as moderate quality due to threats to adult and juvenile life stages from irrigation diversion, small dams, and water quality.

Delta (*i.e.*, estuarine) and mainstem Sacramento and San Joaquin river reaches tended to range from poor to high quality, depending on location. In the alluvial reach of the Sacramento River between Red Bluff and Colusa, the PCEs of rearing and migration habitat are in good condition because, despite the influence of upstream dams, this reach retains natural, and functional channel processes that maintain and develop anadromous fish habitat. The river reach downstream from Colusa and including the Delta is poor in quality due to impaired hydrologic conditions from dam operations, water quality from agriculture, degraded nearshore and riparian habitat from levee construction and maintenance, and habitat loss and fragmentation.

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

3. Southern Distinct Population Segment of North American Green Sturgeon

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

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

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

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

IV. ENVIRONMENTAL BASELINE

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

A. Status of the Species and Critical Habitat in the Action Area

1. Status of the Species within the Action Area

The action area functions as a migratory corridor for adult Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead, and provides migration and rearing habitat for juveniles of these species. A large proportion of all Federally listed Central Valley salmonids are expected to utilize aquatic habitat within the action area. The action area also functions as a migratory and holding corridor for adult and rearing and migratory habitat for juvenile Southern DPS of North American green sturgeon. The entire population of migrating adults and emigrating juvenile winter-, and CV spring-run Chinook salmon, and a majority of CV steelhead, must pass through the action area.

a. *Sacramento River Winter-run Chinook Salmon*

Adult Sacramento River winter-run Chinook salmon are expected to be present in the Sacramento River portion of the action area between November and June (Myers *et al.* 1998, Good *et al.* 2005) as they migrate to spawning grounds. Juvenile Sacramento River winter-run Chinook salmon migration patterns in the Sacramento River and Sutter Slough can best be described by temporal migration characteristics found by the USFWS (2001) in beach seine captures along the lower Sacramento River between Sacramento and Princeton, and in the Delta south of Sacramento along the Sacramento River, and in nearby channels such as Sutter and Georgiana sloughs. Because beach seining samples the shoreline rather than the center of the channel as is often the case in rotary screw traps and trawls, it is considered the most accurate sampling effort in predicting the nearshore presence of juvenile salmonids. In the Sacramento River, between Princeton and Sacramento, juveniles are expected between September and mid April, with highest densities between December and March (USFWS 2001). Delta captures were similar, but slightly later as they are downstream; juveniles are expected between November and mid April with highest densities between December and February. Rotary screw trap work at Knights Landing on the Sacramento River by Snider and Titus (2000) captured juveniles between August and April, with heaviest densities observed first during November and December, and second during January through March. The largest captures occurred during periods of sustained high flow, generally greater that 20,000 cfs. The presence of juvenile Sacramento River winter-run Chinook salmon in Sutter slough is dependant on hydrologic conditions and the species exposure to them in the north Delta (Jeff McLain, NMFS, pers. comm., 2006). For example, the operation of the DCC gates affects Sacramento River flow entering Sutter Slough increasing salmonid diversions into Sutter Slough. In most cases, past catches of Sacramento River winter-run Chinook salmon juveniles in Sutter Slough have been relatively low (Jeff McLain, NMFS, pers. comm., 2006

b. *Central Valley Spring-run Chinook Salmon*

Adult CV spring-run Chinook salmon are expected on the Sacramento River between March and July (Myers *et al.* 1998, Good *et al.* 2005). Peak presence is believed to be during February and March (CDFG 1998). In the Sacramento River, juveniles may begin migrating downstream almost immediately following emergence from the gravel with most emigration occurring from December through March (Moyle *et. al.* 1989, Vogel and Marine 1991). Snider and Titus (2000) observed that up to 69 percent of spring-run Chinook salmon emigrate during the first migration phase between November and early January. The remainder of the CV spring-run Chinook salmon emigrate during subsequent phases that extend into early June. The age structure of emigrating juveniles is comprised of YOY and yearlings. The exact composition of the age structure is not known, although populations from Mill and Deer Creek primarily emigrate as yearlings (Colleen Harvey-Arrison, CDFG, pers. comm., 2004), and populations from Butte Creek primarily emigrate as fry (Ward *et. al.* 2002). Younger juveniles are found closer to the shoreline than older individuals (Healey 1991). As is the case for Sacramento River winter-run Chinook salmon, the presence of juvenile CV spring-run Chinook salmon in Sutter slough depends on hydrologic conditions and the species exposure to them in the north Delta (Jeff McLain, NMFS, pers. comm., 2006). In most cases, past catches of CV spring-run Chinook salmon juveniles in Sutter Slough have been relatively low (Jeff McLain, NMFS, pers. comm., 2006).

c. *Central Valley Steelhead*

The proportion of steelhead in this DPS that migrate through the action area is unknown. However, because of the relatively large amount of suitable habitat in the Sacramento River relative to the San Joaquin River, it is probably high. Adult steelhead may be present in all parts of the action area from June through March, with the peak occurring between August and October (Bailey 1954, Hallock *et al.* 1957). Highest abundance of adults and juveniles is expected in the Sacramento River part of the action area. Juvenile steelhead emigrate through the Sacramento River from late fall to spring. Snider and Titus (2000) observed that juvenile steelhead emigration primarily occurs between November and May at Knights Landing. The majority of juvenile steelhead emigrate as yearlings and are assumed to be primarily utilizing the center of the channel rather than the shoreline.

d. *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 (*Status of the Species and Critical Habitat* section), thus the entire population of adults and juveniles must pass through the action area.

Adult Southern DPS of North American green sturgeon migrate upstream through the action area primarily between March and June (Adams *et al.* 2002). Larva and post-larvae are present on the lower Sacramento River between May and October, primarily during June and July (CDFG 2002). Small numbers of juvenile Southern DPS of North American green sturgeon have been captured at various locations on the Sacramento River as well in the Delta (in the action area downstream of Sacramento) during all months of the year (IEP Database, Borthwick *et al.* 1999).

2. <u>Status of Critical Habitat Within the Action Area</u>

a. *Sacramento River winter-run Chinook salmon, Central Valley Steelhead and Central Valley spring-run Chinook Salmon*

The action area is within designated critical habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead. Habitat requirements for these species are similar. The PCEs of salmonid habitat within the action area include: freshwater rearing habitat, freshwater migration corridors, and estuarine areas, containing adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food; riparian vegetation, space, and safe passage conditions. Habitat within the action area is primarily used for juvenile and smolt freshwater rearing and migration and for adult freshwater migration. The condition and function of this habitat has been severely impaired through several factors discussed in the *Status of the Species and Habitat* section of this biological opinion. 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, the conservation value of the action area is high because its entire length is used for extended periods of time by a large proportion of all Federally listed anadromous fish species in the Central Valley.

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 (Regional Board 1998). Urban stormwater runoff contains pesticides, oil, grease, heavy metals, polynuclear aromatic hydrocarbons, other organics and nutrients (Regional Board 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. Accelerated 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 such as dams, bridges, water diversions, and piers are likely a factor in the decline of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead.

Within the action area, the freshwater rearing and migration PCEs have been transformed from a meandering waterway lined with a dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes and flooding. In the reach from Colusa downstream to Verona (RMs 143 to 80) levees are generally constructed near the edge of the river (USFWS 2000). Severe long-term riparian vegetation losses have occurred in this part of the Sacramento River, and there are large open gaps without the presence of important habitat features due to the high amount of riprap (USFWS 2000). Between Verona and Collinsville on the Sacramento River (RMs 80-0) the river is even more ecologically degraded having been impacted by bank protection and riprapping (USFWS 2000). Overall, more than half of the Sacramento Rivers banks in the lower 194 miles have been riprapped (USFWS 2000).

Jones and Stokes (2006a), Stillwater Sciences (2006), and CDWR (2006) estimated the approximate percent of linear coverage of existing (pre-project) revetment, riparian vegetation, and IWM at the levee repair sites. Overall, repair sites currently contain approximately between 44 and 70 percent revetment, 10 to 54 percent riparian vegetation, and 17 to 28 percent IWM (Table 6).

Table 6. Approximate pre-project percent revetment, percent riparian vegetation, and percent IWM in the action area. Percentages were averaged using pre-project values in Jones and Stokes (2006a), Stillwater Sciences (2006), and CDWR (2006).

percent Revetment	**percent Riparian**	**percent IWM**
44-70	**10-54**	**17-28**

2. Southern Distinct Population Segment of North American Green Sturgeon

The action area is utilized by the Southern DPS of North American green sturgeon adults for holding and migration purposes. 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). Erickson *et al.* (2002) also found many of these sites were also found close to sharp bends in the Rogue River.

The high number of diversions in the action area on the Sacramento River and in the north Delta is a potential threat to the Southern DPS of North American green sturgeon. NMFS assumes larval green sturgeon are susceptable to entrainment primarily from benthic water diversion facilities during the first 5 days of development and suseptable to diversion entrainment from facilities drawing water from the bottom and top of the water column when they are exhibiting noctornal behavior (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.

Adult migration barriers in the action area include the Sacramento Deep Water Ship Channel locks, Fremont Weir, and DCC Gates. These barriers can delay migration of Southern DPS North American green sturgeon affecting reproductive capacity and general health. 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 (Regional Board 1998). Urban stormwater runoff contains pesticides, oil, grease, heavy metals, polynuclear aromatic hydrocarbons, other organics and nutrients (Regional Board 1998) that contaminate drainage waters and destroy aquatic life necessary for green sturgeon survival (NMFS 1996). 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 transformation of the Sacramento River from a meandering waterway lined with dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes resulted in homogenization of the river, including effects to the rivers sinuosity (USFWS 2000). In addition, the change in the ecosystem as a result of the removal of riparian vegetation and IWM likely impacted potential prey items and species interaction that green sturgeon would experience while holding. The effects of channelization on upstream migration of green sturgeon are unknown.

The Sacramento River 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 benthic (with the exception of the post-larvae nocturnal swim-up believed to be a dispersal mechanism), the massive channelization effort in 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).

B. Factors Affecting the Species and Habitat in the Action Area

Because the size of the action area encompasses much of the applicable Sacramento River winter-run and CV spring-run Chinook salmon ESUs, and the CV steelhead DPS as well as the Southern DPS of North American green sturgeon, many of the factors affecting the species are discussed in the *Status of the Species and Habitat section* of this biological opinion. This section will focus on portions of the action area that are most relevant to the general location of the proposed action.

1. <u>Sacramento River Winter-run Chinook Salmon, Central Valley Steelhead, and Spring-run Chinook Salmon</u>

The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs affecting listed salmonids in the action area. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks. Consequently, the mainstream of the river often remains too high and turbid to provide quality rearing habitat. High water temperatures also limit habitat availability for listed salmonids in the lower Sacramento River. High summer water temperatures in the lower Sacramento River can exceed 72 °F, and create a thermal barrier to the migration of adult and juvenile salmonids (Kjelson *et al.* 1982). In addition, water diversions, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months limiting the survival of juvenile salmonids (Reynolds *et al.* 1993). Impacts to adult migration present in the action area, such as migration barriers, water conveyance factors, and water quality, non-native species, commercialization, *etc.*, are discussed in the *Status of Species and Critical Habitat* section.

Levee construction and bank protection have affected salmonid habitat availability and the processes that develop and maintain preferred habitat by reducing floodplain connectivity, changing riverbank substrate size, and decreasing riparian habitat and SRA. Individual bank protection sites typically range from a few hundred to a few thousand lf in length. Such bank protection generally results in two levels of impacts to the environment: (1) site-level impacts which affect the basic physical habitat structure at individual bank protection sites; and (2) reach-level impacts which are the accumulative impacts to ecosystem functions and processes that accrue from multiple bank protection sites within a given river reach (USFWS 2000). Revetted embankments result in loss of sinuosity and braiding and reduce the amount of aquatic habitat.

Impacts at the reach level result primarily from halting erosion and controlling riparian vegetation. Reach-level impacts which cause significant impacts to fish are reductions in new habitats of various kinds, changes to sediment and organic material storage and transport, reductions of lower food-chain production, and reduction in IWM.

The use of rock armoring limits recruitment of IWM (*i.e.*, from non-riprapped areas), and greatly reduces, if not eliminates, the retention of IWM once it enters the river channel. Riprapping creates a relatively clean, smooth surface which diminishes the ability of IWM to become securely snagged and anchored by sediment. IWM tends to become only temporarily snagged along riprap, and generally moves downstream with subsequent high flows. Habitat value and ecological functioning aspects are thus greatly reduced, because wood needs to remain in place to generate maximum values to fish and wildlife (USFWS 2000). Recruitment of IWM is limited to any eventual, long-term tree mortality and whatever abrasion and breakage may occur during high flows (USFWS 2000). Juvenile salmonids are likely being impacted by reductions, fragmentation, and general lack of connectedness of remaining nearshore refuge areas.

