**DEPARTMENT OF THE ARMY**
**U.S. ARMY CORPS OF ENGINEERS**
**441 G STREET NW**
**WASHINGTON, D.C. 20314-1000**

OCT 5 2011

CEMP-SPD

MEMORANDUM FOR Commander, South Pacific Division (CESPD-DE)

SUBJECT: Request Approval for Vegetation Variance Request for P.L. 84-99, 2005-2006 Rehabilitation Mitigation for Repair

1. Reference SPD Commander memorandum dated December 12, 2010, wherein you submitted the official package requesting Headquarter review and approval for subject variance.

2. The request for a vegetation variance is approved. A Vegetation variance request approval sheet signed by the Chief of Construction and Engineering and U.S. Headquarters Levee Safety Officer on September 30, 2011, is included in the enclosure.

FOR THE COMMANDER:

for Ada Benavides

SCOTT L. WHITEFORD
Chief, South Pacific Division
Regional Integration Team
Directorate of Military Programs

Encls
as

## SIGNATURES

Vegetation Variance Request for P.L. 84-99 2006-2006 Mitigation for Repairs

SUBMITTED BY: U.S. Army Corps of Engineers, Sacramento District

for Mary Perlea, Levee Safety Program Manager — Date: 9/17/10

Meegan Nagy, Levee Safety Program Manager — Date: 9/13/10

REVIEWED BY: U.S. Army Corps of Engineers, Sacramento District

for Michael D. Mahoney, Levee Safety Officer — Date: 9/20/10

ACCEPTED BY: U.S. Army Corps of Engineers, Sacramento District

COL William J. Leady, Commander — Date: 21 SEPTEMBER 2010

REVIEWED BY: U.S. Army Corps of Engineers, South Pacific Division

for Andrew Constantaras, Levee Safety Officer — Date: 12/10/10

ACCEPTED BY: U.S. Army Corps of Engineers, South Pacific Division

10 DEC 2010

BG Scott "Rock" Donahue, Commander — Date

ENDORSED BY: U.S. Army Corps of Engineers, Risk Management Center

30 September 2011

Kevin Holden, Agency Technical Review Team — Date

ACCEPTED BY: U.S. Army Corps of Engineers, Headquarters

3 Oct 2011

James Dalton, Levee Safety Officer — Date

REPLY TO
ATTENTION OF

**DEPARTMENT OF THE ARMY**
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO CA 95814-2922

CESPK-LSO

SEP 26 2011

MEMORANDUM FOR Mr. Kevin Holden, Agency Technical Team Leader, U.S. Army Corps of Engineers, Rock Island District, Clock Tower Building, P.O. Box 2004, Rock Island Illinois, 61204-2004

SUBJECT: Vegetation Variance Request for P.L. 84-99 2005-2006 Rehabilitation Mitigation for Repairs

1. The Sacramento District submitted a request for a variance from vegetation standards found in Engineering Technical Letter 1110-2-571 for several sites included within the Sacramento River Flood Control Project that were repaired under the Public Law 84-99 Rehabilitation Assistance Program. South Pacific Division subsequently endorsed the vegetation variance request and transmitted the request to the Regional Integration Team on 10 December 2010.

2. An agency technical review (ATR), led by yourself, has been completed. The Sacramento District is appreciative of the team's efforts especially the cooperation and patience shown by its members. A total of 66 comments were received from the ATR team. All comments have been resolved and are closed. This transmittal provides the final responses to comments and the final vegetation variance request document.

3. Sacramento District looks forward to learning the ATR team's final recommendation.

4. The Sacramento District's point of contact for this action is Ms. Paige Caldwell, Chief, Readiness Section. She may be reached at (916) 557- 6903.

for Rick L. Poeppelman, P.E.
Sacramento District Levee Safety Officer

Encl
1. Vegetation Variance Request for Mitigation for P.L. 84-99 2005-2006 Repair Sites, Track Changes, September 2011
2. Vegetation Variance Request for Mitigation for P.L. 84-99 2005-2006 Repair Sites, September 2011
3. Final ATR Comments and Responses, September 2011

REPLY TO
ATTENTION OF

**DEPARTMENT OF THE ARMY**
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO CA 95814-2922

SEP 21 2010

CESPK-CO

MEMORANDUM FOR

Commander, Brigadier General Scott F. Donahue, South Pacific Division, 1455 Market Street San Francisco, CA 94103-1398 (ATTN: Ken Harrington, SPD, Levee Safety Program Manager)

SUBJECT: Vegetation Variance Request for P.L. 84-99 2005-2006 Rehabilitation Mitigation for Repairs

1. The Sacramento District is seeking a vegetation variance request from the US Army Corps of Engineers (USACE) vegetation standard, as found in Engineering Technical Letter 1110-2-571, for several sites included within the Sacramento River Flood Control Project that were repaired under Public Law 84-99 Rehabilitation Assistance Program.

2. Several storm events in 2005 and 2006 resulted in erosion of the waterside toe and/or slope of project levees along the Sacramento River and tributaries. The USACE's construction methods for repairs along 137 specific sites caused adverse impacts to the environment and requires mitigation for shaded aquatic riverine habitat. We have combined the variance request for these separate sites into one document because many of the details and historical knowledge of the sites are the same for each site. Additionally, the sites were repaired using the same basic method, and all were repaired under the PL 84-99 authority using 2007 War Supplemental funds.

3. The USACE is required to mitigate 40,000 feet of shaded riverine aquatic habitat to meet our commitment to the resource agencies and to comply with of the Endangered Species Act and/or the Magnuson-Stevens Fishery Conservation and Management Act.

4. The Sacramento District is requesting a vegetation variance for approximately 14,000 feet of willow pole plantings located in Reclamation Districts (RD) 3, 150, and 551. The remaining footage will either be planted outside the vegetation free zone or will be purchased at an approved mitigation bank. For the sites included in this vegetation variance request, the willow poles will be planted *within* the 15 foot waterside vegetation free zone, but will *not* be planted above the waterside toe.

5. Hydraulic and geotechnical evaluations show that the safety, structural integrity and functionality are retained, and that accessibility for maintenance, inspection, monitoring, and flood-fighting is also retained.

6. The Sacramento District has determined that the proposed variance would not diminish system reliability and is necessary to preserve and protect natural resources. Therefore, the District recommends approval of this vegetation variance request. The Sacramento District Office of Counsel has reviewed this vegetation variance request and determined that it is legally sufficient.

7. The Sacramento District's Point of Contact for this action is Michael Mahoney, Levee Safety Officer. He may be reached at (916) 557- 6714.

WILLIAM J. LEADY, P.E.
COL, EN
Commanding

Encl
1. Vegetation Variance Request for Mitigation for P.L. 84-99 2005-2006 Repair Sites

# Vegetation Variance Request

## Requesting Agency:
## US Army Corps of Engineers Sacramento District

## Project: Mitigation for PL 84-99 2005-2006 Repair Sites

September 2011

**TABLE OF CONTENTS**

FIGURES

# VEGETATION VARIANCE REQUEST

## INTRODUCTION

In December 2005 and January 2006, a series of storms struck Northern California and Nevada. The Sacramento River and several tributaries reached flood stage. In addition to high flows, high tides and winds were experienced in the Sacramento – San Joaquin Delta. A Federal Disaster Declaration was issued for thirty-one California counties for storms, flooding, mudslides and landslides.

As a result of the December 2005 and January 2006 storms, several Federal levees were damaged, and local sponsors, predominantly the Central Valley Flood Protection Board, submitted requests for rehabilitation assistance for over 300 sites. This vegetation variance request applies to 41 of those sites. Chapter 6 includes specific information as it relates to the 2005 and 2006 storms.

The Corps and the State of California have completed repairs for all of the sites; construction was completed primarily during August-November of 2007 and August – January 2008/2009. Repairs primarily included placement of quarry stone and riprap at the erosion site in order to properly fortify the sites to protect them from future damage. Under the Authority of PL 84-99, the slopes were rehabilitated with riprap to structurally restore them to pre-flood conditions. The extent of the riprap was based on the location of the erosion on the slope and was extended several feet above the erosion. The riprap was placed at each site continuously from the bottom of the slope to the top several feet above the erosion void. Specifically, riprap was placed on the lower portion of the slope where it slid down the incline, into the water and formed a base at the bottom of the slope for the remainder of the riprap to be supported. For the deeper erosion damaged sites, as-built drawings show the bottoms of excavations to have a horizontal cut from which the riprap is founded and constructed upon. At the sites where a portion of the erosion limits extended below the waterline, riprap was placed to the depth of the erosion limit for that portion and the surface matched to surrounding slope grade.

Construction included the removal and/or trimming of some trees, which provided shaded riverine aquatic (SRA) habitat for endangered anadromous fish species, and exposure of bare soil, which could have adverse impacts on water quality and turbidity in critical shallow water habitat for the endangered Delta Smelt. Additionally, placement of the rock and/or riprap is considered by environmental resources agencies to prevent any future growth of SRA habitat by natural propagation. As a result of the impacts due to construction, consultation was initiated with the resource agencies through submittal of Biological Assessment (BA) and a Not Likely to Adversely Affect determination. This BA includes the Sacramento District's commitments and best management practices to avoid and minimize impacts to threatened and endangered species. Implementation of the proposed plantings will meet our commitment to the resource agencies. Detailed information regarding consultation with the resource agencies is included in Chapter 8.

Planting of approximately 40,000 linear feet (lf) of SRA and shallow-water habitat are required to mitigate for the construction affects on endangered species. The Sacramento District identified

two willow species to serve as SRA and shallow water habitat: arroyo (*Salix lasiolepis)* and sandbar (*Salix exigua),* as shown on Plate P-001*.* Arroyo willows are a medium to large-sized species that are shrub-like with many trunks, often forming thickets, or with a single, heavy, many forked trunk, and an open, rounded crown. Arroyo willows can grow to a mature size of 30 feet tall by 30 feet wide, with up to a 5 inch diameter breast height (dbh). It is generally found to be much smaller at 15 feet by 15 feet with a 3 inch dbh at growth year 15. Sandbar willows are typically small and shrubby with slender trunks, and usually grow in thickets, only occasionally are they single-trunked. Sandbar willows can grow to a mature size of 20 feet tall by 8 feet wide, with a 2 inch dbh. It is generally found to be 15 feet tall by 6 feet wide with a 1 inch dbh at growth year 15. A very small percentage of the sandbar willows have been known to achieve up to a 3 inch dbh. The sandbar willow suckers by rhizomes and is expected to spread with time. The arroyo and sandbar willows were selected for their ability to provide SRA and shallow water habitat and they are believed to have a minimal impact to levee safety due to their relatively small maturity size, root structure, heartiness, and survivability. Arroyo and sandbar willows provide different types of habitat benefits and both are proposed for planting. However, it is anticipated that arroyo willows would require greater maintenance effort and in an effort to reduce that, the Sacramento District is proposing to plant primarily sandbar species with intermittent arroyo species for the subject vegetation variance sites. Both arroyo and sandbar willows have been evaluated in this vegetation variance request.
Chapter 2, Drawings P-002 and P-003 show the planting pattern and typical willow pole section, respectively. Two rows of willow poles would be installed parallel to the shoreline. The first row would be placed 1.5 feet above the waterline. The second row would be placed 3 feet upslope of the first row. The plants would be spaced 6 feet off center along each row. The planting pattern would have two sandbar willows followed by an arroyo willow. This pattern would be repeated along each row. The arroyo willows would be offset from the adjacent row. This accounts for twice as many sandbar willows being installed as arroyo willows. Where these two species become successful and compete for space, the sandbar willow will initially provide some SRA, but will increasingly become subservient to the arroyo willow and thin out. These willow poles would be planted along the waterline at the time of planting, but in no case above the project landside toe. The stinger planting method, discussed in Chapter 4, will be used in hopes of improving survivability and success rate.
Of the two species, the sandbar willow naturally grows in wetter soil conditions and generally closer to the river's edge. However, since the arroyo willow grows to a larger size and thereby provides more SRA, it is desirable to get it as close to the shoreline as possible and will be included in the first row as well. The arroyo willow is the more "drier" soil preferred of the two species. The proposed approach is to intersperse both species along each row to help offset the unknowns and irregularities. Plant survivability will be dependent on a number of factors, such as the water surface elevation at the time of installation, timing of the installation, the viability of the plant material, soil texture, the availability of groundwater to the pole cutting material, and subsequent water surface elevation in the river (high or low water events).

Engineering Technical Letter 1110-2-571 (ETL) generally defines the vegetation free zone as the levee prism plus 15 feet extending beyond the levee toes for a height of eight feet vertically, measured from any point of the ground within the vegetation free zone. Of the approximate 40,000 lf required for mitigation, approximately 24,000 lf fall within the vegetation free zone and the remaining approximate 16,000 lf are outside the vegetation free zone. The Sacramento District has performed an engineering evaluation the results of which show that these plantings should not cause adverse hydraulic impacts and should permit the channel to convey its design flow, even when the willows fully mature in size. Based on engineering judgment it was determined that it is extremely unlikely that the plantings would cause adverse geotechnical impacts to the structural integrity of the levee considering the location of the plantings on the waterside levee slope. For approximately 10,000 lf of the 24,000 lf, located within the vegetation free zone, the willows, if planted on site, would be located within the levee prism. The Sacramento District decided to purchase mitigation credits from a mitigation bank for the 10,000 lf so as to avoid planting on the levee (i.e., within the levee prism). The remaining approximate 14,000 feet would be located within the 15-foot vegetation free zone (hereafter referred to as the vegetation variance zone) on the waterside of the levee and therefore requires a vegetation variance. **Table Intro 1** summarizes the planting distances and location respective to the levee prism.

**Table Intro 1**: Willow Pole Planting Lengths and Locations

| Location | Length (in feet) | Variance Required |
|---|---|---|
| Waterside, outside the 15' vegetation variance zone | 16,342 | No |
| Waterside, inside the 15' vegetation variance zone | 14,122 | Yes |
| Mitigation Bank | 9,898 | No |

The Sacramento District is requesting a vegetation variance for the approximately 14,000 feet of willow pole plantings located in Reclamation Districts (RD) 3, 150, and 551. For each of these areas, a vegetation variance and subsequent plantings are the only feasible means to preserve, protect, and enhance natural resources. The following chapters include detailed information regarding this PL 84-99 vegetation variance request as specified in the Draft Policy Guidance Letter – Variance from Vegetation Standards for Levees and Floodwalls, dated February 9, 2010.