The Corp's SRBPP constructed bank protection projects at RM 149 in 2001, and 56.7 in 2004. The RM 149 project included conservation measures recommended by NMFS and the USFWS to remove the jeopardizing effects of the action constructing a set-back levee, or other conservation measures identified by the IWG that create or restore floodplain habitats, create additional riparian habitat, increase IWM recruitment, or improve the growth and survival of listed salmon and steelhead in the action area. The biological opinion required Corps to initiate a programmatic consultation for the SRBPP and to develop a comprehensive aquatic monitoring and evaluation program. All of the conditions necessary to avoid jeopardy have not been implemented. However, the biological opinion did not include a timeframe within which the measures must be completed, but did describe a schedule for which conservation measures would increase annually if the measures were not implemented in year 1 (2001). However, the Corps has implemented several of the measures and is committed to completing the remaining measures in the near future. To complete the measures, the Corps is proposing to implement off-site mitigation will be implemented on the right (*i.e.*, north) bank of the Lower American River, 0.5 miles above the confluence with the Sacramento River, and at a site on the Sacramento River, near RM 81. The Corps currently is drafting a draft biological assessment for NMFS to review prior to requesting a formal programmatic consultation. The Corps is committed to a comprehensive monitoring plan implementation in 2008. The Corps has awarded contracts for project-specific monitoring for 2007 to Stillwater Sciences until a plan can be developed in cooperation with CDWR. The current plan awarded to Stillwater Sciences addresses monitoring at all SRBPP sites constructed since 2001. The Corps will issue a request for proposals for 5 years of monitoring by July 1, 2007.

The Lower American River compensation site is expected to provided habitat improvements that will benefit several listed salmonid ESUs, including winter-run Chinook salmon due to the proximity of the site to the Sacramento River and the tendency for juveniles fish to seek off-channel, non-natal rearing sites during high Sacramento River flow conditions. Maslin *et al.* (1997) believe that non-natal tributaries are often used by outmigrating salmon and steelhead because they provide better growth conditions (*i.e.*, reduced turbidity, higher water temperatures) than may be present on the Sacramento River. During the winter-run outmigration period, the

American River would provide better rearing conditions due to the lower turbidity and higher water temperatures. The project length is approximately 1,000 feet, the width varies from 0 to 300 feet measured from the edge of the river, and the project footprint is approximately 4 acres. This reach of the lower American River was substantially altered by the massive amounts of sediment deposited as a result of hydraulic mining in the upper watershed. The result is an elevated floodplain that has significantly altered the natural relationship between the river and the surrounding floodplain. The desirable vegetation communities are not reproducing and the floodplain is rarely available to fish. The Corps has issued a design contract, and construction will be initiated during 2007. The predominant project feature would be a large graded bench with an elevation range between 4 and 12 feet covering approximately a 2.0 acre area. The majority of this area is between elevation 5 and 9 feet. These elevations are designed to produce shallow inundation at average spring and winter river stages of 8 feet and 9.5 feet, respectively. The bench area grading includes two sloping depressions that are designed with inlets from the main channel to facilitate full drainage of the project site and reduce the risk of stranding fish during the transition to very low water river stages. Overall, the site will support a broad range of riparian habitat, providing a thick band of vegetation near the river and a less dense and varied palette over the rest of the project footprint. The design also includes the incorporation of IWM to provide enhanced fish cover along the bank and brush mattresses to control erosion. A distribution of relatively level benches at various elevations will provide shallow water for diverse salmonid rearing opportunities at target river stages. Preliminary SAM modeling for conceptual designs shows that the American River site will provide extensive habitat value that may fully compensate for the habitat losses at RM 149, and 56.7.

The Sacramento RM 82 site also offers opportunities for offsite mitigation if the American River site does not provide full compensation as to be determined through SAM modeling. The Corps is coordinating with CDWR to complete the real estate negotiations associated with acquiring the property. Once this is complete, a habitat restoration and enhancement project will be designed to compensate for past, and possibly future bank protection projects, as necessary.

The objectives of the lower American River restoration are to restore natural habitats that will benefit special-status species including Federally listed fish, and several other plant and wildlife species. A primary component is to create juvenile salmonid habitat by constructing a vegetated bench with a range of elevations that will be inundated by typical winter and spring river stages. The range of elevations is designed to provide shallow (*i.e.*, 1 to 3 feet) of inundation in the target seasons and to create several planting zones related to hydrologic characteristics. The planting zones will provide a mixture of vegetation types to protect against erosion and provide cover for salmonids. The grading and planting plan is also designed to minimize predator species habitat and eliminate potential fish stranding in an existing closed depression in the terrace at the site. The project design is intended to be consistent with management objectives for Discovery Park, including those presented in the River Corridor Management Plan for the Lower American River.

In November 2006, The Corps SRBPP and CDWR's Division of Engineering completed construction of 33 critical levee erosion repair projects in the Sacramento River, the Bear River, and in Sutter and Cache Sloughs. The Corp's SRBPP constructed bank protection repairs at thirteen sites, along the Sacramento River between RMs 26.9 and 123.5. CDWR constructed bank protection repairs at sixteen sites in the SRFCP. Ten sites were along the Sacramento River, two sites were along the Bear River, two sites were along Cache Slough, one sight was along Sutter Slough, and one site was along Butte Creek. A setback levee was constructed at RM 145.9 to avoid adverse impacts to sensitive aquatic resources. These projects placed rock and wood revetments along the waterside slope of each erosion site. One repair along the Sacramento River was a set-back levee. Overall, these projects reinforced approximately 25,801 lf of shoreline, covering approximately 50.9 acres, with 26.4 acres of rock riprap placed below the mean summer water level. The area above the mean summer water level was covered with soil and planted with riparian vegetation at all Corps and some CDWR sites. Seasonally inundated benches total approximately 11.6 acres. Approximately 6,795 lf of IWM was placed both above the mean summer water level and 7,346 lf was placed below.

Similar to the proposed action, the previous 33 bank protection projects were designed to repair bank and levee erosion and restore and enhance the riparian and SRA habitat. Generally, this was accomplished by incorporating rock benches, that serve as buffers against extreme toe scour and shear stress while providing space for planting riparian vegetation and creating a platform to support aquatic habitat features. This approach recreates the elements of natural SRA habitat that otherwise would be lost as a result of project construction activities and continued erosion. Implementation of these conservation measures was meant ensure that long-term impacts associated with existing, and future bank protection projects are compensated in a way that prevents incremental habitat fragmentation and reductions of the conservation value of aquatic habitat to anadromous fish within the action area. Successful implementation of all conservation measures is expected to improve migration and rearing conditions for juvenile anadromous fish by increasing the amount of flooded shallow water habitat and SRA habitat throughout the action area.

Despite the integrated conservation measures, long- and short-term impacts are expected. Primarily, long-term (*i.e.*, 5 to 50 year) impacts to listed salmonids will occur in the form of injury or death to juveniles summer and fall WSELs from the modification of shoreline habitat and the loss of IWM and other SRA. Short-term (*i.e.*,1 to 5 year) effects will occur at winter and spring WSELs, primarily from the temporary reduction of IWM and riparian vegetation. Overall, substantial long-term improvements are expected for the life of the project due to the construction of benches, the application of soil and IWM, and the extensive planting of riparian vegetation.

Preliminary reviews of the 33 sites indicate that construction at some sites removed more riparian vegetation, and placed less IWM than was initially planned. As a result CDWR has developed a 6-point riparian protection plan and is coordinating closely with NMFS for any vegetation removal required to install project features. CDWR also will re-evaluate each site for IWM quantities, will conduct a follow-up SAM analysis, and will conduct several years of SAM-related monitoring. If the habitat values do not meet the modeled values, additional compensation measures will be implemented.

In January, 2007, the Corps began construction on an additional 14 sites, totaling approximately 9,817 lf along the Sacramento River and Sutter Slough. Similar to the 33 projects constructed in 2006, these projects are placing rock and wood revetments along the waterside slope of each erosion site. Once complete, these projects will affect approximately 21.7 acres, vegetated approximately 13.3 acres, and place approximately 7,705 lf of IWM. The effects of these projects are similar to the effects of the previously described 33 sites finished in November, 2006, with the exception that construction of the 14 ongoing projects started during winter months and overlapped with peak migration periods for several species and life-history stages of anadromous fish.

In mid-January, the Brannan-Andrus Levee Maintenance District (BALMD) began 13 levee repair projects along 3,500 lf of the Sacramento River between RMs 10.9 and 15.4. Similar to the previously described levee repair projects, the BALMD repair sites included extensive on-site compensation measures and are expected to maintain, and eventually improve migration and rearing conditions for juvenile anadromous fish by increasing the amount of flooded shallow water habitat and SRA habitat throughout the action area.

Comprehensive aquatic evaluations of the projects constructed since 2001 are not available. Biological opinions written for bank protection projects since 2001 have emphasized the need for a comprehensive monitoring and evaluation program. In response to these biological opinions, the Corps and CDWR have convened an aquatic monitoring committee that included biologists and engineers from the Corps, CDWR, USFWS, CDFG, and NMFS. The Corps has awarded contracts to begin preliminary aquatic and physical habitat monitoring at all of the sites they have constructed since 2001, and three CDWR projects.

2. <u>Southern Distinct Population Segment of North American Green Sturgeon</u>

Point source and non-point source pollution resulting from agricultural discharge and urban and industrial development occurs in the action area. The effects of these impacts are discussed in detail in the *Status of the Species and Habitat* section. Environmental stresses as a result of low water quality can lower reproductive success and may account for low productivity rates of green sturgeon (Klimley 2002). Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high trace element concentrations may deleteriously affect early life-stage survival of fish in the Sacramento River (USFWS 1995). Principle sources of organic contamination in the Sacramento River are rice field discharges from Butte Slough, Reclamation District 108, Colusa Basin Drain, Sacramento Slough, and Jack Slough (USFWS 1995). In addition, organic contaminants from agricultural returns, urban and agricultural runoff from storm events, and high trace element concentrations may deleteriously affect early life-stage survival of green sturgeon. The high number of diversions in the action area on the Sacramento River and in the north Delta are a potential threat to North American green sturgeon. Other impacts to adult migration present in the action area, such as migration barriers, water conveyance factors, and water quality, non-native species, *etc.*, are discussed in the *Status of Species and Critical Habitat* section.

The Sacramento River is utilized by larvae and post-larvae and to a lesser extent, juvenile North American green sturgeon for rearing and migration purposes. Although it is believed that larvae and post-larvae as well as juveniles primarily are benthic (with the exception of the post-larvae nocturnal swim-up believed to be a dispersal mechanism), the massive channelization effort in 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).

C. Likelihood of Species Survival and Recovery and Conservation Value of Critical Habitat in the Action Area

A majority of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead currently utilize the Sacramento River for rearing and migration. Some of these fish are expected to use off-channel estuarine areas in Sutter Slough and the Bear River for rearing and migration. Although the fish habitat in these areas is currently degraded, it has a high conservation value for the species because of their location, and the habitat features they provide that are essential to fulfilling certain life history requirements such as growth during outmigration. Recent improvement in bank protection practices that integrate fish habitat features will contribute to improvements of habitat condition and function throughout the action area.

In their recent evaluation of the viability of Central Valley salmonids, Lindley et al. (2007) found that extant populations of Sacramento River winter-run Chinook salmon and CV steelhead appear to be fairly viable. These populations meet several viability criteria including population size, growth, and risk from hatchery strays. The viability of the ESU to which these populations belong appears low to moderate, and the ESU remains vulnerable to extirpation due to their small-scale distribution and high likelihood of being affected by a significant catastrophic event. Lindley et al. were not able to determine the viability of existing steelhead populations, but believe that the DPS has a moderate to high risk of extirpation since most of the historic habitat is inaccessible due to dams, and because the anadromous life-history strategy is being replaced by residency.

The southern DPS of North American green sturgeon utilize the mainstem Sacramento River for spawning, rearing, and migration purposes. In addition, the Southern DPS of North American green sturgeon are known to occur in Delta areas, and recently have been seen in the Feather and Yuba River. Habitats of the Sacramento River are very important for the Southern DPS of North American green sturgeon as they are the only know location for spawning. Recent population estimates indicate that there are few fish relative to historic conditions, and that loss of habitat has affected population size and distribution. However, sturgeon remain widely distributed along the Pacific coast from California to Washington, and recent findings of fish in the Feather and the Yuba River indicate that their distribution in the Central Valley may be more broad that the previously thought. This suggests that the DPS probably meets several viable species population criteria for distribution and diversity, and indicates that the Southern DPS of North American green sturgeon faces a low to moderate risk of extirpation.

Based on these viability assessments, and the recent habitat improvements occurring throughout the action area to improve the conservation value of aquatic habitat for listed fish, Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the southern DPS of North American green sturgeon are likely to continue to survive and recover in the action area.

V. EFFECTS OF THE ACTION

A. Approach to the Assessment

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

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

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

NMFS generally approaches "jeopardy" analyses in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of proposed actions on individual members of listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - 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 a sound. Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

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

The information used in this assessment includes fishery information previously described in the *Status of the Species* and *Environmental Baseline* sections of this biological opinion; studies and accounts of the impacts of riprapping and in-river construction activities on anadromous habitat and ecosystem function; and documents prepared in support of the proposed action, including the January 2006 BA (URS 2006); SAM results; project designs; field reviews, and meetings held between the Corps, NMFS, USFWS, and CDFG.

B. Assessment

The assessment will consider the nature, duration, and extent of the proposed action relative to the migration timing, behavior, and habitat requirements of Federally listed Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon. Specifically, this assessment will consider the potential impacts related to construction and O&M activities, and will use the SAM model (Corps 2004) to assess species response to habitat modifications from proposed bank protection projects over a 50-year period. At this time, the SAM does not apply to green sturgeon. Therefore, long-term impacts to green sturgeon will be evaluated separately from impacts to anadromous salmonids.

The assessment of effects considers the potential occurrence of Federally listed Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon, relative to the magnitude, timing, frequency, and duration of project activities. Effects of the proposed project on aquatic resources include both short- and long-term impacts. Short-term effects, which are related primarily to construction activities (*i.e.*, increased suspended sediment and turbidity), may last several hours to several weeks. O&M impacts are related to annual actions necessary to maintain project features and may occur for the life of the project (*i.e.*, 50 years). Long-term impacts may last months or years and generally involve physical alteration of the river bank and riparian vegetation adjacent to the water's edge.

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

1. Construction-related Effects

Construction will occur between November 13, 2006, and November 30, 2007, and will affect approximately 11,540 lf of river and slough bank and channel bottom. Specifically, construction will affect 8,840 lf of the Sacramento River, and 2,600 lf of Sutter Slough. Phase 1 will involve the placement of toe rock to provide immediate stability to critical sites. Phase 2, will involve limited construction below the water line, but will affect riparian and shoreline areas primarily above the summer WSEL.

Phase 1 In-water construction activities, including the placement of rock revetment, could result in direct effects to fish from the placement of rock into occupied habitat during peak migration periods. The project would result in localized, temporary disturbance of habitat conditions that may alter natural behavior patterns of adult and juvenile fish and cause the injury or death of individuals. These effects may include displacement, or impairment of feeding, migration, or other essential behaviors by adult and juvenile salmon, steelhead, and green sturgeon from noise, suspended sediment, turbidity, and sediment deposition generated during in-water construction activities. Some of these effects could occur in areas downstream of the project sites, because noise and sediment may be propagated downstream.

Phase 2 would require only limited in-water construction, and would occur at a time when low numbers of fish would be present throughout the action area. Riparian habitat within the project footprint that was not disturbed by Phase 1, may be affected during Phase 2. Due to the summer construction period and limited extent of in-water work, Phase 2 actions are not likely to cause direct adverse effects to listed fish, but may adversely affect critical habitat.

The extent of Phase 1 construction-related effects is dependant upon the timing of fish presence in the action area, and their ability to successfully avoid project-related disturbance. Phase one coincides with the peak migration periods of all Federally listed anadromous fish species. Peak winter-run Chinook salmon emigration in the action area occurs between November and January, and commonly coincides with initial flow increases of up to 20,000 cfs, which occur from December through February. Juvenile CV spring-run Chinook salmon and CV steelhead migration can begin as early as November, but similar to winter-run, the peak migration occurs during sustained high flow periods between December and March. Sacramento River winter-run Chinook salmon are expected to be present in the action area from December through May. CV spring-run Chinook are expected in the action area from January through July, and CV steelhead will be present from November through May of Phase 1, and from September through November during Phase 2.

Green sturgeon larvae and post-larvae are present in the action area between June and October with highest abundance during June and July (CDFG 2002), and remain in freshwater portions of the Delta for up to 10 months (Kynard *et al.* 2005). In addition, small numbers of juvenile sturgeon less than two years of age have been captured in the action area sporadically in the past (Jeff McLain, NMFS, pers. comm., 2006). Adult green sturgeon holding occurs in the Sacramento River in deep pools for up to six months per year, primarily between March and July (USFWS 2002).

a. *Potential Direct Effects from Rock Placement into Occupied Aquatic Habitat*

(1) *Salmon and Steelhead*

The placement of rock below the waterline will cause noise and physical disturbance that could displace juvenile and adult fish into adjacent habitats, or crush and injure or kill individuals. The impact of rock being placed in the river disrupts the river flow by producing surface water waves disturbing the water column; resulting in increased turbulence and turbidity. Migrating juveniles react to this situation by suddenly dispersing in random directions (Carlson *et al.* 2001). This displacement can lead them into predator habitat where they can be targeted, and injured and killed by opportunistic predators taking advantage of juvenile behavioural changes. Carlson *et al.* (2001) observed this behaviour occurring in response to routine channel maintenance activities in the Columbia River. Some of the fish that did not immediately recover from the disorientation of turbidity and noise from channel dredges and pile driving swam directly into the point of contact with predators. Feist (1991) found that noise from pile driving activities in the Puget Sound affected the general behaviour of juveniles by temporarily displacing them from construction areas. Nearly twice as many fish were observed at construction sites on non-pile driving days compared to days when pile driving occurred.

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

NMFS was unable to find any scientific evidence that fish may be injured or killed by crushing from rock placement. Regardless, many juvenile fish are small, relatively slow swimmers, typically found in the upper two feet of the water column, and oriented to nearshore habitat. Larger fish, including adults and smolts probably would respond by quickly swimming away from the placement site, and would escape injury or death. Fry-sized fish (those that are less than 50mm) that are directly in the path of rock placement may be less likely to avoid the impact. Therefore, it appears likely that the placement of large quantities into this habitat has the potential to crush and injure or kill fry-sized salmon and steelhead. However, the best available outmigration data throughout the Sacramento River, indicate that a large majority of fry-size listed salmon or steelhead are transported downstream during high flow conditions. In such a case, the CDWR would likely suspend construction until flows subsided. CDWR also has proposed to suspend construction if ongoing fishery monitoring programs indicate that large numbers of anadromous fish are within the action area. The RM 182 site is the only area where fry-sized fish are likely to be present during construction. This is evidenced by the fry-sized winter-run Chinook salmon that are consistently trapped by CDFG rotary screw traps from August through December, at GCID, near RM 222. RST captures are low in August and peak from October through November. NMFS expects that due to the presence of winter-run fry during the placement of approximately 100,000 cubic yards of rock along 4,500 lf of the Sacramento River at RM 182, some individuals are likely to be crushed and killed, or displaced from their preferred habitat and preyed upon by larger piscivourous fish such as pikeminnow and striped bass.

The operation of heavy equipment such as crane mounted barges and the sound generated by construction activities may temporarily affect the behavior of migrating adult salmonids, possibly causing migration delays. Construction will be restricted to the channel edge, and would include implementation of the avoidance and minimization measures that will prevent impacts to these migration corridors. Construction activities that are limited to the shoreline are not likely to injure or kill adult winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead because their crepuscular migration behavior, and use of mid-channel, deep water habitats allows them to easily avoid nearshore disturbance and migrate through the action area without experiencing physical injury or death.

(2) *Green Sturgeon*

Rock placement will occur while green sturgeon are present in the action area. In-water activities could cause injury or mortality to individual green sturgeon that do not readily move away from the areas directly affected by rock placement. However, NMFS expects that since juvenile and adult green sturgeon show a preference for benthic habitat types, few fish should be exposed to rock placement along the shoreline, and construction activities are not likely to injure or kill juveniles or adults.

b. *Potential Effects of Sediment and Turbidity*

Rock placement and nearshore construction will disturb soils and the riverbed and result in increased erosion, siltation, and sedimentation. Short-term increases in turbidity and suspended sediment may disrupt feeding activities of fish or result in temporary displacement from preferred habitats.

(1) *Salmon and Steelhead*

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 Nephelometric Turbidity Unit (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. Bisson and Bilby (1982) reported that juvenile coho salmon avoid turbidities exceeding 70 NTUs. 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). We expect turbidity to affect Chinook salmon and steelhead in much the same way that it affects other salmonids, because of similar physiological and life history requirements between species.

Newcombe and Jensen (1996) believe that impacts on fish populations exposed to episodes of high suspended sediment may vary depending on the circumstance of the event. They also believe that wild fish may be less susceptible to direct and indirect effects of localized suspended sediment and turbidity increases because they are free to move elsewhere in the system and avoid sediment related effects. They emphasize that the severity of effects on salmonids depends not only on sediment concentration, but also on duration of exposure and the sensitivity of the affected life stage.

Suspended sediment from construction activities would increase turbidity at the project site and could continue downstream. Although Chinook salmon and steelhead are highly migratory and capable of moving freely throughout the action area, an increase in turbidity may injure fish by temporarily disrupting normal behaviors that are essential to growth and survival such as feeding, sheltering, and migrating. 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. Project-related turbidity increases may also affect the sheltering abilities of some fish and may decrease their likelihood of survival by increasing their susceptibility to predation.

Based on similar projects conducted by CDWR and the Corps, construction activities are expected to result in periodic turbidity levels that exceed 25 to 75 NTUs. These levels are capable of affecting normal feeding and sheltering behavior. Based on observations during similar construction activities in the Sacramento River, turbidity plumes are not expected to extend across the Sacramento River, but rather the plume is expected to extend downstream from the site along the side of the channel. Turbidity plumes will occur during daylight hours during in-water construction. At a maximum, these plumes are expected to be as wide as 100 feet, and extend downstream for up to 1,000 feet. Most plumes extend into the channel approximately 10 to 15 feet, and downstream less than 200 feet. In contrast, the channel of the Sacramento River is several hundred feet wide. Once construction stops, water quality is expected to return to background levels within hours. Adherence to erosion control measures and BMPs such as use of silt fences, straw bales and straw wattles will minimize the amount of project-related sediment and minimize the potential for post-construction turbidity changes. Since project-related turbidity plumes will be limited to shoreline construction areas, and the Sacramento River is much wider than any plume that could be generated, NMFS expects that individual fish will mostly avoid the turbid areas of the river and use alternate migration corridors or rearing habitat. For those fish that do not avoid the turbid water, exposure is expected to be brief (*i.e.*, minutes to hours) and not likely to cause injury or death from reduced growth, or physiological stress. This expectation is based on the general avoidance behaviors of salmon and the Corps proposal to suspend construction when turbidity exceeds Regional Board standards. However, some juveniles that are exposed to turbidity plumes may be injured or killed by predatory fish that take advantage of disrupted normal behavior. Once fish migrate past the turbid water, normal feeding and migration behaviors are expected to resume.

(2) *Green Sturgeon*

Green sturgeon will be present in the action area during construction, and therefore may be exposed and affected by short-term increases in turbidity and suspended sediment if these increases disrupt feeding and migratory behavior activities of post-larvae, juvenile, and adult fish. Turbidity and sedimentation events are not expected to affect visual feeding success of green sturgeon, as they are not believed to utilize visual cues (Sillman *et al.* 2005). Instead, olfaction appears to be a key feeding mechanism. In addition, green sturgeon are primarily benthic, and their presence along the shoreline is not expected to be common. Therefore, adverse effects including injury or death from temporary increases in sediment and turbidity are not likely.

c. *Other Potential Water Quality Effects*

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

d. *Summary of Construction-related Effects to Species*

(1) *Salmon and Steelhead*

Those fish that are exposed to project construction will encounter short-term (*i.e.*, minutes to hours) construction-related noise, physical disturbance, and water quality changes that may cause injury or death by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors, and affecting sheltering abilities. Some juvenile fish may be crushed, and killed or injured during rock placement, especially fry-sized winter-run Chinook salmon that may be present at RM 182. Others may be displaced from natural shelter and preyed upon by piscivorous fish. Although construction will occur during peak migration periods, adult fish are expected to avoid construction activities due to their predominately crepuscular migration behaviors.

(2) *Green Sturgeon*

NMFS expects that green sturgeon will be present in the action area during Phase 1 and Phase 2 construction because of the peak migration periods that occur during this time. Green sturgeon are primarily benthic, and their presence along the shoreline is not expected to be common. Therefore, adverse effects including injury or death from construction activities are not likely.

e. *Construction-related effects to Critical Habitat*

Construction activities will alter short-and long-term site-scale physical characteristics of the PCEs of salmon and steelhead critical habitat, including elements of freshwater and estuarine rearing and migration habitat. The short term impacts are less usable and degradable water quality conditions that were previously discussed in *Section 1, Short-term Construction-related Impacts,* in terms of how the changes will affect juvenile adult and juvenile behavior and survival. The long-term effects are discussed below in *Section 3, Long Term Impacts as Projected by the SAM Model.*

2. <u>Effects of Project Operation and Maintenance</u>

O&M activities are expected to occur between July 1 and November 30 for the life of the project (*i.e.*, 50 years) to maintain the flood control and environmental values of the site. Anticipated O&M actions include vegetation management and irrigation for up to three years, periodic rock placement to prevent or repair localized scouring, and periodic replacement or modification of IWM structures. O&M actions will include BMPs, summer in-water construction windows, and other minimization and avoidance measures will be implemented to reduce these effects to anadromous salmonids, green sturgeon, and their habitat. Effects would be limited to the annual placement of up to 600 cubic yards of material, except that they will be smaller and localized. Most repairs would require less than 600 cubic yards of material. Impacts from O&M actions generally will be similar to the impacts of initial construction, and include injury or death to salmon and steelhead from predation cause by turbidity changes that temporarily disrupt normal behaviors, and affect sheltering abilities; impacts to green sturgeon are not expected. However, since O&M actions are only expected to repair damaged elements of the project, they are expected to be infrequent (*i.e.*, occurring only once every several years), small (*i.e,* only affecting small sections of the project area), and will not occur at all sites. Therefore relatively few salmonids should be affected by O&M actions, and actual injury and mortality levels will be low relative to overall population abundance and not likely to cause any long-term, negative population responses.

3. Long Term Impacts as Projected by the SAM Model

The project is expected to result in long-term habitat modifications, including modifications to the designated critical habitat of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead. The modifications will affect fish behavior, growth and survival, and the PCEs of critical habitat including freshwater and estuarine rearing sites and migration corridors.