# CHAPTER 1 GENERAL DESCRIPTION OF THE LEVEE SYSTEM

## 1.1 Project Authority

This vegetation variance request applies to several reaches of the Sacramento River Flood Control Project (SRFCP). The SRFCP was originally authorized in the Flood Control Act of 1917 and was amended in 1928, 1937, and 1941.

The Sponsor for this project is the Central Valley Flood Protection Board (CVFPB), which has several agreements with local maintaining agencies. Reclamation District (RD) 3, 150, and 551 are the local maintaining agencies for the reaches of the SRFCP subject to this vegetation variance request.

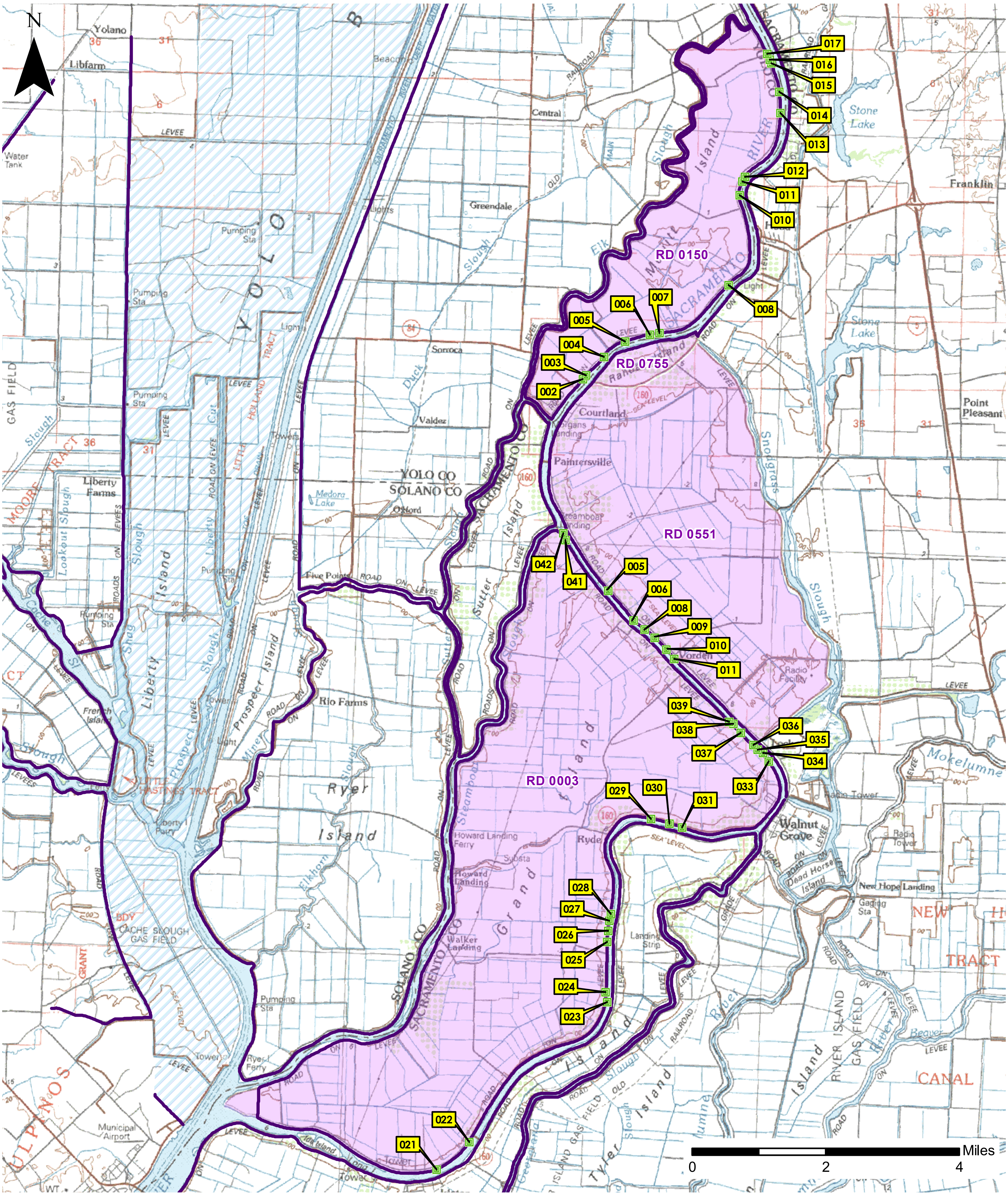
## 1.2 Project Area / Location

The 2005-2006 repair sites extended as far north as Tehama County and as far south as Stockton, California. The project area for this vegetation variance request includes reaches of the SRFCP located in RDs 3, 150, and 551, only.

A project map, Figure 1, has been included to depict the general location of the mitigation sites subject to this vegetation variance request. Further, Table 1.1 summarizes the distribution of the repair sites by the local maintaining agency. It denotes the Protected Area (PA) with a description of the boundaries and land area enclosed within a common 'levee system' as well as the total length of the proposed plantings. Table 1.2 provides a listing of coordinates and lengths of the riprap at each of the rehabilitation sites as obtained during construction.

**Table 1.2:** Project Area Details

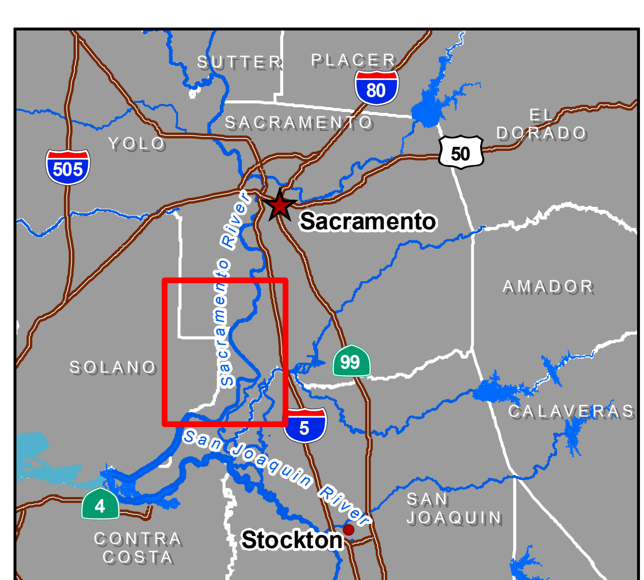
| LMA – Protected Area | Waterway | Number of Sites | Total Length (ft) |
|---|---|---|---|
| RD 3 – Grand Island in Sacramento County | Sacramento River | 20 | 5,852 |
| RD 150 – Merritt Island in Yolo County | Sacramento River | 15 | 5,868 |
| RD 551 – Randall Island and Pierson District on east bank of Sacramento River and south bank of Snodgrass Slough in Sacramento County | Sacramento River | 6 | 2,402 |




**Map Legend**

- Planting Sites
- Federal Levee
- Yolo Bypass
- Reclamation District

USGS Quadrangles (100k):
*SACRAMENTO*, 1994
*LODI*, 1993




U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

**WILLOW PLANTING SITES**

FEDERAL LEVEE PROJECTS
SYSTEM MAP

FIGURE 1

**Table 1.3** Site Coordinates and Lengths

| RECLAMATION DISTRICT | SITE NUMBER | COORDINATES | | LENGTH (FT) |
|---|---|---|---|---|
| | | START | END | |
| RD 3 | 20051230-002-021 | 38.16535, -121.60423 | 38.16527, -121.60453 | 90 |
| | 20051230-002-022 | 38.17172, -121.59531 | 38.17107, -121.59579 | 355 |
| | 20051230-002-023 | 38.20185, -121.558361 | 38.202389, -121.558273 | 198 |
| | 20051230-002-024 | 38.20312, -121.55863 | 38.20549, -121.55847 | 855 |
| | 20051230-002-025 | 38.21502, -121.55849 | 38.21524, -121.55852 | 75 |
| | 20051230-002-026 | 38.21750, -121.55836 | 38.21764, -121.55835 | 55 |
| | 20051230-002-027 | 38.21947, -121.55807 | 38.22007, -121.55798 | 220 |
| | 20051230-002-028 | 38.22117, -121.55763 | 38.22140, -121.55768 | 100 |
| | 20051230-002-029 | 38.24207, -121.54765 | 38.24187, -121.54644 | 360 |
| | 20051230-002-030 | 38.23994, -121.53751 | 38.24091, -121.54137 | 590 |
| | 20051230-002-031 | 38.24041, -121.53932 | 38.23994, -121.53751 | 590 |
| | 20051230-002-033 | 38.25425, -121.51443 | 38.25525, -121.51544 | 460 |
| | 20051230-002-034 | 38.256533, -121.516473 | 38.256658, -121.516642 | 66 |
| | 20051230-002-035 | 38.25696, -121.51761 | 38.25761, -121.51839 | 340 |
| | 20051230-002-036 | 38.25772, -121.51836 | 38.25875, -121.52009 | 570 |
| | 20051230-002-037 | 38.26072, -121.52261 | 38.26099, -121.52290 | 120 |
| | 20051230-002-038 | 38.262615, -121.524633 | 38.26289, -121.525016 | 148 |
| | 20051230-002-039 | 38.26299, -121.52556 | 38.26352, -121.52630 | 290 |
| | 20051230-002-041 | 38.30182, -121.57179 | 38.30202, -121.57194 | 90 |
| | 20051230-002-042 | 38.303068, -121.572165 | 38.303795, -121.572792 | 280 |

| RECLAMATION DISTRICT | SITE NUMBER | COORDINATES | | LENGTH (FT) |
|---|---|---|---|---|
| | | START | END | |
| RD 551 | 20051230-021-005 | 38.29159, -121.56035 | 38.29068, -121.55940 | 436 |
| | 20051230-021-006 | 38.28503, -121.55299 | 38.28458, -121.55245 | 219 |
| | 20051230-021-008 | 38.28309, -121.54983 | 38.28281, -121.54935 | 173 |
| | 20051230-021-009 | 38.28181, -121.54773 | 38.28021, -121.54559 | 836 |
| | 20051230-021-010 | 38.27900, -121.54405 | 38.27823, -121.54319 | 383 |
| | 20051230-021-011 | 38.27699, -121.54179 | 38.27624, -121.54091 | 355 |
| RD 150 | 20051230-006-002 | 38.33706, -121.56755 | 38.33673, -121.56793 | 247 |
| | 20051230-006-003 | 38.33784, -121.56669 | 38.33754, -121.56707 | 148 |
| | 20051230-006-004 | 38.34219, -121.56166 | 38.34121, -121.56241 | 429 |
| | 20051230-006-005 | 38.34611, -121.55235 | 38.34362, -121.56001 | 2397 |
| | 20051230-006-006 | 38.34673, -121.54948 | 38.34673, -121.54955 | 15 |
| | 20051230-006-007 | 38.34705, -121.54675 | 38.34703, -121.54702 | 74 |
| | 20051230-006-008 | 38.35773, -121.52809 | 38.35769, -121.52812 | 15 |
| | 20051230-006-010 | 38.37942, -121.52509 | 38.37491, -121.52483 | 1703 |
| | 20051230-006-011 | 38.38016, -121.52473 | 38.38004, -121.52475 | 53 |
| | 20051230-006-012 | 38.38150, -121.52380 | 38.38082, -121.52437 | 307 |
| | 20051230-006-013 | 38.39529, -121.51453 | 38.39497, -121.51450 | 118 |
| | 20051230-006-014 | 38.39978, -121.51487 | 38.39966, -121.51486 | 52 |
| | 20051230-006-015 | 38.40614, -121.51746 | 38.40549, -121.51711 | 203 |
| | 20051230-006-016 | 38.40664, -121.51774 | 38.40662, -121.51774 | 5 |
| | 20051230-006-017 | 38.40799, -121.51849 | 38.40774, -121.51837 | 102 |
| | | | **TOTAL:** | **14122** |

### 1.3 Population at Risk and Potential Economic Losses

Information for this section was provided in the Project Information Report (PIR) for each RD following the storm events. Tables 1.2 and 1.3, below, describe the population at risk and the potential economic losses for each RD.

**Table 1.3:** Human and Economic Loss Potential

| **LMA** | **$ in Millions** | | | **Population at Risk** |
|---|---|---|---|---|
| | **Annual Benefits** | **Net Benefits** | **Value of Protected Property** | |
| RD 3 | 11.4 | 10.82 | 75 | 1,091 |
| RD 150 | 2.61 | 1.63 | 16 | 211 |
| RD 551 & RD 755* | 1.23 | 1.16 | 39 | 688 |

* RD 551 and 755 protect the same area and are therefore included together here.

### 1.4 Critical Public Infrastructures and Facilities

Several critical public infrastructures and facilities were identified in the project area. The table below summarizes those identified.

**Table 1.4:** Critical Public Infrastructures at Risk

| **LMA** | **Critical Infrastructures** |
|---|---|
| RD 3 | Power Substation, Roads, 11 miles of Hwy 160, 2 miles of Hwy 220, Downtown Walnut Grove. |
| RD 150 | Roads, Minor Urban. |
| RD 551<br>RD 755 | 3 miles of Hwy 160, Roads, Radio Facilities, Fire Station, Schools, Downtown Courtland. |

* RD 551 and 755 protect the same area and are therefore included together here.

### 1.5 Special Environmental Considerations

California's Central Valley is an environmentally rich region home to more than 100 threatened and endangered species and temporary habitat for several threatened and endangered migrating species.