Long-term project effects include the alteration of river hydraulics and cover along approximately 11,540 lf of shoreline as a result of changes in bank configuration and structural features. These changes may affect the quantity and quality of nearshore habitat for juvenile Chinook salmon, steelhead. Simple revetted slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit the 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.

Removal of riparian vegetation and IWM from stream banks results in the temporal loss of a primary source of overhead and instream cover for juvenile salmonids. The removal of riparian vegetation and IWM and the replacement of natural bank substrates with rock revetment can adversely affect important ecosystem functions. Living space and food for terrestrial and aquatic invertebrates is lost, eliminating an important food source for juvenile salmonids. Loss of riparian vegetation and soft substrates reduces inputs of organic material to the stream ecosystem in the form of leaves, detritus, and woody debris, which can affect biological production at all trophic levels. The magnitude of these effects depends on the degree to which riparian vegetation and natural substrates are preserved or recovered during the life of the project. As a result, habitat diversity, complexity, and quality for survival and growth are diminished.

Several project features were designed to address the need for ecologically functional shallow-water, floodplain habitat, riparian habitat, and cover in the confined reaches of the lower Sacramento River. The inclusion of a bench, planting riparian vegetation, and placement of IWM will help restore habitat diversity. Irregular shorelines, riparian vegetation, IWM, and variability in bench elevations are expected to create low-velocity zones of deposition where sediment and organic material will be stored and made available to aquatic invertebrates and other decomposers. Vegetated low benches also will provide high-quality shallow water habitat for fish during winter and spring that will increase in value over time, as the vegetation becomes established.

Riparian vegetation along streams provides shade, which incrementally moderates stream temperatures and prevents direct solar exposure of fish at shallow depths. The role of riparian shade in moderating stream temperatures is greatest on small streams and decreases with increasing stream size. Because of the large size of the Sacramento River, relative to its existing shoreline canopy, the effect of riparian vegetation in moderating water temperatures is minor, compared with the effects of reservoir operations, discharge, and meteorological conditions. Similarly, the effect of shade on Sutter Slough is minimal, primarily because of the low elevations and extremely warm summer air temperatures.

Most importantly, the removal of riparian vegetation reduces the potential recruitment of IWM and diverse fish habitat features at the project site and downstream. Minimizing the removal of existing riparian vegetation will reduce project impacts on IWM recruitment. However, for the purpose of the SAM assessment, it is assumed that up to 40 percent of the existing shoreline riparian canopy may be affected by project implementation. This is a very rough estimate, as effects to the riparian canopy will be necessary only to facilitate the placement of rock from a barge. Similarly, although all IWM will be left in place, some IWM will be covered with rock, and the SAM assessment assumes that up to 50 percent of the function of existing IWM will be lost to construction. Extensive revegetation, and installation of additional IWM is expected to reduce these impacts and losses of function.

a. *SAM Analysis*

Long-term project effects to critical habitat and salmonid responses to such changes are measured in terms of the length and area of bank and channel bed disturbed by construction, and the quantity and quality of habitat as measured by the SAM. The SAM was developed by the Corps, in consultation with NMFS, USFWS, CDFG and CDWR, to address specific habitat assessment and regulatory needs for ongoing and future bank protection actions in the SRBPP action area. The SAM was designed to address a number of limitations associated with previous habitat assessment approaches and provide a tool to systematically evaluate the impacts and compensation requirements of bank protection projects based on the needs of listed fish species (with the exception of Southern DPS green sturgeon). A major advantage of the SAM is that it integrates species life history and flow-related variability in habitat quality and availability to generate species responses to project actions over time. Species responses represent an index of a species growth and survival based on a 30-day exposure to post project conditions at a variety of seasons and life-history stages, over the life of the project.

In general, the SAM quantifies habitat values in terms of a bank line or area-weighted species response index (WRI) that is calculated by combining habitat quality (*i.e.*, fish response indices) with quantity (*i.e.*, bank length or wetted area) for each season, target year, and relevant species/life stage. The fish response indices are derived from hypothesized relationships between key habitat variables and the responses of individual species and life stages. Rearing and outmigrating Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead responses to habitat variables tend to be similar, although seasonal presence and exposure may vary.

The response indices vary from 0 to 1, with 0 representing unsuitable conditions and 1 representing optimal conditions for survival and growth. For a given site and scenario (*i.e.*, with or without project), the SAM uses these relationships to determine the response of individual species and life stages to the measured or predicted values of each variable for each season and target year, and then multiplies these values together to generate an overall species response index. This index can then multiplied by the area or lf of bank or the project area to which it applies to generate a weighted species response index, expressed as feet or square feet. The species response index provides a common metric that can be used to quantify habitat values over time, compare project alternatives to existing conditions, and evaluate the effectiveness of on-site and off-site compensation actions. Positive SAM results are a relative index of improved growth and survival conditions, and negative results (SAM deficits) are indicators of reduced growth and survival conditions, or injury and death of individuals exposed to a project site.

The SAM (Corps 2004) employs the following six habitat variables to characterize nearshore and floodplain habitats of listed fish species:

- Bank slope – Bank Slope is an indicator of shallow-water habitat availability, which is important for juveniles for feeding, rearing, and refugia from high flows and predators. The relationship of bank slope to fish response is related to how variations in fish size and foraging strategies affect growth potential and expose various species and life stages to predation risk. For fry and smolts of each species, shallow water near the bank is considered to be high value because it provides refuge from predators and low velocity feeding and rearing habitat (Power 1987, Waite and Barnhart 1992, and Schlosser 1991). Smaller fish can avoid predation by piscivorous fish to some degree by selecting shallower water. Although larger fish (*i.e.*, smolts) typically use deeper water habitats, it is assumed that predation risk also increases. Adult life stages are not affected by the same predation as juveniles and tend to utilize deep, mid-channel habitat as migratory corridors. Therefore, adults are not expected to be sensitive to changes in bank slope.

  Bank slopes corresponding to each seasonal shoreline were obtained for existing and with-project conditions by averaging the slopes from a series of cross sections representing existing bank and 90 percent design contours. Following a review of the original methods, it was recommended that seasonal bank slopes be measured from the submerged portion of the bank immediately below the average seasonal water-surface level. For the purposes of this assessment, the bank slope extending from each seasonal shoreline to a depth of 3 feet was used to characterize shallow water habitat.

- Floodplain availability – This is the ratio of wetted channel and floodplain area during the 2-year flood to the wetted channel area during average winter and spring flows.

Floodplain availability is used as an indicator of seasonally flooded shallow-water habitat availability, which is important for juveniles for feeding, rearing, and refugia from high flows and predators. Use of seasonally inundated flooded habitat is generally considered to increase growth of juvenile salmonids due to greater access to areas with high invertebrate productivity from flooded terrestrial matter (Sommer *et al.* 2001). Predation risk in seasonally flooded areas is expected to be less in seasonally inundated areas with large amounts of hiding cover and a lack of piscivorous fish. Adult life stages tend to utilize deep, mid-channel habitat and are not expected to be sensitive to changes in floodplain availability.

For this assessment, floodplain availability is measured by dividing the wetted channel and floodplain area during the 2-year flood event by the wetted channel area during average winter and spring flows. This variable was set at 1.0 for both existing and with-project conditions because no significant changes in this ratio will occur as a result of the project.

- Bank substrate size – This is measured as the median particle diameter of the bank (*i.e.*, D50) immediately below (*i.e.*, 0 to 3 feet) each average seasonal WSEL. Bank substrate size is used as an indicator of juvenile refugia from predators, but also as an indicator of suitable predator habitat. Increased predator density has been observed at riprapped sites relative to natural banks at studies in the Sacramento River and the Delta (Michny and Deibel 1986, Michny 1989). Substrate size also is used as an indicator of food availability. The effects of substrate size on mortality risk are expected to be greatest at small grain sizes due to a lack of cover from avian and piscivorous fish predation. Predation risk is lower at intermediate sizes close to the size of the affected life stage because small interstitial spaces offer cover from predators. Predation risk is highest when grain sizes exceed the length of the affected life stage, because interstitial spaces are capable of providing effective cover for piscivorous fish species. Adult life stages tend to utilize deep, mid-channel habitat and are not expected to be sensitive to changes in bank substrate size.

  For this assessment, a value of 0.01 inch was used to characterize fine sediment, and a value of 10 inches was used to characterize rock revetment, the two dominant substrate types under existing and with-project conditions.

- Instream structure – This is measured as the percent of shoreline coverage of IWM along each average seasonal WSEL. The value of instream structure to salmonids has been directly demonstrated by various studies. Instream structure is an indicator of juvenile refugia from predators (Michny and Hampton 1984, Michny and Deibel 1986). Instream structure is used as an indicator of food availability, feeding station availability, and as cover and resting habitat for adults. Instream structure provides high quality resting areas for adults and juveniles, cover from predation, and substrate for macroinvertebrate production (USFWS 2000, Lassettre and Harris 2001, Piegay 2002).

For this assessment, the variable was measured by estimating the percentage of shoreline occupied by IWM within the inundation zone associated with each seasonal WSEL under existing and with-project conditions. Estimates of existing IWM were based on field estimates and photographs of the project sites taken in October 2006. For with-project conditions, IWM values of 40 to 80 percent IWM were assumed at summer and spring seasonal elevations.

- Aquatic and submerged terrestrial vegetation – This is measured as the percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal WSEL. Aquatic vegetation is used as an indicator of juvenile refugia from predators, and food availability. Rearing success is strongly affected by aquatic vegetation (Corps 2004). Biological response to aquatic vegetation is influenced by the potential for food production and cover to sensitive life stages. Because salmonid fry and juveniles are commonly found along shore in flooded vegetation (Cannon and Kennedy 2003) increases in aquatic and submerged terrestrial vegetation is expected to result in a positive salmonid response (*i.e.*, increased growth, reduced risk of predation). Adult salmonids are not expected to be sensitive to changes in aquatic or submerged terrestrial vegetation.

  For this assessment, the variable was measured by estimating the percentage of shoreline that is occupied by vegetation within the inundation zone associated with each average seasonal flow under existing and with-project conditions. Measurements of the linear extent of existing vegetation along the summer-fall and winter-spring shoreline were based on field estimates and photographs of the project sites taken in October 2006. With-project estimates of vegetative cover were based on the planting plans and observed growth rates and canopy widths of planted trees and shrubs on constructed banks. It was assumed that vegetative cover along the winter and spring shorelines will increase from 20 percent in year 1 to 75 percent by year 15.

- Overhanging shade – This is measured as the percent of the shoreline coverage of shade along each average seasonal WSEL. The value of overhanging shade is an indicator of juvenile refugia from predators, and food availability. Numerous studies have shown the importance of overhanging shade to salmonids. Overhanging shade provides overhead cover, and allochthonous inputs of leaf litter and insects which provide food for juveniles. Michny and Hampton (1984), and Michny and Deibel (1986) juvenile salmonid abundance was highest in reaches of the Sacramento River with shaded riparian cover.

  Shade was measured by estimating the percentage of shoreline in which riparian vegetation extends over the water during average seasonal flows. Measurements of the linear extent of shade along the summer-fall and winter-spring shoreline were based on field estimates and photographs of the project sites taken in October 2006. Based on the project description, it was assumed that all mature trees currently shading the winter-spring shoreline would be maintained under with-project conditions. It also was assumed that the extent of shade over the winter and spring shoreline will increase in response to increasing vegetative cover but that shade cover will be limited to a smaller percentage of the total shoreline length because of expected gaps in the canopy. Expected increases in canopy widths of trees and shrubs on the constructed bench eventually will result in shading of the summer-fall shoreline. Shade cover is expected to result in 50 percent shading of the winter-spring shoreline and 10 percent of the summer-fall shoreline by year 15.

The SAM was used to quantify the responses of the target fish species and life stages to with-project conditions over a 50-year project period relative to the species and life stage responses under without-project (existing) conditions. The assessment followed the general steps outlined in the SAM Users Manual (Stillwater Sciences and Dean Ryan Consultants & Designers 2004). All computations were performed using the electronic calculation template provided by Stillwater Sciences. The results are presented in terms of WRIs for each target species, life stages, and season of occurrence in the project area. Input data includes site- and reach-scale data on existing bank slope, floodplain availability, bank substrate size, instream structure, aquatic and submerged aquatic vegetation, and overhanging shade at four average seasonal WSELs.

SAM modeling results from the BA (URS 2007), are summarized in Appendix B, Figures 1 through 16 of this biological opinion. Results are shown for each species, at each average seasonal WSEL, over a 50 year period, at year 1, 5, 10, 15, and 50. The results are preliminary because the details of Phase 2 will be developed while Phase 1 is under construction. The SAM analysis will be repeated during or following construction to more accurately reflect as-built conditions. Results are summarized for Chinook salmon and CV steelhead at average seasonal water surface WSELs.

The model is capable of projecting how without-project scenario conditions would change over time. However, the modeling for this project compares the with-project conditions to a static existing baseline to simplify the interpretation of modeling results, and because the baseline SRA conditions at the project sites would decline over the projected 50-year life of the project as the small amount of remaining SRA habitat disappears, without replacement, to ongoing erosion. Also, given the critical state of the existing sites, the without-project scenario is likely to include emergency flood fighting that would result in substantial habitat degradation.