Environmental analysis was performed for all of the repair sites. Several species, or their habitat, have been identified with potential to be found in the project area. They are included as follows for your information only: San Joaquin Kit Fox (*Vulpes macrotis mutica*), Riparian Brush Rabbit (*Sylvilagus bachmani riparius*), Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*), Delta Green Ground Beetle (*Elaphrus viridis*), Delta Smelt (*Hypomesus transpacificus*), Green Sturgeon (*Acipenser medirostris*), Central Valley Steelhead

(*Oncorhynchus mykiss*), Central Valley Spring-Run, Late-Summer, Fall, and Winter-Run Chinook Salmon (*Oncorhynchus tshawytscha*), California Red-Legged Frog (*Rana aurora*), California Tiger Salamander (*Ambystoma californiense*), Giant Garter Snake (*Thamnophis gigas*), Fairy Shrimp (*Branchinecta lynchi*), Bald Eagle (*Haliaeetus leucocephalus*), Swainson's Hawk (*Buteo swainsoni*), California Clapper Rail (*Rallus longirostris obsoletus*), Western Yellow-Billed Cuckoo (*Coccyzus americanus*), and Orcutt Grasses and Hoover's Spurge (*Chamaesyce hooveri*).

Further environmental analysis resulted in a "may affect, not likely to adversely" determination for impacts to listed fish species due to construction practices (i.e. placed riprap instead of soil) used to rehabilitate levees under PL 84-99 following the 2006 event, and due to the fact that we constructed outside of approved ESA work windows.  In order to obtain concurrence from the resource agencies on this determination, the Sacramento District proposed to mitigate for impacts by restoring approximately 40,000 linear feet of aquatic habitat. This vegetation variance request, if approved, will permit approximately 14,000 lineal feet to be planted within the 15 foot waterside vegetation free zone.

Mitigation is required for minor habitat impacts to Delta Smelt, Chinook Salmon, Central Valley steelhead, and green sturgeon. This vegetation variance request would permit planting of SRA habitat to protect these species.  Detailed information regarding environmental analysis, impacts and consultation may be found in Chapters 3 and 8.

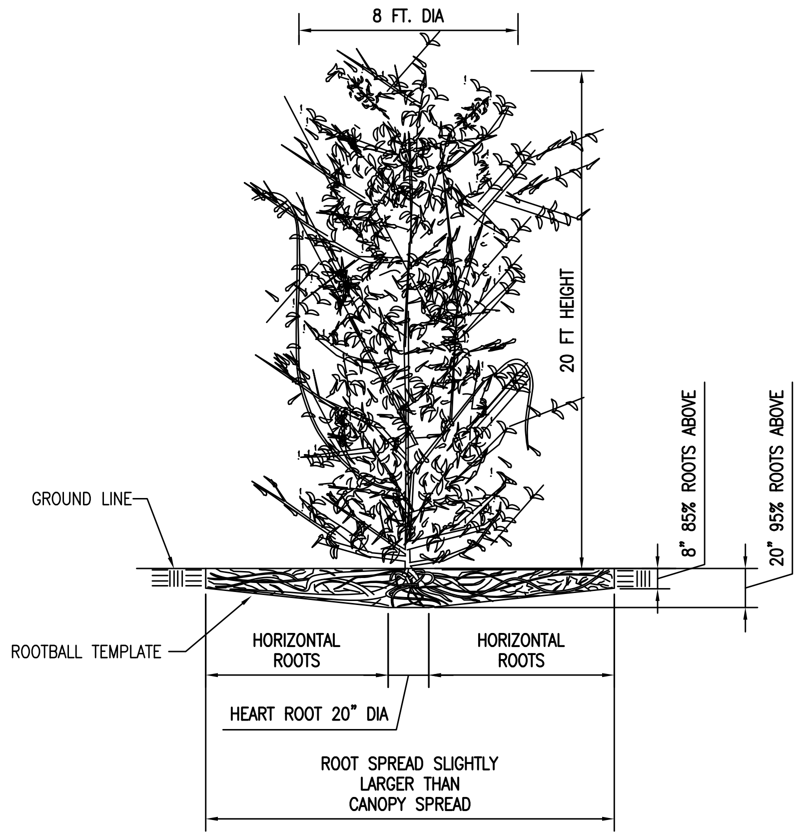
## CHAPTER 2 DRAWINGS

Included in this chapter are depictions of both the arroyo and sandbar willow species which show typical root ball and crown root structure, height and diameter of each species, and a depiction of the planting pattern discussed in the Introduction (P-001 through P-003). Also included are cross-sectional drawings created using a hybrid of the National Levee Database (NLD) cross-sections and as-built cross-sections for the PL 84-99 repairs. Each cross-section shows the arroyo willow which is the larger of the two species. Descriptions of the arroyo and sandbar species can be found in the Introduction. Accompanying each cross-section are aerial site maps depicting the willow planting areas.

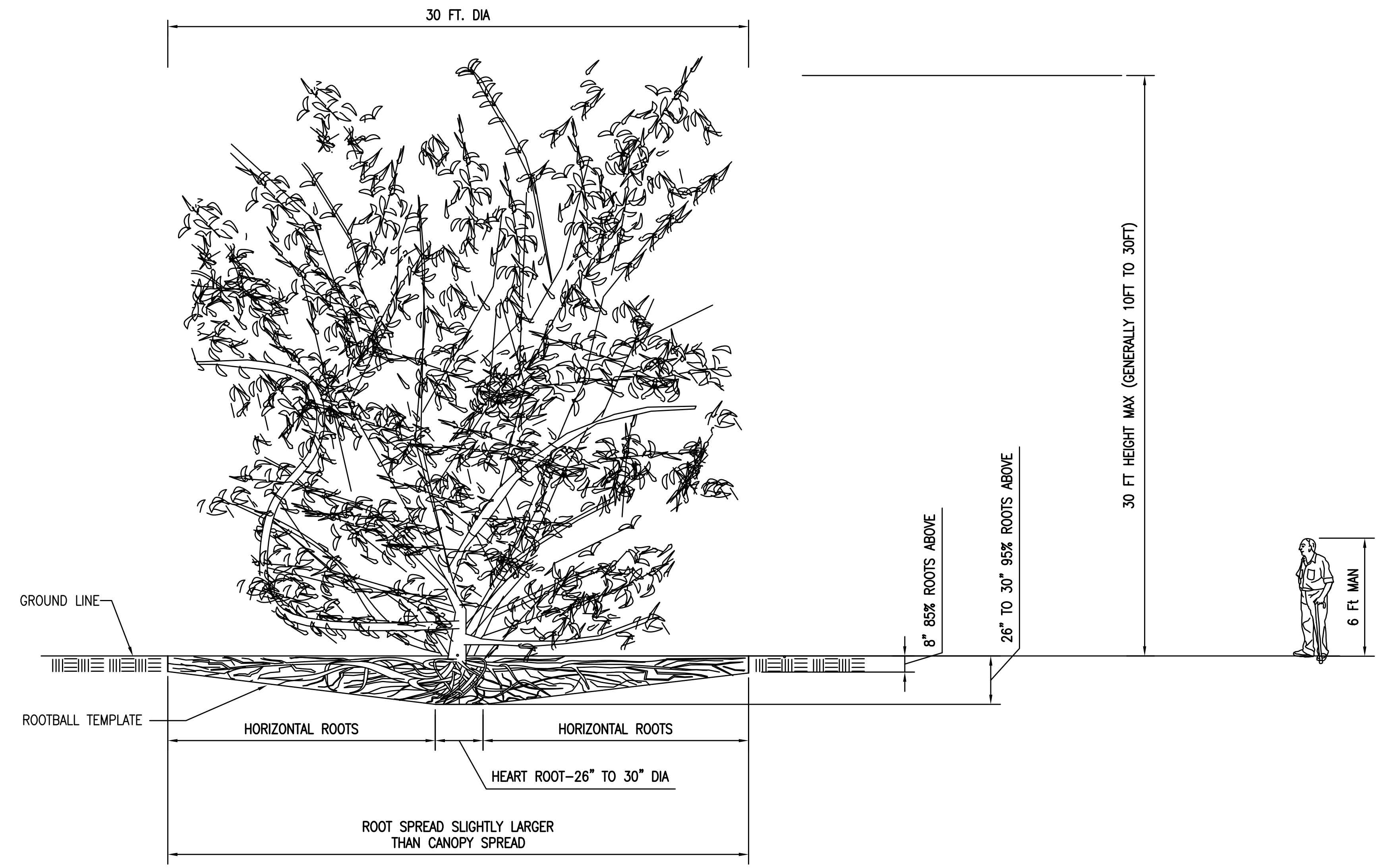
A total of nine typical cross-section drawings were prepared and are included in this chapter. All 41 sites for which we are requesting a variance are represented within the 9 cross-sections. The nature of PL 84-99 rehabilitation work is to repair the sites as quickly as possible (preferably prior to the next flood season). This rapid approach does not lend itself to the collection of GIS coordinates of the repair sites, detailed design engineering analysis, contract drawings, or as-built reports. Therefore, in preparing this vegetation variance request to meet the requirements as laid out in the policy guidance letter, the cross-sections were developed using a two-step process: first, the closest NLD cross-section was identified for each site, then those sites that were within the same RD and that had similarly matching NLD cross-sections were grouped together. Secondly, the most conservative, representative as-built cross-sections were chosen for the sites grouped by NLD cross-section. Noted on each cross-sectional drawing is the specific NLD cross-section used to create that specific cross-sectional drawing. Lastly, on each of the drawings the theoretical minimum levee prism has been identified. However, it should be noted that we do not currently have sufficient geotechnical data to analyze whether the theoretical minimal levee prism alone would adequately perform as a flood reduction levee.

Each drawing includes two water surface elevations: normal water surface elevation and the ordinary high water surface elevation. The normal water surface elevation was taken as the mean winter water surface elevation. The mean winter water surface elevation is the winter seasonal stage based on average gage data for the months of December, January, and February. The ordinary high water surface elevation was determined as the two-year flood event. For clarification purposes, the vegetation free zone is used interchangeably with the vegetation variance zone, as noted on the drawings. Elevations shown on the cross-sections are in NAVD88. The waterside edge of the riprap (to the right of the drawing) has a small symbol indicating that the riprap continues further down the slope to align with the upstream and downstream rock riprap placement. The lower limit of the riprap is not shown on the cross section.

The aerial site maps following each cross-section are the sites which are represented by that specific cross-section. Each site map depicts the upstream and downstream boundary area of the repair site and thus the planting location. Upstream and downstream boundary points on each of the site maps were located using geo-referenced data. Due to standard margins of accuracy, some boundary points needed to be shifted in some locations. The District has manually shifted these sites and the boundary points will be field verified before planting. On many maps, it is typically easy to see where the riprap was placed during repairs. However, these aerial photographs are from 2008, and may not include all completed construction from the PL 84-99 repairs which were not fully completed until January 2009. Therefore, the boundary points may appear to not entirely match the rock boundaries visible on the photos. This in part is a result of other similar repairs done adjacent to or near the PL84-99 sites. Also, many of these areas show vegetation on the levees. This vegetation will not be removed as a part of this process, nor is it necessarily currently acceptable under the sponsor's O&M manual. This vegetation variance is strictly to complete the mitigation requirements as a result of PL 84-99 construction following the 2006 flood event. Also on each site map are NLD cross-sections, identified by their NLD cross-section number, which were used in the creation of the cross-sections used in this document.




# SANDBAR WILLOW (SALIX EXIGUA)




# ARROYO WILLOW (SALIX LASIOLEPIS)

REFERENCES:

1. FORESTRY COMMISSION, THE INFLUENCE OF SOILS AND SPECIES ON TREE ROOT DEPTH, BY PETER CROW OF FOREST RESEARCH, NOVEMBER 2005.
2. WATER RESOURCES BULLETIN, VOL.28, NO.5, EFFECTS OF WOODY VEGETATION ON SANDY LEVEE INTEGRITY, BY F. DOUGLAS SHIELDS, JR. AND DONALD H. GRAY, OCTOBER 1992.

NOTES:

1. THE TREE SPECIES SHOWN ARE DEPICTED AT MATURITY.

GRAPHIC SCALE

10' 5' 0' 10' 20' 30'

US Army Corps of Engineers Sacramento District

| Symbol | Description | Date | Approved |
| --- | --- | --- | --- |

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

| | | | |
| --- | --- | --- | --- |
| Designed by: Sid Jones | | Date: 8/10/2011 | Rev. |
| Dwn by: gc | Spec No.: | Design file no: | |
| Reviewed by: Sid Jones | | Drawing Code: AS NOTED | |
| Submitted by: /s/ Peter Valentine Chief, Civil Eng. Design Section A | | File name: C-014.DWG Plot date: Dwg scale: | |

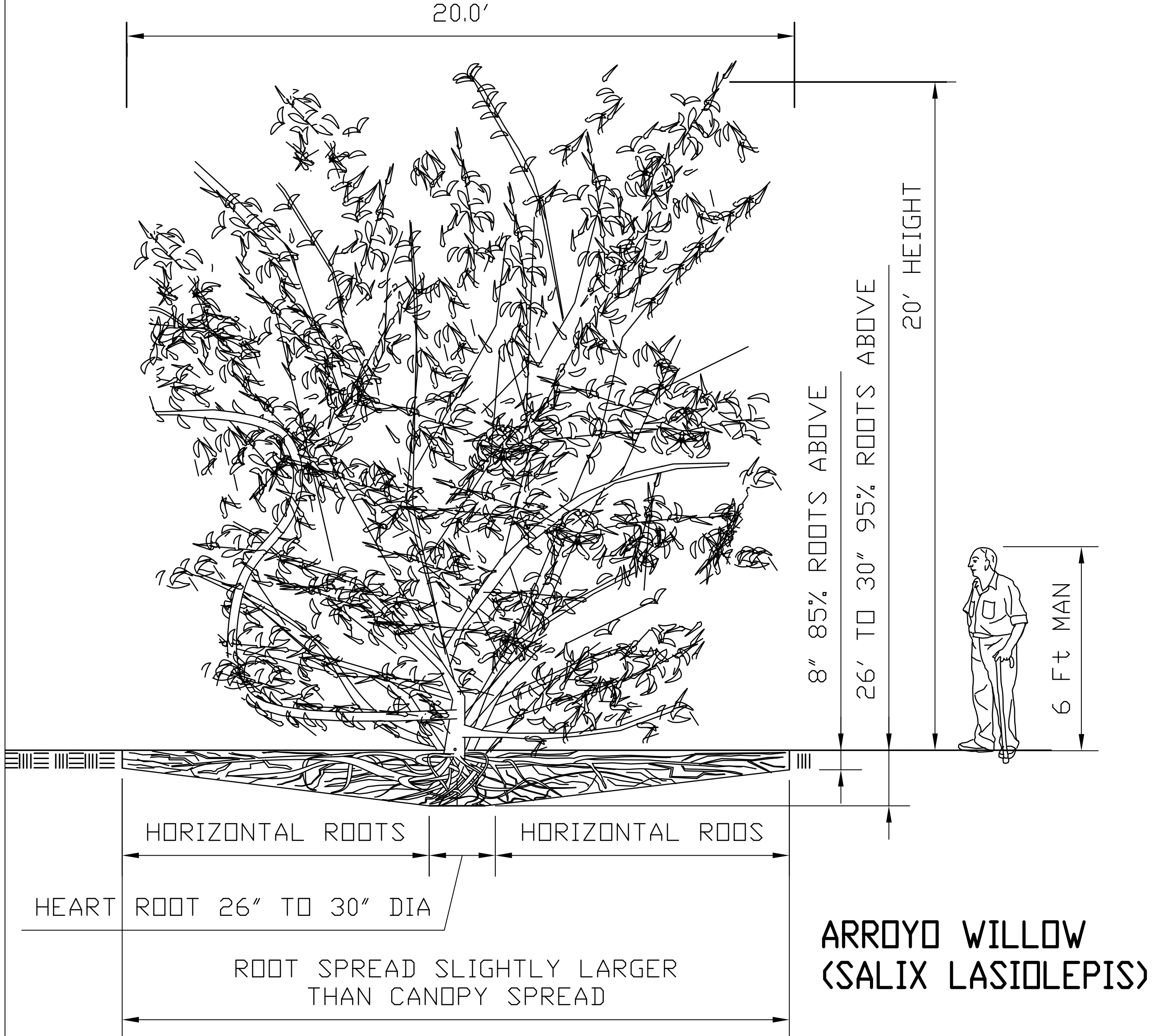
VEGETATION VARIANCE REQUEST

SIZE COMPARISON OF WILLOW SPECIES AT MATURITY

Sheet reference number:

P-001

FILE C-014, TITLE P-001




**ARROYO WILLOW**
**(SALIX LASIOLEPIS)**

REFERENCES:

1. FORESTRY COMMISSION, THE INFLUENCE OF SOILS AND SPECIES ON TREE ROOT DEPTH, BY PETER CROW OF FOREST RESEARCH, NOVEMBER 2005.
2. WATER RESOURCES BULLETIN, VOL.28, NO.5, EFFECTS OF WOODY VEGETATION ON SANDY LEVEE INTEGRITY, BY F. DOUGLAS SHIELDS, JR. AND DONALD H. GRAY, OCTOBER 1992.

NOTES:

1. THE TREE SHOWN IS DEPICTED AT MAXIMUM ANTICIPATED SIZE OF AN ARROYO WILLOW, MAINTAINED IN ACCORDANCE WITH THE MAINTENANCE REQUIRED OF CHAPTER 7 OF THIS VEGETATION VARIANCE REQUEST.
2. THE ANTICIPATED SIZE OF THE MAINTAINED TREE IS BASED ON A MAXIMUM OF 4 INCH DIAMETER TRUNK. VEGETATION MAINTENANCE REQUIRED THAT TRUNKS BE SEVERED BETWEEN 2 AND 4 INCHES. SEE CHAPTER 7 FOR SPECIFIC DETAILS.

GRAPHIC SCALE

10' 5' 0'

**DEPARTMENT OF THE ARMY**
**SACRAMENTO DISTRICT,**
**CORPS OF ENGINEERS**
**AUG 2011**

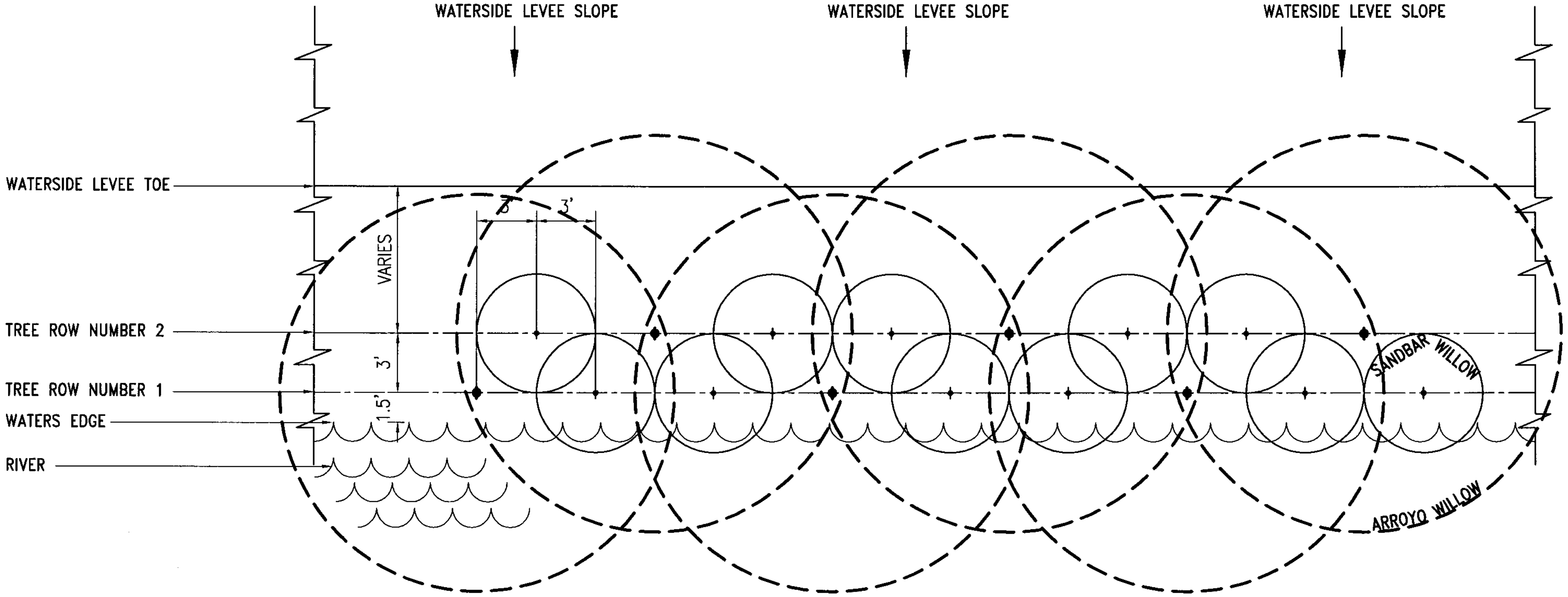
**VEGETATION VARIANCE REQUEST**

**SIZE COMPARSION OF WILLOW**
**MAINTENANCE ARROYO WILLOW**

SCALE: NOTED

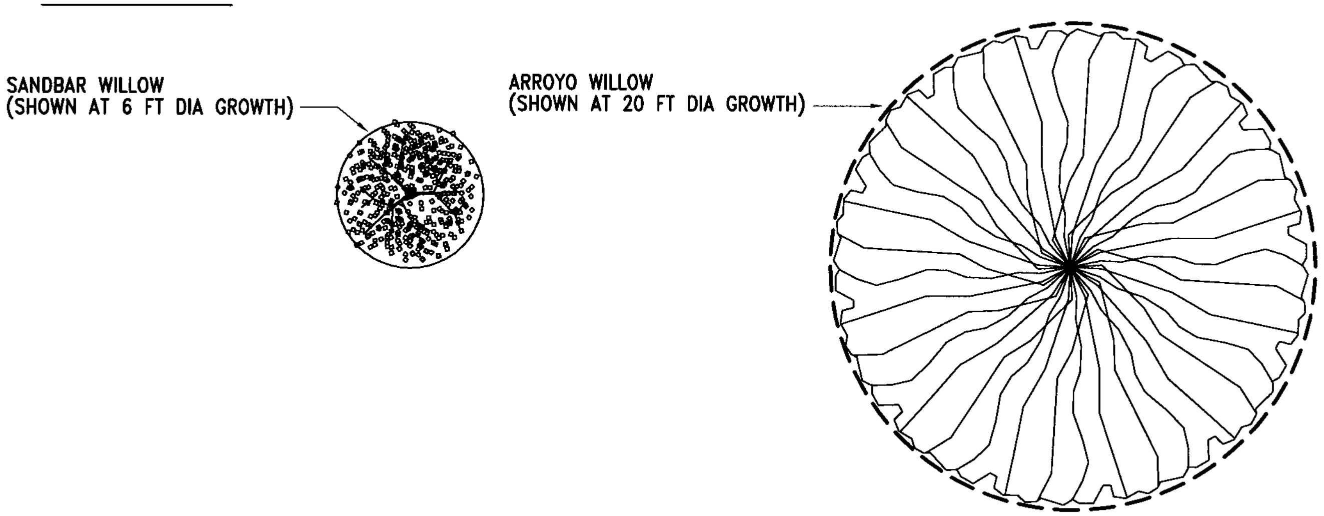
FIGURE: P–001A

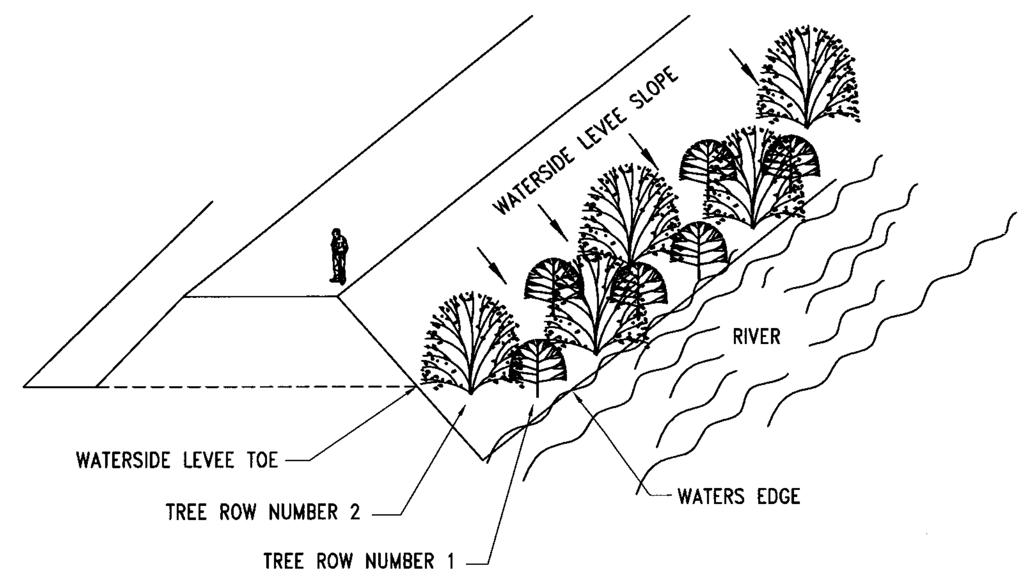
C:\DATA\ACAD2000\PROJECTS\C-TURNER-CALDWELL\C-019.DWG, TITLE P-001A, 8/10/11




TYPICAL PARTIAL PLAN VIEW

PLANT LEGEND:




PARTIAL ILLUSTRATION

SCALE: NOT TO SCALE

PLAN VIEW OF TYPICAL PLANTING PATTERN

SCALE: 1:4

DETAIL 1

US Army Corps of Engineers
Sacramento District

| Symbol | Description | Date | Approved |
|---|---|---|---|

Designed by: Sid Jones
Dwn by: gc
Spec No.:
Reviewed by: Sid Jones
Submitted by: /s/ Peter Valentine, Chief, Civil Eng. Design Section A
Date: 3/24/2010
Rev.
Design file no:
Drawing Code: AS NOTED
File name: C-015.DWG
Plot date:
Dwg scale:

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

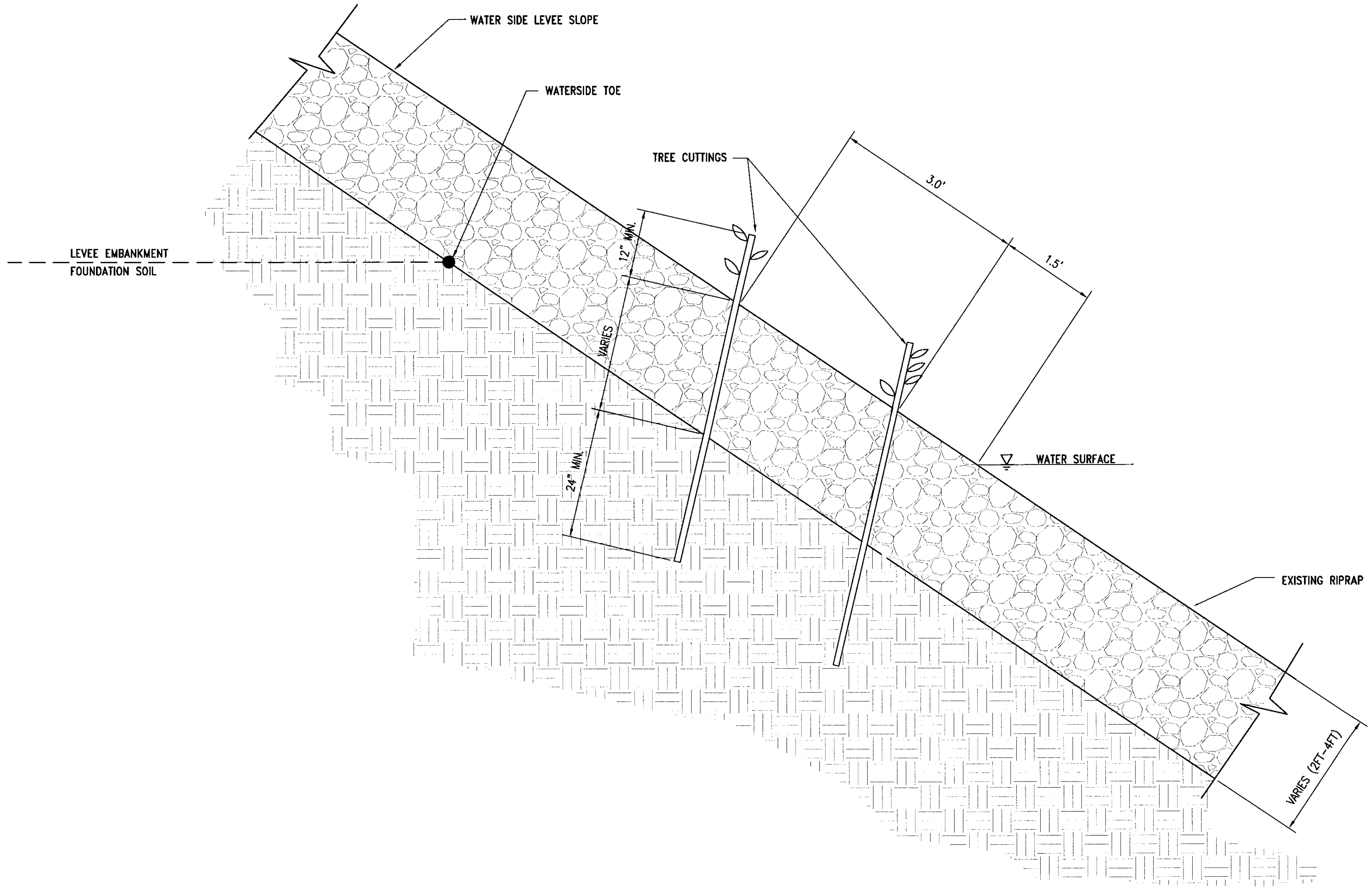
SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