As with many models, SAM modeling is based on many assumptions about species behavior and response to habitat changes. There also are untested assumptions regarding the response of physical project elements to river flows and other unpredictable environmental events. Therefore, there is uncertainty regarding the results. To account for some of the uncertainty, the Corps, NMFS, USFWS, and fishery scientists from Stillwater Sciences, and the URS Corporation discussed and agreed upon model input variables intended to generate conservative estimates of habitat modification and improvement. The model itself accounts for some of the uncertainty by generating results at four different average WSELs. To account for site diversity, model input values are not measured only at discrete average flow elevations, but within three feet of these elevations. Although the model focuses on a discrete average WSEL, seasonal variability of average flows is accounted for in the project designs because project features, and conservation measures (*i.e.*, benches, vegetation, and IWM) are placed at different elevations within the cross-sectional area of the site. Project-specific, and long-term comprehensive monitoring will measure the success of model results by evaluating habitat evolution. These monitoring results will be used to make adaptive project modifications necessary to ensure that fish and habitat responses occur as predicted.

Further support for expectations regarding the physical response to habitat conditions over time is supported by the monitoring results for similar projects in the American and Sacramento Rivers. Riparian and SRA monitoring at eight bank protection or revegetation projects along the American River, demonstrated that riparian goals for tree and shrub width, height, cover, and shoreline cover were met or exceeded at all sites (Ross, 2006). At the Sand Cove bank protection project, along the Sacramento River, riparian establishment rates after year 1 were high, especially on the upper slope of the project. Along the lower slope, and on the bench, sediment deposition ranging from six inches to four feet buried much of the willow cuttings and the surface of the rock bench. The extensive placement of IWM at the site (*i.e.*, 80 percent shoreline coverage) may have played a role in the deposition by reducing local velocities. It is not yet known if the willows will emerge through the sediment, but the deposition and reduced shoreline velocities mimic natural floodplain processes that would not otherwise occur at a conventional bank protection project. Observations at the American River sites by staff from SAFCA, Jones and Stokes, and NMFS, found large numbers of salmon fry using project-constructed shallow-water habitat with integrated SRA. NMFS observed thousands of larval suckers using shallow water habitat refugia provided by the bench and the flooded IWM at the Sand Cove project, while striped bass preyed on others in open water; a demonstration that the IWM was functioning as refugia habitat for small fish, and an indication that it would also be available to salmonids for similar purposes.

a. *Long-term Effects of SRBPP Actions on Anadromous Salmonids*

(1) *Adult Migration*

Adult Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon migrate up the Sacramento River from December through July, and CV steelhead may migrate upstream from September through May. SAM model results had deficits at all sites for all anadromous species lasting from 1 to 50 years.

The SAM reporting results (URS 2007) show that losses of riparian shade and IWM, may reduce habitat value for adult salmonids due to reduced cover available for resting and holding during upstream migration. Adult steelhead appear to be particularly susceptible to reductions in summer and fall IWM due to the potential importance of instream cover for adults that may be holding or migrating upstream. However, the SAM model represents a worst case scenario, and does not consider the proportion of the fish that will migrate close to the river and slough banks. Also, long-term changes in nearshore habitat conditions generally are expected to have negligible effects on adults because adult Chinook salmon and steelhead generally use deep, mid-channel habitats. Thus the habitat affected by the project, is not necessarily habitat that is used by adults, therefore, the loss of IWM and shade is not a habitat change to which adults are exposed. Additionally, based on post-project field evaluations of similar projects constructed by the CDWR and the Corps in 2006, the changes do not appear, in any way, to obstruct or delay the upstream migration of any adult fish and will not affect their ability to successfully reach upstream spawning habitat and reproduce. Therefore, although the model shows a negative response for adult migration, NMFS expects that adult fish are not likely to be injured or killed as a result of the loss of overhead cover, since most fish are expected to migrate through deeper mid-channel pathways and will avoid direct exposure to project sites.

(2) ***Juvenile Rearing and Migration***

Rearing and emigrating juveniles and smolts may occur at most of the project sites during the fall, winter, and spring. At RM 182.0, winter-run Chinook salmon may be present during summer months. Downstream movement of substantial numbers of juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and steelhead appears to be triggered by storm events and the resulting high flow and turbidity, with the peak outmigration period for Sacramento River winter-run Chinook salmon typically occurring from November through January, and the period for CV spring-run Chinook salmon occurring from December through May. Juveniles and smolts are most likely to occur at the project sites during their downstream migration to the ocean, which may begin as early as December and peaks from January to May.

The construction of seasonally inundated riparian floodplain benches, and the retention and/or placement of riparian vegetation, and IWM at all project sites are designed to benefit juvenile Chinook salmon and steelhead by increasing the availability (*i.e.*, habitat area), accessibility (*i.e.*, frequency of inundation), and quality (*i.e.*, shallow water and in stream cover) of nearshore aquatic habitat and SRA habitat relative to current conditions. Because of these design features, the project provides a net increase (*i.e.*, all species and flows at all projects combined over the life of the project) over current conditions in the quantity and quality of estuarine and freshwater rearing sites and migration corridors for juvenile Chinook salmon and steelhead.

Due to already degraded habitat conditions at Sacramento RMs 99.5 and 182.0, the post-project modeled habitat values show an immediate increase that last for the life of the project. However, some short- and long-term impacts to juvenile rearing and smolt outmigration were modeled by the SAM. Habitat deficits occur at Sacramento RMs 70.7, 71.7, 73.0, Bear RM 1.2, and Sutter Slough RMs 24.8 and 25.4. During the years and flow conditions where there is a deficit in SAM values, individual fish that migrate or rear in the project area are expected to be injured or killed by reduced growth conditions and increased predation. The following paragraphs describe the modeled habitat conditions for each site.

At Sacramento RM 70.7, habitat values at spring flow elevations show immediate benefits for rearing and smolting Chinook salmon and steelhead that improve through year 50. Deficits occur at average fall, winter, and summer flows, and affect juvenile rearing and smolting

Chinook salmon and steelhead for 10 to 15 years, followed by increases above the baseline that continue through year 50. Deficits are attributable to short- and long-term reductions in vegetation and shade from project construction, and the resultant loss of fish habitat complexity and juvenile cover. Benefits and improvements over time are related to the installation of IWM, fine textured soil, and the intensive revegetation of the project site.

At Sacramento RM 71.7, habitat values at fall, spring, and summer flow elevations show immediate benefits for rearing and smolting Chinook salmon and steelhead that improve through year 50. Deficits occur at average winter flows affect juvenile rearing and smolting Chinook salmon and steelhead for 12 to 15 years, followed by increases above the baseline that continue through year 50. Deficits are attributable to short- and long-term reductions in vegetation and shade from project construction, and the resultant loss of fish habitat complexity and juvenile cover. Benefits and improvements over time are related to the installation of IWM, fine textured soil, and the intensive revegetation of the project site.

At Sacramento RM 73.0, habitat value deficits occurring at average summer, fall, winter, and spring flows affect juvenile rearing and smolting Chinook salmon and steelhead for 5 to 10 years, followed by increases above the baseline that continue through year 50. Deficits are attributable to short- and long-term reductions in vegetation and shade, and the resultant loss of fish habitat complexity and juvenile cover.

At RM 99.5, and 182.0, the modeled SAM results show immediate and substantially positive habitat values for all species, life stages, and seasonal flow elevations. This primarily is attributed to the low value of existing conditions, and extensive post-project increases in vegetation, shade, and IWM. However, despite these positive results, NMFS expects that there will actually be deficits during year 1 at fall, winter, and spring flows because the integrated conservation features will not be installed until Phase 2, following the first with-project emigration season.

At Sutter Slough RM 24.8 deficits at average winter flows affect Chinook salmon and steelhead rearing and smolt migration for 1 to 4 years, while deficits at average summer, fall, and spring flows last for 12 to 40 years. Deficits are attributable to long-term reductions in vegetation and shade which is caused be the projection of the bank away from existing riparian vegetation. In response to these deficits, CDWR changed the project description to include substantial changes to the Phase 2 design and increase the amount of vegetation near the shoreline, to improve fish habitat and SAM values. Regardless, Sutter Slough is not a primary migration and rearing corridor for listed anadromous fish, so the actions are expected to affect relatively few fish.

At Sutter Slough RM 25.4, minor deficits at average summer, fall, winter, ands spring flows affect Chinook salmon and steelhead rearing and smolt migration for 1 to 6 years. Deficits are attributable to short-term reductions in vegetation and shade.

At Bear RM 1.2, minor deficits affect Chinook salmon and steelhead rearing and smolt migration at winter and spring flows during the first 1 to 2 years. Values for all seasonal flow elevations increase substantially from year 2 through 50. The Bear River does not support a spawning population of Federally listed anadromous fish, and it is not a primary migration and rearing corridor for listed anadromous fish. Therefore, the modeled deficits are expected to affect relatively few fish.

In summary, implementation of the project would result in a temporary loss of aquatic and riparian vegetation and IWM along the affected shorelines. These losses would initially reduce year-round habitat value and reduce growth and survival conditions for most salmonid life stages at all sites beginning in year 1. However, cover losses are immediately followed by construction of planted riparian benches and IWM at all sites, that will increase to levels that exceed baseline conditions generally within 2 to 12 years. Over time, the increasing shade value of planted riparian vegetation would result in eventual net increases in juvenile and smolt habitat.

NMFS expects that the most significant habitat deficits will occur at summer and fall flows due to the inherent difficulty of successfully establishing riparian vegetation in a zone that is impacted by boat wake erosion, and variable flow conditions typical of a regulated river system. The modeled summer and fall habitat deficits are expected to affect relatively few fish, since the majority of adult migration and juvenile rearing and emigration within the action area does not occur during these periods. Instead, a significant majority of Chinook salmon and steelhead adult migration and juvenile rearing and emigration occurs during periods of higher flow that are more accurately represented by conditions at average winter and spring WSELs. Long-term effects at the winter and spring WSELs will be substantially positive, with conditions improving beyond existing conditions through year 50.

b. *Long-term Effects of SRBPP Actions on the Southern DPS of North American Green Sturgeon*

(1) *Adult Migration and Holding*

Adult green sturgeon move upstream through the project sites between March and July. Year-round adult holding occurs in deep pools in of the upper action area, near RM 182.0. Long-term changes in nearshore habitat are expected to have negligible effects on adults because adult sturgeon use deep, mid-channel habitat during migration. The long-term effects of the proposed project related to North American green sturgeon adults would primarily be related to the alteration of the Sacramento River below the waterline as migrating and holding adults utilize benthic habitat. The amount of rock is not expected to impede significantly on adult sturgeon pools in the Sacramento River. The ecosystem changes from the removal or reduction of riparian vegetation and IWM could affect potential prey items and species interactions that green sturgeon would experience while holding. However, these changes are minimized considerably in the project design and the effects of this riparian and IWM removal or reduction would decrease through time as a result of the proposed projects conservation measures. Therefore, NMFS expects that adult fish are not likely to be injured or killed as a result of the project since most fish are expected to migrate through deeper mid-channel pathways and will avoid direct exposure to project sites.

(2) *Larval, Post-larval, and Juvenile Rearing and Migration*

The Sacramento River 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 benthic (with the exception of the post-larvae nocturnal swim-up believed to be a dispersal mechanism), the removal or reduction of riparian vegetation and IWM likely impacts potential prey items and species interactions that green sturgeon would experience while rearing and migrating. These changes are minimized considerably in the project design and the effects of this riparian and IWM removal or reduction would decrease through time as a result of the proposed projects conservation measures.

In the absence of modeled response data for green sturgeon, NMFS expects responses to long-term, project-related habitat conditions to be similar to juvenile salmonids, as described above in *Long-term Effects of SRBPP Actions on Anadromous Salmonids*. However, because green sturgeon are not as near-shore oriented as juvenile Chinook salmon, the relative proportion of the green sturgeon population that will be affected by the short- and long-term conditions should be low.

4. Impacts of Project Monitoring

The monitoring plan, as proposed, only includes passive techniques that track physical habitat parameters such as photo documentation, point estimates of substrate size, IWM, riparian vegetation, and other physical project elements. Non-fishery sampling will be passive and is not expected to have any effect of Federally listed fish or designated critical habitat. At this point, the plan does not include any fishery monitoring. However, NMFS expects that the ongoing efforts of the interagency monitoring plan development committee will result in a plan that will include these 8 project sites in a sampling pool that may include direct sampling of juvenile anadromous salmonids to evaluate the effectiveness of integrated project conservation features for protecting Federally listed fish. Although the details of the monitoring effort are not finalized at the time of writing this biological opinion, fishery monitoring is expected to begin in 2007, and continue for up to 10 consecutive years.

Fishery monitoring is expected to include monthly sampling at selected project locations in the action area throughout the juvenile migration period using boat electrofishing methods. If turbidity is low, passive techniques, including direct underwater observation may be used. NMFS does not expect passive techniques to adversely affect listed fish species or critical habitat. Up to 8 sites may be monitored during periods of no bench inundation, partial bench inundation, and full bench inundation. Sampling will occur once per month throughout the migration and rearing period of juvenile fish in the action area (*i.e.*, November through May). At a maximum each project site is expected to be sampled 6 times per year. However, sampling is expected to rotate through a panel of representative sites, which will reduce the sampling frequency at an individual site. Electrofishing can result in a variety of effects from simple harassment to injury to the fish (adults and juveniles) and death. There are 2 major forms of injuries from electrofishing; hemorrhages in soft tissues and fractures in hard tissues. Electrofishing can also result in trauma to fish from stress (NMFS 2003b). Recovery from this stress can take up to several days, and during this time the fish are more vulnerable to predation, and less able to compete for resources. Stress-related deaths also can occur within minutes or hours of release, with respiratory failure usually the cause. Electrofishing can have severe effects on adult salmonids, particularly spinal injuries from forced muscle contraction. Studies also found dramatic negative effects of electrofishing on the survival of eggs from electroshocked female salmon (NMFS 2003b).