VEGETATION VARIANCE REQUEST

**VEGATATION VARIANCE PLANTING DETAILS**

Sheet reference number:
P-002

FILE C-015, TITLE P-002




## TYPICAL WILLOW POLE SECTION — DETAIL 2

SCALE: 1"=1'

NOTE:

THE DISTANCE FROM THE WATERSIDE TOE TO THE UPPER ROW OF WILLOW POLES WILL VARY AND DEPEND ON WATER LEVELS AT THE TIME OF PLANTING. IN ANY CASE, NO WILLOW POLES WILL BE INSTALLED ABOVE THE TOE.

US Army Corps of Engineers
Sacramento District

| Symbol | Description | Date | Approved |
|---|---|---|---|

Designed by: Sid Jones
Dwn by: gc
Spec No.:
Reviewed by: Sid Jones
Submitted by: /s/ Peter Valentine, Chief, Civil Eng. Design Section A
Date: 3/24/2010
Design file no:
Drawing Code: AS NOTED
File name: C-015.DWG
Plot date:
Dwg scale:
Rev.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

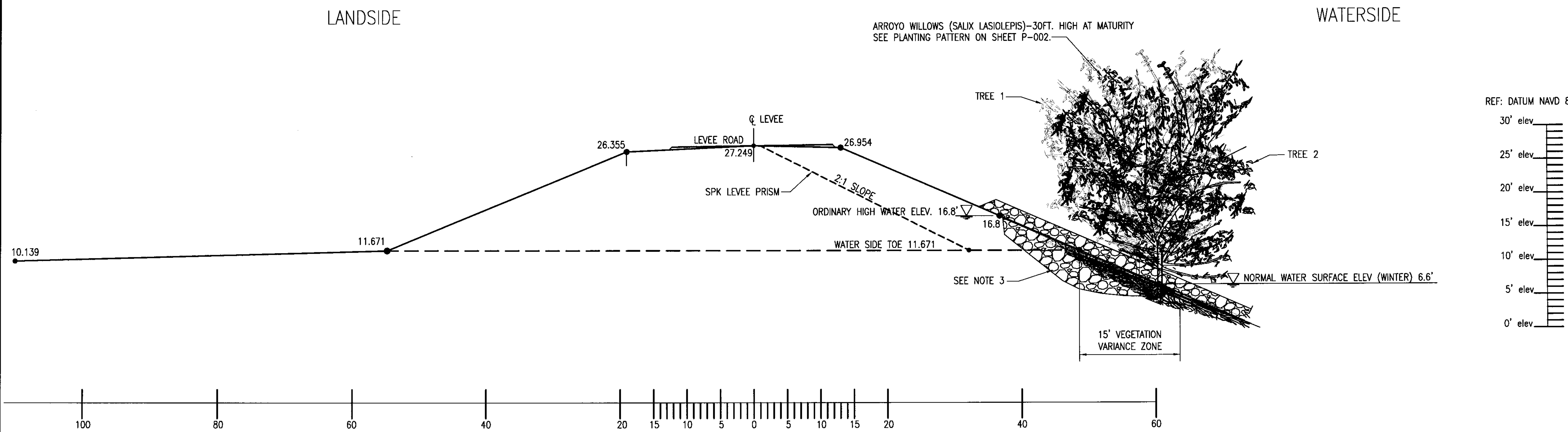
SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

VEGETATION VARIANCE REQUEST

**VEGETATION VARIANCE PLANTING DETAILS**

Sheet reference number:

P-003




RD 150-2, 3, 4, 5, 6 and 7

NLD CROSS SECTION # 5218066005

NOTES:

1. THE GEOMETRY OF THIS CROSS SECTION IS REPRESENTATIVE OF THE NLD CROSS SECTION NOTED TO THE LEFT. THE SPK LEVEE PRISM HAS BEEN IDENTIFIED FOR COMPARISON PURPOSES. THE 2H:1V WATERSIDE SLOPE IS CONSIDERED ACCEPTABLE UNDER AN AGREEMENT BETWEEN THE STATE OF CALIFORNIA AND THE U.S. ARMY CORPS OF ENGINEERS.
2. THE LOCATION OF BOTH PLANTING ROWS ARE SHOWN TO BE WITHIN THE VEGETATION VARIANCE ZONE. NOTE THAT THE ACTUAL LOCATIONS OF THE PLANTINGS WILL BE LOCATED WITH RESPECT TO THE NORMAL WATER SURFACE ELEVATION, WHICH MAY VARY AT THE TIME OF PLANTING. IN NO CASE WILL PLANTINGS BE PLACED ABOVE THE TOE OF THE LEVEE OR WITHIN THE LEVEE PRISM.
3. THE ROCK SECTION SHOWN IS REPRESENTATIVE OF THE RIPRAP PLACED AT SITES RD 150- 2, 3, 4, 5, 6 AND 7 DURING THE PL 84-99 REPAIRS,
4. THE TREES SHOWN ARE OF THE ARROYO WILLOW SPECIES DEPICTED AT MATURITY. ACTUAL VARIETY OF THE PLANTED WILLOWS WILL BE A COMBINATION OF THE ARROYO AND SANDBAR SPECIES. SEE SHEET P-001 FOR A SIZE COMPARISON OF THE ARROYO AND SANDBAR SPECIES.
5. MAINTENANCE OF THE WILLOW TREES WILL BE PERFORMED IN ACCORDANCE WITH THE MAINTENANCE PLAN INCLUDED AS CHAPTER 7 OF THIS VEGETATION VARIANCE REQUEST.

GRAPHIC SCALE

10' 5' 0' 10' 20' 30' 40'

US Army Corps
of Engineers
Sacramento District

Date: 6/10/2010

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

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SACRAMENTO, CA 95814-2922

VEGETATION VARIANCE REQUEST

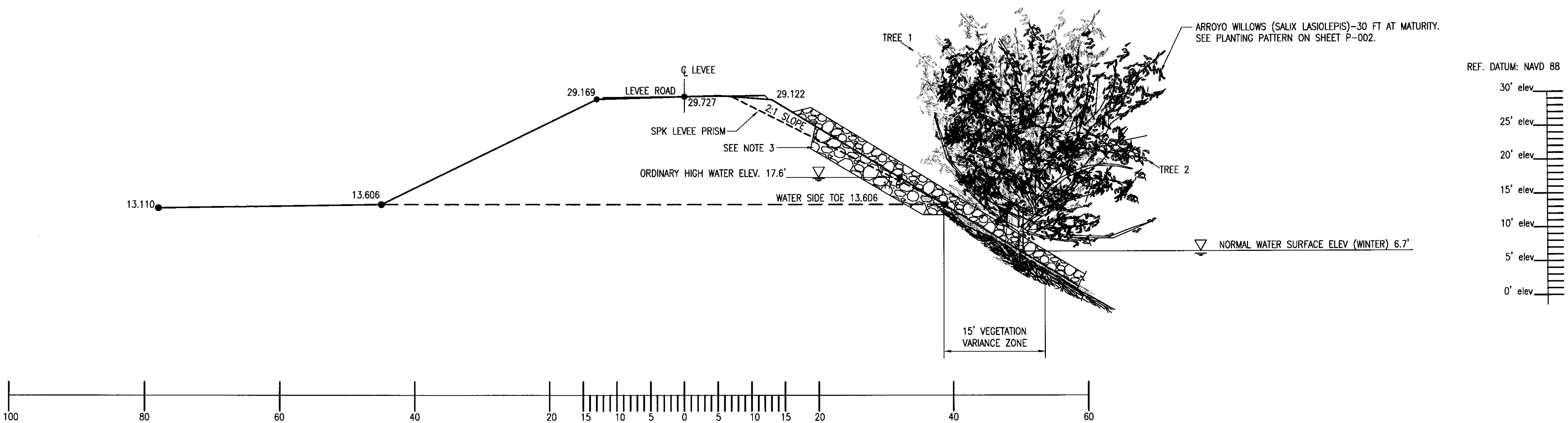
SITE# RD 150-2,3,4, 5, 6 and 7

Sheet
reference
number:
C-001

FILE C-002 TITLE C-001

LANDSIDE

WATERSIDE




SITE # RD 150–8

NLD CROSS SECTION # 5218066004

NOTES:

1. THE GEOMETRY OF THIS CROSS SECTION IS REPRESENTATIVE OF THE NLD CROSS SECTION NOTED TO THE LEFT. THE SPK LEVEE PRISM HAS BEEN IDENTIFIED FOR COMPARISON PURPOSES. THE 2H:1V WATERSIDE SLOPE IS CONSIDERED ACCEPTABLE UNDER AN AGREEMENT BETWEEN THE STATE OF CALIFORNIA AND THE U.S. ARMY CORPS OF ENGINEERS.

2. THE LOCATION OF BOTH PLANTING ROWS ARE SHOWN TO BE WITHIN THE VEGETATION VARIANCE ZONE. NOTE THAT THE ACTUAL LOCATIONS OF THE PLANTINGS WILL BE LOCATED WITH RESPECT TO THE NORMAL WATER SURFACE ELEVATION, WHICH MAY VARY AT THE TIME OF PLANTING. IN NO CASE WILL PLANTINGS BE PLACED ABOVE THE TOE OF THE LEVEE OR WITHIN THE LEVEE PRISM.

3. THE ROCK SECTION SHOWN IS REPRESENTATIVE OF THE RIPRAP PLACED AT SITES RD 150– 8, DURING THE PL 84–99 REPAIRS.

4. THE TREES SHOWN ARE OF THE ARROYO WILLOW SPECIES DEPICTED AT MATURITY. ACTUAL VARIETY OF THE PLANTED WILLOWS WILL BE A COMBINATION OF THE ARROYO AND SANDBAR SPECIES. SEE SHEET P–001 FOR A SIZE COMPARISON OF THE ARROYO AND SANDBAR SPECIES.

5. MAINTENANCE OF THE WILLOW TREES WILL BE PERFORMED IN ACCORDANCE WITH THE MAINTENANCE PLAN INCLUDED AS CHAPTER 7 OF THIS VEGETATION VARIANCE REQUEST.

GRAPHIC SCALE

10' 5' 0' 10' 20' 30' 40'

US Army Corps of Engineers
Sacramento District

Date: 6/10/2010

Designed by: | Dwn by: | Spec No.: | Design file no: | Reviewed by: | Drawing Code: | Submitted by:

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814–2922

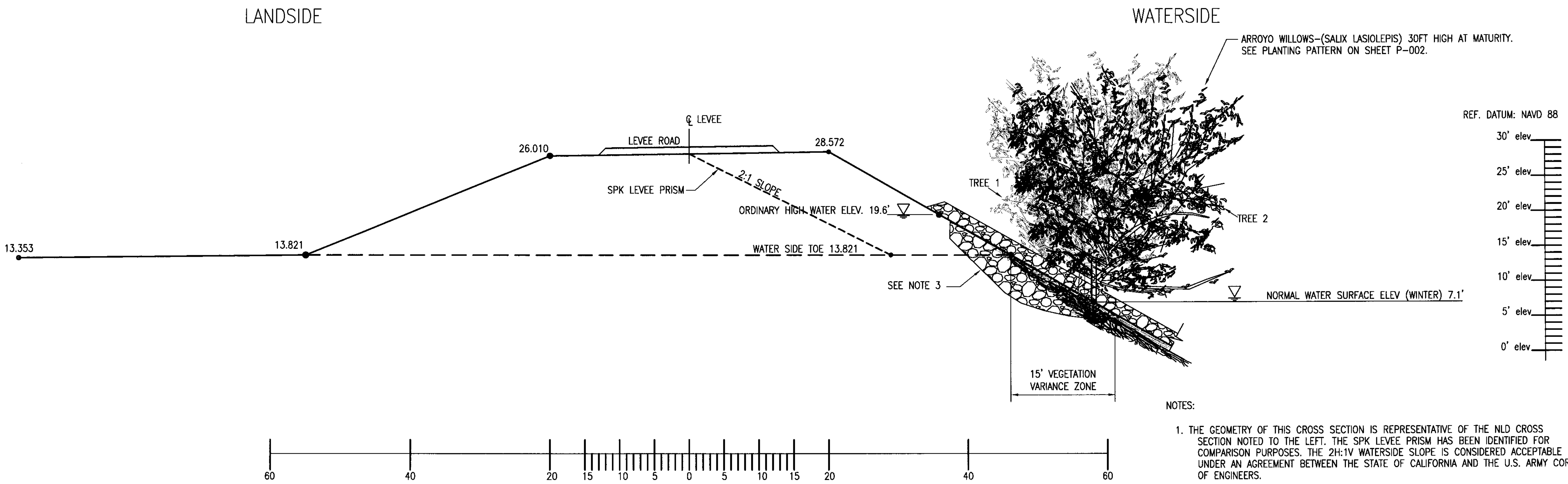
VEGETATION VARIANCE REQUEST

SITE# RD 150–8

Sheet reference number:

C–002

FILE C–011, TITLE C–002




SITE # RD 150–10,11,12,13,14,15,16 and 17

NLD CROSS SECTION # 5218066003

NOTES:

1. THE GEOMETRY OF THIS CROSS SECTION IS REPRESENTATIVE OF THE NLD CROSS SECTION NOTED TO THE LEFT. THE SPK LEVEE PRISM HAS BEEN IDENTIFIED FOR COMPARISON PURPOSES. THE 2H:1V WATERSIDE SLOPE IS CONSIDERED ACCEPTABLE UNDER AN AGREEMENT BETWEEN THE STATE OF CALIFORNIA AND THE U.S. ARMY CORPS OF ENGINEERS.