Because of the spatial and temporal aspect of the electrofishing effort, both juvenile and adult salmonids can be exposed to the sampling; however, because this effort is completed along the shoreline, the probability of encountering adults is low. In addition, the study sites for electrofishing are not in the vicinity of adult salmonids in spawning condition or near redds. Juveniles are more likely to be exposed to the sampling activities, but the relatively few studies that have been conducted on juvenile salmonids indicate that spinal-injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish and may therefore be subject to lower injury rates (*e.g.*, Thompson *et al.* 1997). McMichael *et al.* (1998) found a 5.1 percent injury rate for juvenile steelhead captured by electrofishing in the Yakima River sub basin.

One adult CV steelhead and no listed adult Chinook salmon were captured as a result of IEP electrofishing sampling efforts in 1999, 2001, 2002, and 2003. A total of 8 juvenile Sacramento River winter-run Chinook salmon were captured, one of which died. During the same sampling period, a total of 35 juvenile CV spring-run Chinook salmon were captured (10 in 2002, and 25 in 2003), and 10 juvenile CV steelhead were captured with no mortality. McLain and Castillo (2006) captured Chinook salmon fry in the Delta and the lower Sacramento River at rates that generally ranged from less than one, to almost five fish per minute. Most of the captured fish were classified as Central Valley fall-run Chinook salmon (CV fall-run Chinook salmon (*O. tshawytscha*)). McLain (NMFS, pers. comm. 2006) estimates that captures in the mainstem Sacramento River north of Sacramento could be as high as 10 fish per minute, and a majority of the fish likely would be fall-run Chinook salmon. McLain (NMFS, pers. comm. 2006), also estimates that each pass through a bank protection project of 1,000 feet would last about 20 minutes.

Assuming that electrofishing will occur at all 8 sites, up to six times per year, and sampling will last up to 20 minutes per site, with 10 fish captured per minute, a total of 9,600 fish would be captured per year. Assuming that 95 percent of the captured fish are non-listed CV fall-run Chinook salmon, based on juvenile abundance estimates at Red Bluff Diversion Dam (Gaines and Martin 2002) only 480 fish would be listed salmonids. Assuming an injury rate of 10 percent (a conservative estimate that doubles the level observed by McMichael *et al.* (1998)), 48 listed salmonids may be injured. At a mortality rate of 5 percent (common level reported in the Central Valley), 24 additional juvenile fish would be killed. If the capture, injury, and mortalities are divided equally between Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead (an assumption based on an equal level of effort occurring during the migration period of each species without accounting for fluctuating juvenile population abundance), the monitoring would result in the annual capture of approximately 160 fish, the annual injury of 16 fish, and the annual mortality of 8 fish for each species. These amounts are divided equally. Actual levels should be lower because not all sites will be sampled, and river flows and scheduling complexities are likely to reduce the sampling frequency to fewer than six times per year.

The number of fish that will be captured, injured, or killed is expected to be relatively low compared to the overall abundance of juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead (*i.e.*, 8 mortalities for each species as compared to the hundreds of thousands to millions of individuals that comprise a single outmigrating year class). Because sampling will be limited to nearshore areas, and not in adult migration corridors, no more that 1 adult of each species is expected to be captured each year. The anticipated low levels of capture, injury, and mortality are not expected to result in population level impacts. Monitoring results will be used to validate the effectiveness of project conservation measures for avoiding or minimizing adverse impacts of bank protection projects on Federally listed fish species.

5. <u>Impacts to Critical Habitat</u>

Impacts to the designated critical habitat of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead include the short- and long-term modification of approximately 11,540 lf, and 85 acres of nearshore aquatic and riparian areas that are designated critical habitat. PCEs at the 8 sites include estuarine and riverine areas for rearing and migration. Impacts can be measured using the SAM results because they represent indices of fish response to habitat change.

Most impacts occur during the first 2 to 12 years of the project and result from loss or modification of riparian vegetation, IWM, shallow-water habitat, and the increase in bank substrate size. SAM-modeled deficits typically result from short- and long-term reductions in vegetation and shade caused by construction and extension of the shoreline away from existing vegetation and shade.

More specifically, the condition of estuarine and freshwater rearing and migration PCEs will be reduced at Sacramento RMs 70.7, 71.7, 73.0, Bear RM 1.2, and Sutter Slough RMs 24.8 and 25.4. Extensive benefits to freshwater rearing PCEs will occur at RM 99.5 and RM 182. The project, as a whole (*i.e.*, all sites combined) will cause short-term (*i.e.*, 2 to 12 years) adverse effects, and substantial long-term (5 to 50 years) improvements at most seasonal flow elevations. Most deficits result from short-term reductions in vegetation and shade caused by construction and extension of the shoreline away from existing vegetation and shade. Revegetated areas must grow for several years before shade extends over the shoreline. Fall and summer deficits also result from the conversion of shallow-water habitat with fine-textured substrate to large angular rock placed at a 2:1 or 3:1 slope.

Despite the modeled summer and fall habitat deficits, they are not expected to reduce the overall conservation value of rearing and migration PCEs because the greatest deficits generally are at water surface elevations that do not correspond with peak migration periods, the deficits are low relative to baseline conditions, and because they will increase substantially above baseline conditions over the 50 year life of the project.

6. Interrelated or Interdependent Actions

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). NMFS considered concurrent, ongoing repair of an additional 81 Public Law (PL) 84-99 levee repair projects in the SRFCP as potentially interrelated or interdependent actions in the action. These projects are expected to result in effects to listed salmon, steelhead, and sturgeon that are similar to those previously described in this biological opinion for the proposed action, including short-term adverse effects to these species and their designated critical habitat. NMFS does not consider these actions to be interrelated because there is no single authority or program that binds them together, nor are they interdependent because they would occur regardless of the proposed action.

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.

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by State or local agencies do not require Federal permits. These types of actions, and illegal placement of non-Federal riprap are common throughout the action area. The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic to simplified habitats that affect salmonids in ways similar to the adverse effects associated with the proposed action. Reasonably certain cumulative effects may include any continuing or future non-Federal water diversions. Water diversions through intakes serving numerous small, private agricultural lands and duck clubs along the lower Sacramento River contribute to these cumulative effects. These diversions also include municipal and industrial uses as well as water for power plants. Water diversions affect salmonids and sturgeon by entraining, and injuring or killing adult or juvenile fish.

Additional cumulative effects may result from the discharge of point and non-point source chemical contaminant discharges. These contaminants include selenium and numerous pesticides and herbicides associated with discharges related to agricultural and urban activities. Contaminants may injure or kill salmonids by affecting food availability, growth rate, susceptibility to disease, or other physiological processes necessary for survival.

VII. INTEGRATION AND SYNTHESIS

The purpose of this section is to summarize the effects of the action and then add those effects to the impacts described in the *Environmental Baseline* and *Cumulative Effects* sections of this biological opinion in order to inform the conclusion of the whether or not the proposed action is likely to jeopardize their continued existence.

A. Summary of Impacts of the Proposed Action on Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead

NMFS expects that the proposed action will result in short-term, adverse, construction-related impacts, O&M-related impacts, habitat impacts, and monitoring impacts that will capture, injure, and kill Federally listed Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead. Phase 1 construction-related effects are expected to affect juveniles during the first year of construction. Juveniles are expected to be affected because of their small size, reliance on nearshore aquatic habitat, and vulnerability to factors that injure or kill them, or otherwise affect their growth and survival. Construction-related factors include noise or crushing of fish from rock placement and barge activity, and changes in water quality that temporarily modify natural behavior and may reduce their growth or expose juvenile fish to predation. Phase 2 activities will require limited inwater construction during summer months when juvenile fish are typically not present throughout the action area. Because of the low abundance and minimal level of inwater construction, Phase 2 activities are not likely to cause any adverse effects. Adults should not be injured or killed because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance.

The implementation of BMPs and other on-site measures also will minimize impacts to the aquatic environment and reduce project-related effects to fish. In addition, and with the exception of the occurrence of winter-run Chinook salmon at RM 182, peak migration events correspond with periods of high river flows, when in-river construction activities are likely to be suspended. Furthermore, only one cohort, or emigrating year class, out of perhaps three to five within each salmon and steelhead population will be affected. NMFS expects that actual injury and mortality levels will be low relative to the overall population abundance of all cohorts. This is also expected for RM 182, where construction overlaps with only the early migration period of one winter-run year class, and not the peak period which occurs later in the winter. Because of these consideration, construction-related impacts will be ephemeral in nature, and not likely to persist and cause negative population trends.

O&M impacts will occur for the life of the project and primarily will be caused by infrequent in-water construction and rock placement necessary to maintain the project in functional condition. O&M activities are expected to occur between July 1 and November 30 for the life of the project (*i.e.*, 50 years). Individuals are expected to be injured or killed during the month of November from turbidity-induced predation during the annual placement of the bank protection material of no more than 600 cubic yards of material. Relatively few fish are expected to be injured or killed by O&M activities because the majority of construction will occur before high flows trigger peak migration, and because the implementation of BMPs and other on-site measures are expected to minimize impacts to the aquatic environment.

Fishery monitoring will capture, injure, and kill juvenile and adult anadromous fish for up to ten years. Fish will be captured, injured, and killed from fish sampling for this period between the months of November and May. NMFS expects that fewer than 10 percent of fish captured will be injured, and fewer than 5 percent will be killed. No more that 1 adult of each species is expected to be captured each year. No more than an annual capture of 160 juvenile fish, including an annual injury of 16 fish, and an annual mortality of 8 fish is expected for each Federally listed anadromous salmonid ESU or DPS. Furthermore, monitoring will ensure that project conservation measures are functioning to benefit the species. If monitoring shows that project features are limiting the growth and survival of fish in the action area, then those features will be modified or discontinued. If monitoring shows features that are beneficial, they will continue to be maintained and applied to future projects.

Short- and long-term habitat changes include the temporary loss of aquatic and riparian vegetation and IWM along the affected shorelines. SAM modeling demonstrates that these losses would initially reduce year-round habitat value and reduce growth and survival conditions for juvenile life stages at all sites beginning in year 1 and generally lasting for up to 12 years. As the riparian habitat becomes established and grows, it will eventually (*i.e.*, generally 2 to 12 years) increase to levels that exceed baseline conditions. Over time, the increasing shade value of planted riparian vegetation would result in eventual net increase in habitat value for rearing and smolting steelhead.

The number of juvenile fish that will be injured or killed as a result of short-and long-term habitat impacts, as indexed by the SAM will be low and temporary in nature because the most significant loss of habitat condition and function is limited to the low-flow fall WSELs, while the majority of juvenile fish are expected to be present during winter and spring months, when seasonal water elevations are higher, and project conservation measures are available to the species. Although Federally listed anadromous fish may be present in the action area during the fall months, abundance is relatively low compared to the number of fish that are present during winter months. Furthermore, although there will be short-term (*i.e.*, 2 to 12 years) SAM-modeled deficits in local habitat value, this is not expected to have significant consequences to the species, because the sites will contain numerous integrated habitat features such as shallow-water benches, and large concentrations of IWM, that will function to provide immediate rearing and refugia habitat until the riparian vegetation becomes establishes and covers the wetted perimeter of the river channel. Although these deficits will affect at least 2 to 3 generations of fish, the actual level of injury and death that will occur should be low and insignificant because deficits do not typically affect all river flow and migration conditions, deficits are relatively low when considered in addition to the baseline condition, and because individual project sites typically are only a few hundred feet long allowing fish which minimizes fish exposure and allows individuals to seek out and rear in nearby habitat. Long-term effects (*i.e.*, 12-50 years) at the winter and spring WSELs will be substantially positive, with conditions improving beyond existing conditions through year 50.

Adult fish will not be affected because they use the river channel at the project sites as a migration pathway to upstream spawning habitat, and long-term changes in nearshore habitat conditions generally have been expected to have negligible effects on adults because adult Chinook salmon, and steelhead generally migrate through deep, mid-channel habitats.

B. Impacts of the Proposed Action on the Survival and Recovery of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead

The assessment of factors affecting the species in action area, described in the *Environmental Baseline* section of this biological opinion, described some of the habitat degradations and other factors that are affecting the listed species throughout the action area. The *Environmental* Baseline found that many of adverse factors are being corrected through restoration or other corrective actions, and that because of these actions the likelihood of the species continued existence has begun to improve in recent years. Actions have been undertaken to reduce juvenile entrainment at diversions and to restore riverine habitats such riparian habitat and channel complexity. Consistent with these recent efforts, the proposed action has specifically been designed to minimize and avoid continued nearshore aquatic and riparian habitat loss from large-scale bank protection projects. The proposed implementation of the integrated conservation measures, and the commitment to implement additional compensation measures and conduct a final post-project SAM assessment will ensure that short- and long-term impacts associated with these bank protection projects will be compensated in a way that prevents incremental habitat fragmentation. Although some injury or death to individual fish is expected from construction activities, O&M, short- and long-term habitat modification, and fishery monitoring; successful implementation of all conservation measures is expected to improve migration and rearing conditions, and the growth and survival of juvenile salmon and steelhead during peak rearing and migration periods by protecting, restoring, and in many cases, increasing the amount of flooded shallow water habitat and SRA habitat throughout the action area.

Because of this, when considered in addition to the *Environmental* Baseline, the proposed action is not expected to reduce the likelihood of survival and recovery of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead within the action area. This is largely due to the fact that the project will replace and restore habitat losses habitat through implementation of on-site and off-site conservation measures, but also because construction-related impacts will be temporary and will not impede adult fish from reaching upstream spawning and holding habitat, or juvenile fish from migrating to downstream rearing areas. The number of individuals actually injured or killed by construction and O&M activities is expected to be low because actions will be small, and few fish will be present during the O&M period because actions will not correspond with peak migration periods and high abundance. Additionally, although the project may result in some short-term reduction in the numbers of juvenile fish that survive through the action area, Lindley *et al.* (2007) have found that the extant subpopulations, and to some degree the ESUs as a whole, are meeting viability criteria for abundance. The proposed action is expected to have little influence on other ESU viability criteria for population spatial connectivity, diversity, population growth rate.

C. Summary of the Impacts of the Proposed Action on the Southern DPS of North American Green Sturgeon

NMFS also expects the action to adversely affect the Federally listed Southern DPS of the North American green sturgeon. Adverse effect to this species is expected to be limited to migrating and rearing larvae, post-larvae, juveniles and holding adults. Juveniles are expected to be affected most significantly because of their small size, reliance on aquatic food supply (allochthonous food production), and vulnerability to factors that affect their feeding success and survival. Construction activities will cause disruptions from increased noise, turbidity, and inwater disturbance that may injure or kill larvae, post-larvae, and juveniles by causing reduced growth and survival as well as increased susceptibility to predation. Adverse affects to adults are primarily limited to the alteration of habitat below the waterline affecting predator-prey relationships and feeding success. In the absence of modeled response data for green sturgeon, NMFS expects responses to long-term, project-related habitat conditions to be similar to juvenile salmonids, as described above in *Long-term Effects of SRBPP Actions on Anadromous Salmonids*. However, because green sturgeon are not as near-shore oriented as juvenile Chinook salmon, the relative proportion of the green sturgeon population that will be affected by the short- and long-term conditions should be low.

D. Impacts of the Proposed Action on the Survival and Recovery of the Southern DPS of North American Green Sturgeon

The adverse effects to Southern DPS of North American green sturgeon within the action area are not expected to affect the overall survival and recovery of the DPS. This is largely due to the fact that the project will compensate for temporary and permanent habitat losses of habitat through implementation of on-site and off-site conservation measures. Construction-related impacts will be temporary and will not impede adult fish from reaching upstream spawning and holding habitat, or larvae, post-larvae, and juvenile fish from rearing or migrating to downstream rearing areas. The number of individuals actually injured or killed is expected to be undetectable and negligible and, population-level impacts are not anticipated. Implementation of the conservation measures will ensure that short- and long-term impacts associated with bank protection projects will be compensated in a way that prevents incremental habitat fragmentation, and reductions of the conservation value of aquatic habitat to anadromous fish within the action area. Because of this, the proposed action is not expected to reduce the likelihood of survival and recovery of the Southern DPS of North American green sturgeon within the action area.

E. Impacts of the Proposed Action on Critical Habitat

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

Impacts to the designated critical habitat of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead include the short- and long-term modification of approximately 11,540 lf, and 85 acres of nearshore aquatic and riparian areas that are designated critical habitat. PCEs at the 8 sites include estuarine and riverine areas for rearing and migration. NMFS CHART (2005b) described existing PCEs within the action area as ranging from high quality to degraded, with isolated fragments of high quality habitat. Even with these degraded conditions, the CHART report rated the conservation value of the entire action area as high because it is used as a rearing and migration corridor for all populations of winter-run Chinook salmon and CV spring-run Chinook salmon, and by the largest populations of CV steelhead.

Impacts to PCEs generally will last for 2 to 12 years. The primary project-related impacts to PCEs are at fall and summer low-flow conditions and result from loss or modification of riparian vegetation, shallow-water habitat, and the increase in bank substrate size. These losses and modifications affect juvenile rearing and migration PCEs by reducing instream cover and refuge areas and food production. Freshwater migration corridors must function sufficiently to provide adequate passage; project effects are not expected to reduce passage conditions based on the length of time individual juvenile salmonids will be exposed to the reduced quality and availability of refuge areas as they transit through the action area. Thus, NMFS does not expect the 2 to 12 year reduction in the quality and availability of refuge areas in this reach of the river to be limiting to the anadromous populations in the system. From year 12 through 50, the PCEs will improve as vegetation matures and extends over the shoreline. The improved conditions are expected to improve the growth and survival conditions for juvenile fish. Therefore, we do not expect project-related impacts to reduce the conservation value of designated critical habitat of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information, the current status of CV spring-run Chinook salmon, and CV steelhead, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the 8 CDWR-led Critical Levee Erosion Repairs project, as proposed, is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, or CV steelhead, and is not likely to destroy or adversely modify their designated critical habitat.

After reviewing the best available scientific and commercial information, the current status of the Southern DPS of North American green sturgeon, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the 8 Critical Levee Erosion Repairs project, as proposed, is not likely to jeopardize the continued existence of the Southern DPS of the North American green sturgeon.

IX. 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 listing of the Southern DPS of North American green sturgeon became effective on July 7, 2006, and some or all of the ESA section 9(a) prohibitions against take will become effective upon the future issuance of protective regulations under section 4(d). Because there are no section 9(a) prohibitions at this time, the incidental take statement, as it pertains to the Southern DPS of North American green sturgeon does not become effective until the issuance of a final 4(d) regulation, as appropriate.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant or permit, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps, by issuing a permit to CDWR, has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps and CDWR: (1) fails to assume and implement the terms and conditions, or (2) fails to require the contractors 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, the Corps, or its agent, CDWR, 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)).

This incidental take statement is applicable to all activities related to the HCPP Fish Screen Improvement Project described in the GCID Biological Opinion, and the July 2003 amendment. Unless modified, this incidental take statement does not cover activities that are not described and assessed within GCID Biological Opinion, or the July 2003, amendment.

A. Amount and Extent of Take

NMFS anticipates incidental take of Sacramento River winter-run Chinook salmon, CV steelhead, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon from impacts related to construction, O&M, and through long-term impairment of essential behavior patterns as a result of reductions in the quality or quantity of their habitat. Take is expected to be limited to rearing and smolting juveniles.

NMFS cannot, using the best available information, quantify much of the anticipated incidental take of individual Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the project area. NMFS is capable of quantifying the take associated from the fishery monitoring. For the unquantifiable amount of take, it is possible to describe the conditions that will lead to the take, and use these conditions as a surrogate to describe the extent of anticipated take.

Accordingly, NMFS is quantifying take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon incidental to the action in terms associated with the extent and duration of initial construction and O&M activities, and long-term impacts as indexed by the SAM model. The following level of incidental take from project activities is anticipated:

1. Take of juvenile and smolt Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon in the form of injury and death from predation caused by constructed-related turbidity that extends up to 100 feet from the shoreline, and 1,000 feet downstream, for up to four hours, at each site from November 13, 2006 to June 1, 2007.

2. Take of juvenile and smolt Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon in the form of injury and death from predation caused by constructed-related turbidity related to annual O&M actions is expected to extends up to 100 feet from the shoreline, and 1,000 feet downstream, for up to four hours, at each site from July 1 through November 30.

3. Take of juvenile and smolt Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green

sturgeon, in the form of harm or injury of fish from O&M actions is expected from habitat-related disturbances such as tree removal, that occur from July 1 through November 30, from the annual placement of up to 600 cubic yards of material per site for the extent of the project life (*i.e.*, 50 years). Take will be in the form of harm to the species through modification or degradation of juvenile rearing and migration habitat. The amount and extent of O&M related take for any given project site shall not exceed the annual amount quantified by the SAM results shown in Appendix B, Figures 1 through 16, or as represented by any future post-project SAM results that show differently.

4. Take in the form of harm, injury, and death of rearing and smolting Chinook salmon, steelhead, at fall, summer, spring, and winter WSELs from the modification of 5,990 lf of nearshore habitat that adversely affects the quality and quantity of juvenile Chinook salmon, steelhead, and green sturgeon habitat at Sacramento RMs 70.7, 71.7, and 73.0, Bear RM 1.2, and Sutter Slough RMs 24.8, and 25.4. for, generally between 2 and 12 years, but as high as 40 years at some sites (i.e., winter and summer flows affecting rearing salmon and steelhead at Sutter Slough RM 24.8), as quantified by the SAM results shown in Appendix B, Figures 1 through 16, or as represented by any future post-project SAM results that show differently.

5. Take in the form of capture, injury, and mortality from monitoring activities is expected to occur for up to 10 years. Take in the form of capture from monitoring activities is not expected to exceed an annual amount 160 juvenile fish for each Federally listed anadromous salmonid ESU or DPS. Take in the form of injury is not expected to exceed an annual amount of 16 juvenile fish for each Federally listed anadromous salmonid ESU or DPS. Take in the form of death from monitoring activities is not expected to exceed an annual amount of 8 juvenile fish for each Federally listed anadromous salmonid ESU or DPS. Take in the form of capture, injury, or death is not expected to exceed one adult fish for each for Federally listed anadromous salmonid ESU of DPS. However, because of the low expected numbers for fish capture, injury, and mortality; and the importance of fully evaluating the biological effects of the project over time, and across a broad range of flow, habitat, and migration and rearing conditions, NMFS believes that it is not necessary to limit the exact number of fish that are captured, injured, or killed, but instead to limit the mortality rates. Therefore, take is exempted and limited to no more than 5 percent mortality for all captured juveniles and adults of each species for a period of up to 10 years.

Anticipated incidental take may be exceeded, and not exempted, if project activities exceed the criteria described above, if the project is not implemented as described in the BA prepared for this project, or if the project is not implemented in compliance with the terms and conditions of this incidental take statement.

B. Effect of the Take

NMFS has determined that the above level of take is not likely to jeopardize Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, or the Southern DPS of North American green sturgeon. The effect of this action in the proposed project areas will consist of fish behavior modification, temporary loss of habitat value, and potential death or injury of juvenile Sacramento River winter-run Chinook salmon, CV steelhead, and CV spring-run Chinook salmon, and the Southern DPS of North American green sturgeon.

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 anadromous salmonids.

1. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the project to ensure their effectiveness.

2. Measures shall be taken to minimize the impacts of bank protection by implementing integrated onsite and offsite conservation measures that provide beneficial growth and survival conditions for juvenile salmonids, and the Southern DPS of North American green sturgeon.

D. Terms and Conditions

1. Measure shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the project to ensure their effectiveness.

    a. The Corps shall require CDWR to continue to coordinate with the IWG agencies and the Technical Team of the Interagency Collaborative Flood Management Program during the implementation of Phase II.

    b. The Corps shall require CDWR to develop, a soil application manual that describes techniques for integrating soil into rock for the purpose of establishing riparian vegetation and optimizing short- and long-term growth conditions. The manual shall be developed in coordination and assistance of the IWG agencies and the expert assistance of riparian ecologists and soil specialists.

    c. The Corps shall require CDWR to make every reasonable effort necessary to ensure that Phase II construction minimizes the loss of existing riparian vegetation and allows for the establishment of riparian vegetation at all seasonal WSELs within the project footprint.

d. The Corps shall require CDWR to provide to NMFS a project summary and compliance report within 60 days of completion of construction. This reports shall describe construction status, status of project conservation measures; compliance with and the terms and conditions of the final biological opinion; and any observations or other known effects on the Sacramento River winter-run Chinook salmon, if any; and any occurrences of incidental take of the Sacramento River winter-run Chinook salmon, CV steelhead, and CV spring-run Chinook salmon.

e. The Corps shall require CDWR to provide annual reports, as necessary, to describe the implementation of off-site conservation measures, to summarize O&M actions, and summarize monitoring results.

f. The Corps shall require CDWR to continue to coordinate the implementation of project-specific monitoring as described in *section II, Description of the Proposed Action*, with the IWG agencies.

g. The Corps shall require CDWR to increase the duration of project-specific monitoring from 5 years to a period of 10 years for all SAM-modeled measures. NMFS does not expect that all measures or all sites will require 10 years of monitoring. Instead, through a statistically selective approach, and through ongoing cooperation with the IWG agencies, a representative group of project sites will be monitored for this period. This requirement is based on the need to help validate that projects with SAM-modeled results are on a positive trajectory and successfully reaching or exceeding baseline values.

h. The Corps shall require CDWR to integrate the proposed projects into ongoing monitoring effort being planned and implemented through the coordinated efforts of the IWG agencies through the Interagency Flood Management Program's Monitoring Subcommittee. The purpose of the monitoring is to confirm that the project was implemented as proposed, and to provide information that may help validate that proposed project conservation measures effectively avoid and minimize adverse effects to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon.

i. The Corps shall require CDWR to complete a comprehensive aquatic and riparian monitoring plan, in cooperation with the IWG agencies. Development of this monitoring plan must be done in coordination with the Corps, NMFS and the IWG agencies; must rely on the expertise of biologists, fluvial geomorphologists, statisticians, and other experts in developing aquatic monitoring plans or programs; and must meet the approval of NMFS before being finalized. The purpose of the comprehensive monitoring is ensure that integrated conservation measures are implemented as proposed, and are within the range modeled in the SAM analysis and analyzed in NMFS biological opinion; are effective for avoiding, minimizing, or enhancing habitat value for listed fish; and to validate the assumptions inherent to the SAM model. Monitoring also will be used to develop future avoidance, minimization, and enhancement measures.