2. THE LOCATION OF BOTH PLANTING ROWS ARE SHOWN TO BE WITHIN THE VEGETATION VARIANCE ZONE. NOTE THAT THE ACTUAL LOCATIONS OF THE PLANTINGS WILL BE LOCATED WITH RESPECT TO THE NORMAL WATER SURFACE ELEVATION, WHICH MAY VARY AT THE TIME OF PLANTING. IN NO CASE WILL PLANTINGS BE PLACED ABOVE THE TOE OF THE LEVEE OR WITHIN THE LEVEE PRISM.

3. THE ROCK SECTION SHOWN IS REPRESENTATIVE OF THE RIPRAP PLACED AT SITES RD150–10, 11, 12, 13, 14, 15 16, AND 17, DURING THE PL 84–99 REPAIRS.

4. THE TREES SHOWN ARE OF THE ARROYO WILLOW SPECIES DEPICTED AT MATURITY. ACTUAL VARIETY OF THE PLANTED WILLOWS WILL BE A COMBINATION OF THE ARROYO AND SANDBAR SPECIES. SEE SHEET P–001 FOR A SIZE COMPARISON OF THE ARROYO AND SANDBAR SPECIES.

5. MAINTENANCE OF THE WILLOW TREES WILL BE PERFORMED IN ACCORDANCE WITH THE MAINTENANCE PLAN INCLUDED AS CHAPTER 7 OF THIS VEGETATION VARIANCE REQUEST.

GRAPHIC SCALE

10' 5' 0' 10' 20' 30' 40'

US Army Corps of Engineers Sacramento District

| Symbol | Description | Date | Approved |
| --- | --- | --- | --- |

Designed by: | Date: 6/10/2010 | Rev.

Dwn by: | Spec No.: | Design file no:

Reviewed by: | Drawing Code:

Submitted by: /s/ Peter Valentine, Chief, Civil Eng. Design Section A | File name: C-001.DWG | Plot date: | Dwg scale: NOTED

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
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1325 'J' STREET
SACRAMENTO, CA 95814–2922

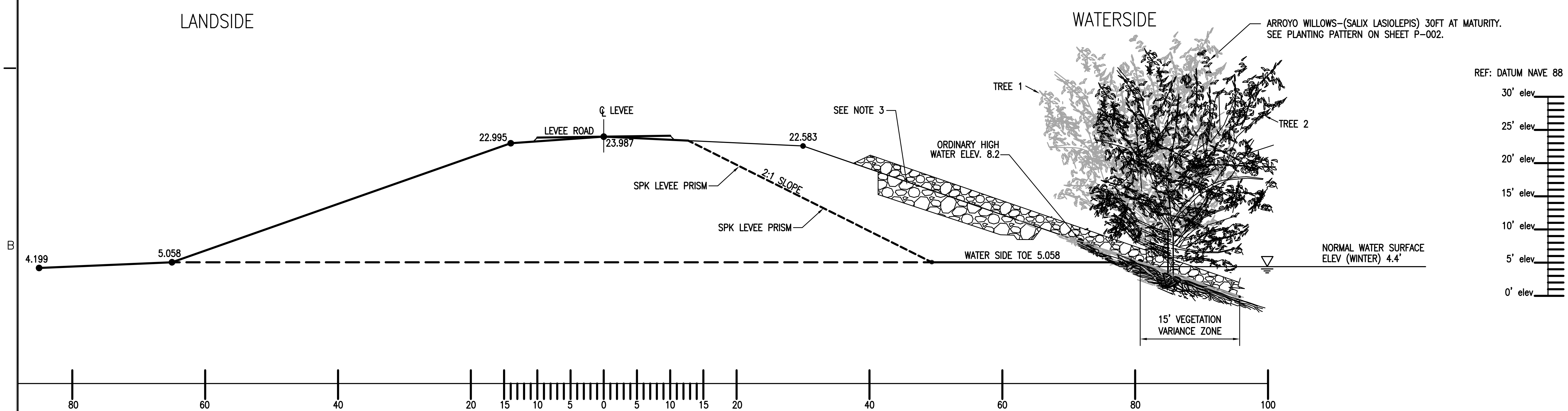
VEGETATION VARIANCE REQUEST

**SITE# RD 150–10,11,12,13,14,15,16 and 17**

Sheet reference number:

C–003

FILE C–001 TITLE C–003




RD 3-21 and 22

NLD CROSS SECTION # 5218074003

NOTES:

1. THE GEOMETRY OF THIS CROSS SECTION IS REPRESENTATIVE OF THE NLD CROSS SECTION NOTED TO THE LEFT. THE SPK LEVEE PRISM HAS BEEN IDENTIFIED FOR COMPARISON PURPOSES. THE 2H:1V WATERSIDE SLOPE IS CONSIDERED ACCEPTABLE UNDER AN AGREEMENT BETWEEN THE STATE OF CALIFORNIA AND THE U.S. ARMY CORPS OF ENGINEERS.

2. THE LOCATION OF BOTH PLANTING ROWS ARE SHOWN TO BE WITHIN THE VEGETATION VARIANCE ZONE. NOTE THAT THE ACTUAL LOCATIONS OF THE PLANTINGS WILL BE LOCATED WITH RESPECT TO THE NORMAL WATER SURFACE ELEVATION, WHICH MAY VARY AT THE TIME OF PLANTING. IN NO CASE WILL PLANTINGS BE PLACED ABOVE THE TOE OF THE LEVEE OR WITHIN THE LEVEE PRISM.

3. THE ROCK SECTION SHOWN IS REPRESENTATIVE OF THE RIPRAP PLACED AT SITES RD150-10, 11, 12, 13, 14, 15 16, AND 17, DURING THE PL 84-99 REPAIRS.

4. THE TREES SHOWN ARE OF THE ARROYO WILLOW SPECIES DEPICTED AT MATURITY. ACTUAL VARIETY OF THE PLANTED WILLOWS WILL BE A COMBINATION OF THE ARROYO AND SANDBAR SPECIES. SEE SHEET P-001 FOR A SIZE COMPARISON OF THE ARROYO AND SANDBAR SPECIES.

5. MAINTENANCE OF THE WILLOW TREES WILL BE PERFORMED IN ACCORDANCE WITH THE MAINTENANCE PLAN INCLUDED AS CHAPTER 7 OF THIS VEGETATION VARIANCE REQUEST.

GRAPHIC SCALE

10' 5' 0' 10' 20' 30' 40'

US Army Corps of Engineers Sacramento District

| Symbol | Description | Date | Approved |
|---|---|---|---|

Designed by: | Date: 6/10/2010 | Rev.

Dwn by: | Spec No.: | Design file no:

Reviewed by: | Drawing Code:

Submitted by: /s/ Peter Valentine, Chief, Civil Eng. Design Section A | File name: C-005.DWG | Plot date: | Dwg scale: AS NOTED

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

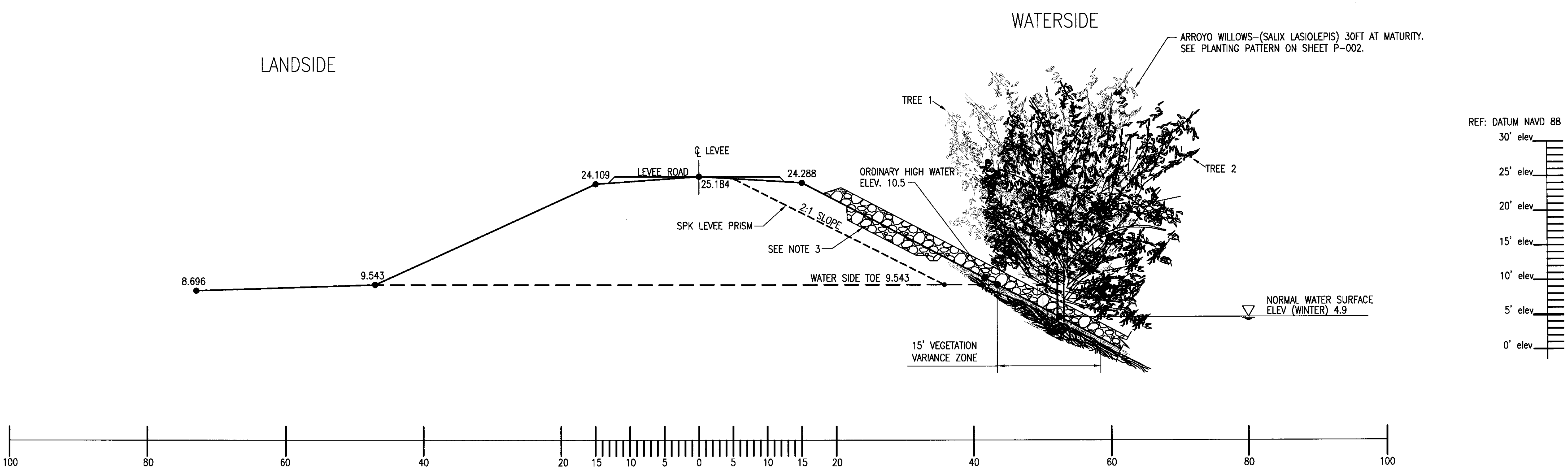
SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

VEGETATION VARIANCE REQUEST

SITE # RD 3-21 AND 22

Sheet reference number: C-004

FILE C-005 TITLE C-004




RD 3 -23,24,25,26,27 and 28

NLD CROSS SECTION # 5218074004

NOTES:

1. THE GEOMETRY OF THIS CROSS SECTION IS REPRESENTATIVE OF THE NLD CROSS SECTION NOTED TO THE LEFT. THE SPK LEVEE PRISM HAS BEEN IDENTIFIED FOR COMPARISON PURPOSES. THE 2H:1V WATERSIDE SLOPE IS CONSIDERED ACCEPTABLE UNDER AN AGREEMENT BETWEEN THE STATE OF CALIFORNIA AND THE U.S. ARMY CORPS OF ENGINEERS.

2. THE LOCATION OF BOTH PLANTING ROWS ARE SHOWN TO BE WITHIN THE VEGETATION VARIANCE ZONE. NOTE THAT THE ACTUAL LOCATIONS OF THE PLANTINGS WILL BE LOCATED WITH RESPECT TO THE NORMAL WATER SURFACE ELEVATION, WHICH MAY VARY AT THE TIME OF PLANTING. IN NO CASE WILL PLANTINGS BE PLACED ABOVE THE TOE OF THE LEVEE OR WITHIN THE LEVEE PRISM.

3. THE ROCK SECTION SHOWN IS REPRESENTATIVE OF THE RIPRAP PLACED AT SITES RD 3- 23, 24, 25 26, 27 and 28, DURING THE PL 84-99 REPAIRS.

4. THE TREES SHOWN ARE OF THE ARROYO WILLOW SPECIES DEPICTED AT MATURITY. ACTUAL VARIETY OF THE PLANTED WILLOWS WILL BE A COMBINATION OF THE ARROYO AND SANDBAR SPECIES. SEE SHEET P-001 FOR A SIZE COMPARISON OF THE ARROYO AND SANDBAR SPECIES.

5. MAINTENANCE OF THE WILLOW TREES WILL BE PERFORMED IN ACCORDANCE WITH THE MAINTENANCE PLAN INCLUDED AS CHAPTER 7 OF THIS VEGETATION VARIANCE REQUEST.

GRAPHIC SCALE

10' 5' 0' 10' 20' 30' 40'

US Army Corps of Engineers Sacramento District

Date: 6/10/2010

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT IN-HOUSE DESIGN 1325 'J' STREET SACRAMENTO, CA 95814-2922

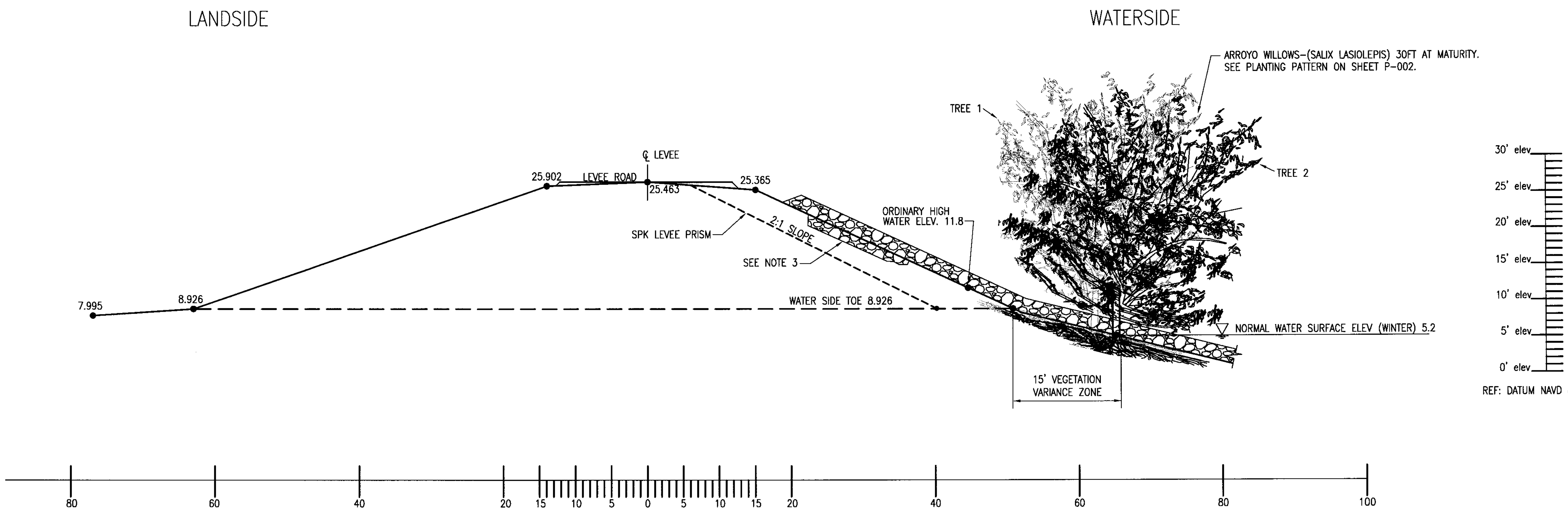
VEGETATION VARIANCE REQUEST

SITE # RD 3-23,24,25,26,27 and 28

Sheet reference number:

C-005

FILE C-006 TITLE C-005




RD 3 -29,30 and 31

NLD CROSS SECTION # 5218074005

NOTES:

1. THE GEOMETRY OF THIS CROSS SECTION IS REPRESENTATIVE OF THE NLD CROSS SECTION NOTED TO THE LEFT. THE SPK LEVEE PRISM HAS BEEN IDENTIFIED FOR COMPARISON PURPOSES. THE 2H:1V WATERSIDE SLOPE IS CONSIDERED ACCEPTABLE UNDER AN AGREEMENT BETWEEN THE STATE OF CALIFORNIA AND THE U.S. ARMY CORPS OF ENGINEERS.

2. THE LOCATION OF BOTH PLANTING ROWS ARE SHOWN TO BE WITHIN THE VEGETATION VARIANCE ZONE. NOTE THAT THE ACTUAL LOCATIONS OF THE PLANTINGS WILL BE LOCATED WITH RESPECT TO THE NORMAL WATER SURFACE ELEVATION, WHICH MAY VARY AT THE TIME OF PLANTING. IN NO CASE WILL PLANTINGS BE PLACED ABOVE THE TOE OF THE LEVEE OR WITHIN THE LEVEE PRISM.

3. THE ROCK SECTION SHOWN IS REPRESENTATIVE OF THE RIPRAP PLACED AT SITES RD3- 29, 30, AND 31, DURING THE PL 84-99 REPAIRS.

4. THE TREES SHOWN ARE OF THE ARROYO WILLOW SPECIES DEPICTED AT MATURITY. ACTUAL VARIETY OF THE PLANTED WILLOWS WILL BE A COMBINATION OF THE ARROYO AND SANDBAR SPECIES. SEE SHEET P-001 FOR A SIZE COMPARISON OF THE ARROYO AND SANDBAR SPECIES.

5. MAINTENANCE OF THE WILLOW TREES WILL BE PERFORMED IN ACCORDANCE WITH THE MAINTENANCE PLAN INCLUDED AS CHAPTER 7 OF THIS VEGETATION VARIANCE REQUEST.

GRAPHIC SCALE

10' 5' 0' 10' 20' 30' 40'

US Army Corps of Engineers Sacramento District

Date: 6/10/2010

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT IN-HOUSE DESIGN 1325 'J' STREET SACRAMENTO, CA 95814-2922

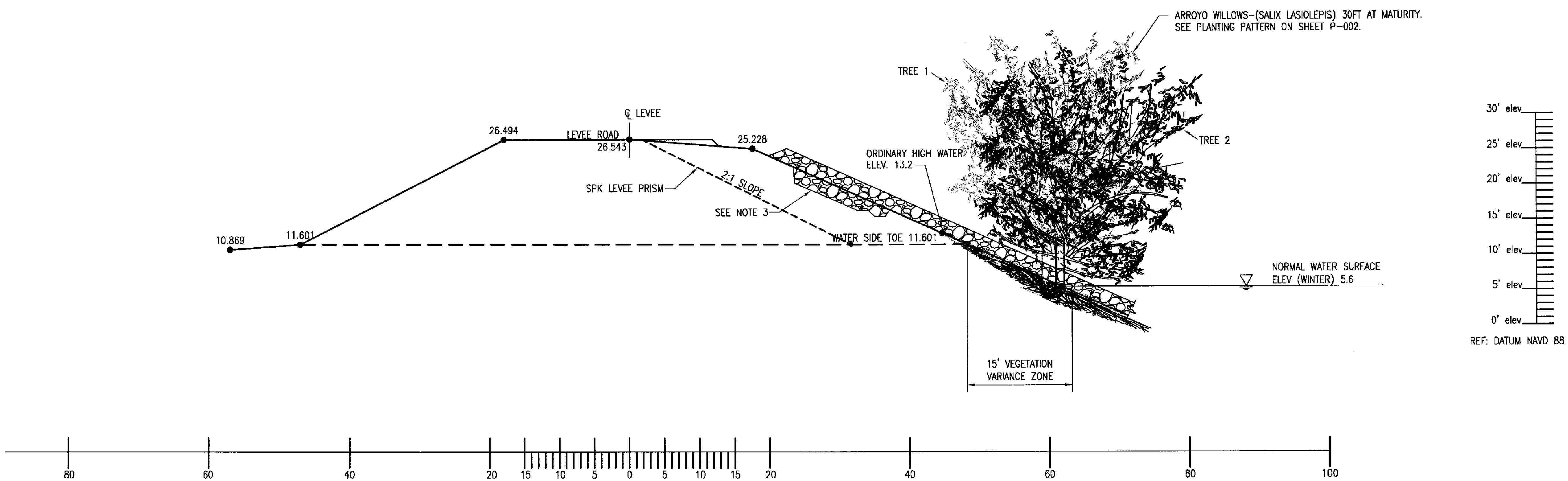
VEGETATION VARIANCE REQUEST

SITE # RD 3-29,30 and 31

Sheet reference number:

C-006

FILE C-007 TITLE C-006




RD 3 -33,34,35,36,37,38, and 39

NLD CROSS SECTION # 5218074007

NOTES:

1. THE GEOMETRY OF THIS CROSS SECTION IS REPRESENTATIVE OF THE NLD CROSS SECTION NOTED TO THE LEFT. THE SPK LEVEE PRISM HAS BEEN IDENTIFIED FOR COMPARISON PURPOSES. THE 2H:1V WATERSIDE SLOPE IS CONSIDERED ACCEPTABLE UNDER AN AGREEMENT BETWEEN THE STATE OF CALIFORNIA AND THE U.S. ARMY CORPS OF ENGINEERS.
2. THE LOCATION OF BOTH PLANTING ROWS ARE SHOWN TO BE WITHIN THE VEGETATION VARIANCE ZONE. NOTE THAT THE ACTUAL LOCATIONS OF THE PLANTINGS WILL BE LOCATED WITH RESPECT TO THE NORMAL WATER SURFACE ELEVATION, WHICH MAY VARY AT THE TIME OF PLANTING. IN NO CASE WILL PLANTINGS BE PLACED ABOVE THE TOE OF THE LEVEE OR WITHIN THE LEVEE PRISM.
3. THE ROCK SECTION SHOWN IS REPRESENTATIVE OF THE RIPRAP PLACED AT SITES RD 3- 33, 34, 35, 36, 37, 38, and 39, DURING THE PL 84-99 REPAIRS.
4. THE TREES SHOWN ARE OF THE ARROYO WILLOW SPECIES DEPICTED AT MATURITY. ACTUAL VARIETY OF THE PLANTED WILLOWS WILL BE A COMBINATION OF THE ARROYO AND SANDBAR SPECIES. SEE SHEET P-001 FOR A SIZE COMPARISON OF THE ARROYO AND SANDBAR SPECIES.
5. MAINTENANCE OF THE WILLOW TREES WILL BE PERFORMED IN ACCORDANCE WITH THE MAINTENANCE PLAN INCLUDED AS CHAPTER 7 OF THIS VEGETATION VARIANCE REQUEST.

GRAPHIC SCALE

10' 5' 0' 10' 20' 30' 40'

US Army Corps of Engineers Sacramento District

| Symbol | Description | Date | Approved |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Designed by: | | Date: 6/10/2010 | Rev. |
| Dwn by: | Spec No.: | Design file no: | |
| Reviewed by: | | Drawing Code: | |
| Submitted by: /s/ Peter Valentine Chief, Civil Eng. Design Section A | | File name: C-008.DWG Plot date: Dwg scale: AS NOTED | |

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

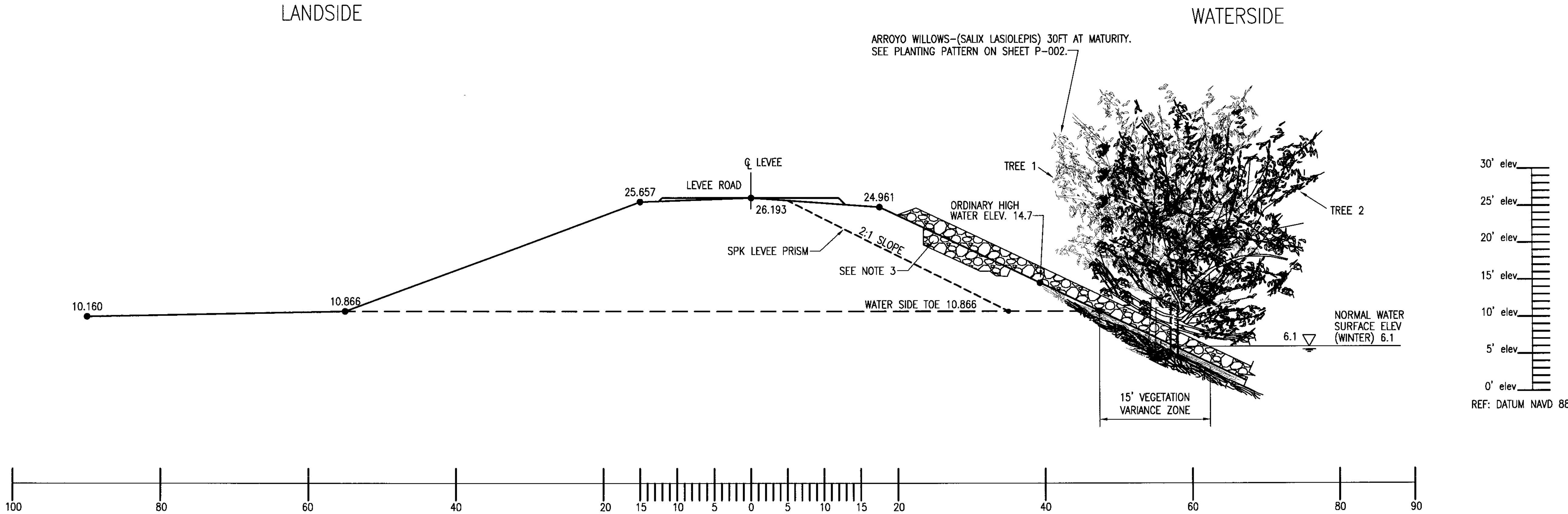
VEGETATION VARIANCE REQUEST

**SITE # RD 3-33,34,35,36,37,38 and 39**

Sheet reference number:

C-007

FILE C-008, TITLE C-007




RD 3-41 and 42

NLD CROSS SECTION # 5218074008

NOTES:

1. THE GEOMETRY OF THIS CROSS SECTION IS REPRESENTATIVE OF THE NLD CROSS SECTION NOTED TO THE LEFT. THE SPK LEVEE PRISM HAS BEEN IDENTIFIED FOR COMPARISON PURPOSES. THE 2H:1V WATERSIDE SLOPE IS CONSIDERED ACCEPTABLE UNDER AN AGREEMENT BETWEEN THE STATE OF CALIFORNIA AND THE U.S. ARMY CORPS OF ENGINEERS.
2. THE LOCATION OF BOTH PLANTING ROWS ARE SHOWN TO BE WITHIN THE VEGETATION VARIANCE ZONE. NOTE THAT THE ACTUAL LOCATIONS OF THE PLANTINGS WILL BE LOCATED WITH RESPECT TO THE NORMAL WATER SURFACE ELEVATION, WHICH MAY VARY AT THE TIME OF PLANTING. IN NO CASE WILL PLANTINGS BE PLACED ABOVE THE TOE OF THE LEVEE OR WITHIN THE LEVEE PRISM.
3. THE ROCK SECTION SHOWN IS REPRESENTATIVE OF THE RIPRAP PLACED AT SITES RD 3-41 AND 42, DURING THE PL 84-99 REPAIRS.
4. THE TREES SHOWN ARE OF THE ARROYO WILLOW SPECIES DEPICTED AT MATURITY. ACTUAL VARIETY OF THE PLANTED WILLOWS WILL BE A COMBINATION OF THE ARROYO AND SANDBAR SPECIES. SEE SHEET P-001 FOR A SIZE COMPARISON OF THE ARROYO AND SANDBAR SPECIES.
5. MAINTENANCE OF THE WILLOW TREES WILL BE PERFORMED IN ACCORDANCE WITH THE MAINTENANCE PLAN INCLUDED AS CHAPTER 7 OF THIS VEGETATION VARIANCE REQUEST.

GRAPHIC SCALE

10' 5' 0' 10' 20' 30' 40'

US Army Corps
of Engineers
Sacramento District

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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

SACRAMENTO DISTRICT
IN-HOUSE DESIGN
1325 'J' STREET
SACRAMENTO, CA 95814-2922

VEGETATION VARIANCE REQUEST

SITE # RD 3-41 and 42

Sheet reference number:
C-008

FILE C-009, TITLE C-008

## CHAPTER 3 ENVIRONMENTAL CONSIDERATIONS AND ALTERNATIVE SOLUTIONS

### 3.1 Environmental Analysis

An environmental analysis was performed during planning and design on impacts to federally listed species. Based on this analysis a "may affect, not likely to adversely affect" determination was reached for the following species: endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, threatened delta smelt, and threatened Southern Distinct Population Segment (DPS) of North American green sturgeon and the endangered valley elderberry longhorn beetle (VELB), and their respective designated critical habitat. As this time, VELB mitigation has been completed; however, mitigation for impacts to species utilizing shaded riverine aquatic (SRA) habitat and shallow water habitat has yet to be completed.