Monitoring the effectiveness of the measures installed to meet SAM values may require scientific inquiry that extends beyond in-stream data collection. Tools such as computer modeling and hydraulic models as well as tagging studies should be used as necessary to assess the relative value of each element of the SAM model. In-stream studies must include sampling procedures to determine species composition and abundance together with physical observations and measurements at selected construction and control sites.

j. Electrofishing shall be conducted following NMFS Guidelines.

k. The Corps shall require CDWR to develop a database for storing site monitoring data. The database shall include fields that track SAM-modeled habitat attributes and fishery data over time. The database shall be developed with the oversight the Monitoring Subcommittee.

l. The Corps shall require CDWR to ensure that, for the life of the project, future maintenance actions ensure performance of the sites to a level necessary to retain the SAM-modeled habitat values.

2. Measures shall be taken to minimize the impacts of bank protection by implementing integrated onsite and offsite conservation measures that provide beneficial growth and survival conditions for juvenile salmonids.

a. The Corps shall require CDWR to purchase 1,560 linear feet of fish habitat preservation and enhancement credits from a NMFS-approved anadromous fish conservation bank within the action area. This amount represents the total maximum SAM-modeled seasonal deficit for Chinook salmon and steelhead juvenile rearing and smolt habitat, for each site, in bankline weighted WRIs. These credits also are intended to minimize the take that occurs during the first year of construction during peak juvenile migration periods, and the first year of adverse effects related to Phase I construction, prior to the installation of project conservation measures in Phase II (*i.e.*, the current SAM results credit conservation measures being installed in year 1, when they actually are installed in year 2). Credits must be purchased within 30 days of the completion of Phase II. CDWR may request NMFS to adjust this amount following the completion of final SAM results, or implementation of other offsite compensation measures. However, such final SAM modeling must be completed using input values and assumptions that meet the approval of all IWG agencies. This request must be made in writing and submitted to the reporting address listed below.

b. The Corps shall require CDWR to minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and that where appropriate, removed IWM will be anchored back into place. NMFS shall be contacted prior to the removal of any tree greater than 4 inches dbh.

c. The landscape plan for all sites shall include planting fascine bundles as close as possible to the mean August WSEL to provide instream vegetation and shoreline shading from 1 year to 5 years following repairs.

d. The Corps shall require CDWR to ensure that the planting of native vegetation will occur within the same year that construction occurs. Planting shall be completed no later than fall 2007. All plantings must be planted to sufficient depths, surrounded by soil, and provided with the appropriate amount of water to ensure successful establishment.

e. The Corps shall require CDWR to install IWM features at Sacramento RMs 99.5, and 182, in a density and configuration similar to the 90 percent designs developed for RM 71.7, so long as such an application of IWM will not adversely affect the flood damage reduction goals of the project.

f. The Corps shall require CDWR to plant the upper bench surface at RM 182 with riparian forest vegetation. The objective is to create habitat connectivity with mature riparian forests found upstream, within, and downstream from the project area.

g. The Corps shall require CDWR to ensure to the maximum extent practicable, and without adversely affecting engineering and flood protection integrity, or the growth and survival of existing vegetation, that measures are taken during Phase 2 to integrate soil into project sites by using means that are determined to be feasible and appropriate, including, but not limited to installing soil in 3-foot lifts, using a vibratory equipment to work soil into rock layers, or washing soil into rock with water.

h. The Corps shall require CDWR to conduct an updated SAM assessment of all sites upon completion of Phase 2. If this assessment shows additional uncompensated habitat deficits, the Corps must provide a compensation strategy to NMFS within 3 months, and any necessary additional compensation must be completed within 12 months. CDWR also may chose to purchase conservation credits at a NMFS-approved anadromous fish conservation bank.

i. The Corps shall require CDWR to limit the inwater construction period for routine O&M actions to July 1 to August 31. O&M actions must fully replace habitat features that are damaged or disturbed during construction so that habitat values, as measured in the SAM results in Appendix B, are met. O&M actions also must apply conservation measures to minimize resource damage and turbidity during construction.

j. The Corps shall require CDWR to adhere to the reporting requirements described in this biological opinion.

k. The Corps shall require CDWR to provide a copy of this biological opinion to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in this biological opinion and to educate and inform all other contractors involved in the project as to the requirements of this biological opinion. A notification that contractors have been supplied this biological opinion will be provided to the reporting address below.

l. NMFS approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to the listed anadromous fish species, an overview of the life-history of all the species, information on take prohibitions, protections afforded these animals under the ESA, and an explanation of the relevant terms and conditions of this biological opinion. Written documentation of the training must be submitted to NMFS within 30 days of the completion of training. As needed, training shall be conducted in Spanish for Spanish language speakers and other languages as needed or necessary.

m. The Corps shall require CDWR to submit the names and curriculum vitae of the biological monitor(s) for phase 1 and 2 of the proposed project.

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

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

X. CONSERVATION RECOMMENDATIONS

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

The Corps and CDWR, under the authority of section 7(a)(1) of the Act, should implement recovery and recovery plan-based actions within and outside of traditional flood damage reduction projects. Such actions may include, but are not necessarily limited to restoring natural river function and floodplain development.

1. The Corps and CDWR, under the authority of section 7(a)(1) of the Act, should implement recovery and recovery plan-based actions within and outside of traditional flood damage reduction projects. Such actions may include, but are not necessarily limited to restoring natural river function and floodplain development.

2. The Corps and CDWR should cooperate with local levee maintenance districts, flood control agencies, and State and Federal resource agencies to develop an anticipatory erosion repair program that emphasizes the use of biotechnical techniques, and minimizes the use of rock rip rap to treat small erosion sites before they become critical.

3. The Corps and CDWR should develop project designs that minimize site-level impacts by treating the failure mechanisms that cause erosion.

4. The Corps and CDWR should create a tiered approach to developing project designs. Tier 1 would include evaluating land-based design opportunities such as levee set-backs and levee widening. Tier 2 would include in-river alternatives that protect, and enhance habitat for anadromous salmonids.

5. The Corps and CDWR should make set-back levees integral components of the Corp's authorized bank protection or ecosystem restoration efforts.

6. The Corps and CDWR should evaluate the SRFCP's effectiveness for providing flood damage reduction using regional climate change forecasts and anticipated shifts in precipitation and other related hydrologic regimes.

7. The Corps and CDWR should make more effective use of ecosystem restoration programs, such as those found in Sections 1135 and 206 of the respective Water Resource Developments Acts of 1986 and 1996. The section 1135 program seems especially applicable as the depressed baselines of the Sacramento River winter-run Chinook salmon, CV steelhead, and CV spring-run Chinook salmon are, to an appreciable extent, the result of the Corps' SRBPP program.

8. The Corps and CDWR should incorporate the costs of conducting lengthy planning efforts, involved consultations, implementation of proven off-site conservation measures, and maintenance and monitoring requirements associated with riprapping into each project's cost-benefit analysis such that the economic benefits of set-back levees are more accurately expressed to the public and regulatory agencies. This includes a recognition of the economic value of salmonids as a commercial and sport fishing resource.

9. The Corps and CDWR should conduct or fund studies to identify set-back levee opportunities, at locations where the existing levees are in need of repair or not, where set-back levees could be built now, under the SRBPP, or other appropriate Corps authority. Removal of the existing riprap from the abandoned levee should be investigated in restored sites and anywhere removal does not compromise flood safety.

10. The Corps and CDWR should preserve and restore riparian habitat and meander belts along the Delta with the following actions: (1) avoid any loss or additional fragmentation of riparian habitat in acreage, lineal coverage, or habitat value, and provide in-kind mitigation when such losses are unavoidable (*e.g.*, create meander belts along the Sacramento River by levee set-backs), (2) assess riparian habitat along the Sacramento River from Keswick Dam to Chipps island and along Delta waterways within the rearing and migratory corridor of juvenile winter-run Chinook salmon, (3) develop and implement a Sacramento River and Delta Riparian Habitat Restoration and Management Plan (*e.g.*, restore marshlands within the Delta and Suisun Bay), and (4) amend the Sacramento River Flood Control and SRBPP to recognize and ensure the protection of riparian habitat values for fish and wildlife (*e.g.*, develop and implement alternative levee maintenance practices).

11. Section 404 authorities should be used more effectively to prevent the unauthorized application of riprap by private entities.

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

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the SRBPP 14 Critical Levee Erosion Repairs. Reinitiation of formal consultation is required if: (1) the amount or extent of taking specified in any incidental take statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the action, including the avoidance, minimization, and compensation measures listed in the *Description of the Proposed Action* section is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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Enclosure 2

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT
ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

ACTION AGENCY:	United States Army Corps of Engineers Sacramento District
ACTIVITY:	Eight California Department of Water Resources Critical Levee Erosion Repairs
CONSULTATION CONDUCTED BY:	NOAA's National Marine Fisheries Service, Southwest Region
FILE NUMBER:	151422SWR2005SA00659
DATE ISSUED:	AUG 10 2007

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

This document represents the National Marine Fisheries Service's (NMFS) Essential Fish Habitat (EFH) consultation based on our review of information provided by the U.S. Army Corps of Engineers (Corps) on eight critical levee erosion repair projects proposed by the California Department of Water Resources (CDWR) in the Sacramento River Flood Control project (SRFCP). The Magnuson-Stevens Fishery Conservation Act (MSA) as amended (U.S.C 180 et seq.) requires that EFH be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NMFS on activities which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies. The geographic extent of freshwater EFH for Pacific salmon in the Sacramento River includes waters currently or historically accessible to salmon within the Sacramento River and Sutter Slough.

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

The biological opinion for the Eight CDWR Critical Levee Erosion Repairs addresses Chinook salmon listed under the both the Endangered Species Act (ESA) and the MSA that potentially will be affected by the proposed action. These salmon include Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), and Central Valley spring-run Chinook salmon (CV spring-run Chinook salmon (*O. tshawytscha*)). This EFH consultation will concentrate on Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) because they are covered under the MSA but not listed under the ESA.

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

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

A. Life History and Habitat Requirements

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

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

II. PROPOSED ACTION.

The Corps proposes to issue a permit to CDWR to implement levee erosion protection at 8 sites in the Sacramento River, Sutter Slough, and the Bear River. The proposed action is described in the *Description of the Proposed Action* section of the preceding biological opinion (Enclosure 1).

III. EFFECTS OF THE PROJECT ACTION

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

Adverse effects to Chinook salmon habitat will result from construction related impacts, operations and maintenance impacts, and long-term impacts related to modification of aquatic and riparian habitat at the 14 project sites. Primary construction related impacts include riprapping approximately 9,817 lf of riverbank. Integrated conservation measures to minimize adverse effects of riprapping will be applied to all sites. Conservation measures include construction of seasonally inundated terraces that will be planted with riparian vegetation. IWM will be placed both below and above the mean summer water surface elevation to provide habitat complexity, refugia, and food production of juvenile anadromous fish.

In-channel construction activities such as vegetation removal, grouting, and rock placement will cause increased levels of turbidity. Turbidity will be minimized by implementing the proposed conservation measures such as implementation of BMPs and adherence to Regional Board water quality standards. Fuel spills or use of toxic compounds during project construction could release toxic contaminants into the Sacramento River. Adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway because the prevention and contingency measures will require frequent equipment checks to prevent leaks, will keep stockpiled materials away from the water, and will require that absorbent booms are kept on-site to prevent petroleum products from entering the river in the event of a spill or leak.

The effects of O&M actions will be similar to construction impacts. The Corps expects to place no more than 600 tons of rock annually. Most actions are expected to occur during the summer when anadromous fish are not expected to be present. Additionally, since O&M actions will not occur every year, and actions will be specific and localized in nature, O&M impacts will be smaller and shorter in duration.

At some sites, there will be short and long-term losses of habitat value. Long-term impacts are expected to adversely affect EFH for adult salmon at all seasonal water surface elevations for 2 to 12 years. Impacts at the fall and summer water surface elevation are expected to the most substantial due to the inherent difficulties of re-establishing riparian vegetation at these zones. Long-term effects of the project (*i.e.*, 5 to 50 years) will be positive as riparian habitat becomes mature. Overall, the action will result in a net increase in habitat conditions for Chinook salmon that essential to their survival and growth, especially at winter and spring flows when the majority of fish are outmigrating through the action area. This net increase is expected to maintain and improve the conservation value of the habitat for Chinook salmon and avoid habitat fragmentation that typically is associated with riprapping.

IV. CONCLUSION

Upon review of the effects of SRBPP Critical Levee Erosion Repair project, NMFS believes that the project will result in adverse effects to the EFH of Pacific salmon protected under the MSA.

V. EFH CONSERVATION RECOMMENDATIONS

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

Section 305(b)4(B) of the MSA requires the Corps to 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 Corps 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 Corps 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.

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