Environmental analysis takes into account project impacts to species and their habitat. As a result of project repairs, 40,000 linear feet of potential SRA habitat were impacted thus requiring mitigation. Emergency repairs required the removal of grasses, forbs, and woody vegetation. Loss of vegetation reduces input of organic materials to the ecosystem, which can affect biological production at all trophic levels.

Levee slopes protected with riprap change hydraulic conditions at localized areas to greater depths and faster, more homogeneous water velocities. Higher water velocities typically inhibit deposition and the retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along banks, especially by eliminating the shallow, slow-velocity banks used by juvenile fish as refuge and escape from fast currents, deep water, and predators (Stillwater Sciences 2006). These changes affect the quantity and quality of bank habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Garland et al. 2002, Schmetterling et al. 2001).

The Sacramento River is a fast moving system; planting willows on-site would allow some slowing of the current along the bank. This would result in some deposition of sediments and in turn, improve surrounding habitat areas by encouraging riparian vegetation recruitment. While this would not re-establish the once vast riparian habitat of the historic Sacramento River Valley, it would restore the sites to pre-flood conditions.

In order to reach a "may affect, not likely to adversely" determination for impacts to the listed fish species an agreement was made with the resource agencies to mitigate for impacts by restoring approximately 40,000 lf of SRA and shallow water habitat. Of the 40,000 lf required for mitigation, approximately 24,000 lf fall within the vegetation free zone, leaving the remaining 16,000 lf outside the vegetation free zone and able to be planted on-site. This vegetation variance request, if approved, will permit approximately 14,000 lf of the 24,000 lf to be planted within the 15 foot waterside vegetation free zone. The remaining 10,000 lf of SRA habitat has been purchased at an agency approved mitigation bank.

### 3.2 Alternatives to a Vegetation Variance

As detailed in ER 500-1-1 and EP 500-1-1, the intent of PL 84-99 rehabilitation projects is to restore the levee or other flood damage reduction project "to its pre-disaster condition and level of protection." In keeping with this intent, the Sacramento District rehabilitated the levees at all of the sites discussed in this vegetation variance request to their pre-disaster condition. All sites included either erosion or wave-wash damage repair. To create a permanent fix, quarry stone and riprap was utilized for its stability, durability, and performance to withstand future flood events. This type of fix was selected because the predominate soil type at the eroded areas is sand/silt. Replacing the soil in kind has historically led to repeating repair efforts since the soil continues to erode away. Construction has been completed; therefore, setback levees or other alternatives for these projects are not practicable. Furthermore, PL 84-99 does not grant the authority to construct new levees or improve the level of protection. Therefore, no other engineering alternatives were or are being considered for this vegetation variance request. However, alternatives to plantings were considered and evaluated and are described below.

### 3.2.1 Alternatives Considered and Eliminated from Further Evaluation

Off-Site Plantings. Sites adjacent to project repairs were analyzed for planting. No locations were found that had sufficient space to meet ETL requirements. Additionally, off-site alternatives were eliminated because it is not acceptable to the resource agencies and we are required to comply with NMFS BO 2009/01912, USFWS BO 81420-2008-J-1030 and LOC 2009/01912. The PL 84-99 repair sites occurred in areas designated as 'critical habitat' for salmonids and delta smelt. The project contributed to habitat fragmentation by removing onsite vegetation. Habitat fragmentation hinders salmonids' ability to move throughout the river system. Juvenile salmonids are most likely to be impacted from fragmentation by not having continuous access to river bank refuge areas. Conservation and recovery of salmonids depend on having diverse habitats with connections among those habitats. Without on-site mitigation there would be a lack of continuous habitat for Federally listed salmonids and delta smelt.

On-Site Anchored Wood. In-stream woody material (IWM) and SRA habitat do not provide the same benefits. IWM provides cover along the bank and helps juvenile salmonids avoid predators, whereas, SRA habitat provides overhead shade, nutrient deposits, and food sources. The placement of IWM alone does not satisfy the terms of the biological opinions. Removing riparian vegetation from riverbanks not only results in the loss of a primary source of overhead and instream cover for juvenile salmonids, it also removes living space and food for terrestrial and aquatic invertebrates, eliminating an important food source for juvenile salmonids. Since project repairs removed SRA habitat, mitigation would need to compensate for loss.

### 3.2.2 Alternatives Considered and Selected for Further Evaluation

Several alternatives were considered and selected for further evaluation. These include the following:

a.) Planting only at locations that meet the ETL, i.e., only plant at locations where the plantings would be outside the 15 foot waterside vegetation free zone;
b.) Planting at each site regardless of location and seeking a variance for plantings located within the vegetation free zone;
c.) Planting at locations both outside and inside the 15 foot waterside vegetation free zone, but not on the levee slope;
d.) Purchase all or part of the necessary mitigation at a mitigation bank.

Planting only at locations outside the vegetation free zone would be possible for approximately 16,000 lf. The analysis in the BO and LOC from NMFS and USFWS relied on a proposal of planting of willow poles on-site to restore SRA and shallow water habitat, if the planting plan is not able to be implemented, further consultation would be necessary and could result in a jeopardy opinion.

Planting on-site for the entire length, 40,000 lf would require variances for approximately 24,000 lf of levee. However, that would entail planting approximately 10,000 lf on the levee slope. The Sacramento District felt it would be prudent to avoid planting within the levee prism.

Planting at locations within the 15 foot waterside vegetation free zone would provide a reasonable approach to obtaining a variance at locations where it is clear there is no impact to levee integrity. This alternative leaves an approximately 10,000 lf deficit on our required mitigation.

Mitigation banking provides opportunity to purchase credits instead of providing on-site mitigation. Unfortunately, SRA habitat mitigation banks are limited and many lack necessary approvals for operating at this time. However, one mitigation bank was identified as having all the necessary approvals and the ability to sell credits to the Corps. Mitigation Banks are typically cost-prohibitive and, in the case of this project, the bank must provide habitat for both marine and anadromous species. In addition, the resource agencies prefer mitigation occur in-situ so that SRA provides shade and habitat throughout the primary migratory corridors, and is not limited to mitigation bank areas. That is, resource agencies prefer on-site and in-kind mitigation and typically only accept mitigation banking where shown to be necessary.

The Sacramento District chose to pursue an alternative that combined most of the above alternatives. Specifically, the Sacramento District is proposing to plant 16,342 lf outside the vegetation free zone, 14,122 lf within the vegetation free zone but not within the levee prism (that is the subject of this vegetation variance request), and 9,898 lf from a mitigation bank.

In February 2011, the Sacramento District purchased credits at Liberty Island Mitigation Bank which meets the requirements of the resource agencies. Thus, completing the first part of the mitigation plan. The Sacramento District's purchase included all available SRA habitat credits meaning that there are not currently any other mitigation banks with SRA habitat credits acceptable by the resource agencies.

### 3.3 Justification that the Vegetation is Necessary to Preserve and Protect Natural Resources

California river channels and their associated riparian vegetation are important to wildlife for breeding and rearing habitat, in addition, it functions as the primary migration corridors. Due to land use changes, approximately 95% of the historic riparian habitat has been lost in California since European settlement to make way for cities, agriculture, mining and other development (Evans and Gaffney, 2003). Logging, urban development, dams, water diversions, gravel mining, and agriculture have all contributed to this loss. The straightening of creeks for commercial, residential, and agricultural activities, and floodplain development, has reduced the width and maturity of the riparian zone, thus changing the river's form through erosion and depositional processes. Dams retain sediment, cut off critical salmonid spawning habitat and have either augmented or reduced the natural flow regime. These changes have contributed to the decline of wild salmonids. California's rivers once meandered across their forested floodplains, overflowing their banks as a result of winter rains and creating a complex of diverse habitat types. Currently many rivers and creeks have been severely confined, degraded and simplified, resulting in a significant loss of salmonid habitat and biological diversity in general.

Today, most of the larger rivers function as a flood conveyance structures for the purpose of human safety. This has been the justification for the removal of riparian vegetation along most waterways. The primary design consideration is human safety and currently relatively little emphasis is given to riparian vegetation and habitat function. Bank stabilization often is accomplished by the use of rip-rap rock placed upon the bank from its toe towards its crest. In meandering systems, rock used in this way may halt natural river movements. This effectively eliminates one form of natural sediment recruitment, and halts or impedes river processes responsible for creating and rejuvenating plant and wildlife habitat.

Riparian habitats are those adjacent to rivers and streams or occurring on nearby floodplains and terraces. The riparian corridor is the critical interface between terrestrial and aquatic systems and supports a large number of fish and wildlife species which depend on it for food and shelter. Trees and shrubs growing on the bank and over-hanging the channel provide shade for the water column adjacent to the bank providing SRA habitat for fish and other aquatic life. The shade from the vegetation helps to cool water temperatures in the river, retains high levels of dissolved oxygen, and seasonally provides insects for fish to forage. SRA is important to the juvenile salmon and steelhead as they migrate down the river to the sea. Terrestrial insects that live on riparian vegetation fall into the river and provide an important food source for these young fish. Native streamside vegetation provides leaf litter which is eaten by many aquatic insects. Most of the invertebrates found in the river occur on the woody debris. These invertebrates, in turn, are the primary food of juvenile salmon and steelhead. In addition to access to food, roots and woody debris of riparian plants provide fish with rearing habitat, as well as, protection from predators. With the severe decline in riparian habitat many species, including Chinook salmon runs, steelhead, and delta smelt are now threatened or endangered.

Salmon and steelhead have unique life histories that categorize them as "salmonids". Salmonids are anadromous, meaning that they hatch in freshwater, spend part of their life in the ocean and then return to freshwater to spawn. The entire freshwater phase of the salmonid life cycle is adapted to natural flow regimes and associated water temperatures, including adult upstream migration, spawning, and juvenile rearing and out migration. Adult salmon require cold, deep holding pools and cool oxygen-rich waters flowing over and through spawning gravels. Juvenile salmon exhibit higher growth rates when they forage in the warmer shallow waters of inundated floodplains in the spring.

Once abundant, wild salmon populations in California peaked in the late 19th and early 20th centuries and have been in slow decline ever since. Overall, salmon have disappeared from more than 40 percent of their range (NMFS, 1998). There are different seasonal (i.e., spring, summer, fall, or winter) "runs" in the migration of Chinook salmon from the ocean to freshwater, even within a single river system. Only about 10 percent of all spawning salmon stray from their home rivers, so salmon from one population very infrequently interbreed with salmon from other populations (NMFS, 2003).

Unlike salmon and steelhead, delta smelt do not travel much and are only found in the Sacramento-San Joaquin Delta. Delta smelt utilize the brackish and freshwater habitats for its rich source of food and shelter. The delta smelt's adhesive eggs attach to hard substrates such as rocks, gravel, tree roots, and submerged branches. The species' pelagic life history, dependence on zooplankton, very short life span (1-2 years), and low fecundity are characteristics which make the species sensitive to disturbances of its reproductive habitat and larval nursery areas. Therefore, any activities which would adversely affect near-shore shallow water habitat within the species' range are considered potential threats to the species.

Since the delta smelt is small (2-3 inches in length) and a somewhat passive swimmer, it provides a vital prey base to the larger fish species utilizing the bay-delta ecosystem, including salmon. Delta smelt are not only a vital link in the food chain but also acts like a barometer for the overall health of the bay-delta and upstream waters. Fewer delta smelt don't simply signify poor environmental conditions in the delta; they also indicate a weaker food web for larger predators. Riparian habitat performs many functions that are essential to fish survival and productivity, and it is critical in supporting suitable instream conditions necessary for the recovery of California's endangered fish species.

Riparian habitats play an important role not only in the life cycle of fish but it also supports an abundance of other wildlife species. Over half of the reptiles and three-fourths of the amphibians in California live in riparian areas. Large numbers of migratory and resident birds rely on streamside habitat. Over one-hundred native species of land mammals are dependent on the riparian zone, including raccoons, ringtails, and river otters. Therefore, alterations to riparian areas can have a significant impact on a multitude of species.

Another serious impact associated with the removal of riparian habitat is the introduction of non-native plants. Exotic or non-native plants have spread rapidly and taken over thousands of acres of streamside habitat. These invasive species exclude native vegetation, may increase fire danger and often use large amounts of water, decreasing available resources for fish, and wildlife. Exotic plants usually do not support the same diversity of wildlife found in native riparian areas. If exotic species dominate the riparian zone, native riparian plants cannot become established. When this happens, the habitat values are often degraded or lost. This results in changes in stream temperature, modification of instream structure and the aquatic food chain. The once complex riparian zone that provided shade, food and structure for salmonids and other species is transformed into a monoculture of grass with very little habitat value. Invasive species can have extremely negative effects on riparian areas in a relatively short period of time. The spread of invasive, nonnative plants can be controlled by planting native species such as willows. Although the purpose of planting willow poles is to provide SRA, planting of the willow poles may also prevent invasive plants from being established in the project area.

The willows that have been proposed are a native species adapted to channel environments and are a good choice for riparian restoration at bank stabilization projects due to their ability to withstand flood flows. In general, willows need significant amounts of light and a year-round source of moisture. They form specialized roots along their stems, allowing for vegetative reproduction in riparian corridors. It is this feature that allows them to be installed as dormant pole cuttings. Willows are good candidates for re-vegetation as long as their root zone remains moist during the summer. Additionally, willows, a pioneering wood species, are one of the first to become established and stabilize substrate and enhance sediment build-up for other larger tree species to establish and grow.

Riparian vegetation is an essential part of our water resources; it promotes cooler water temperatures, higher dissolved oxygen levels, habitat for insects which are primary food sources for fish, rearing habitat, and protection from prey. Statewide, riparian areas support more species of wildlife than any other vegetation type. Riparian vegetation decline is detrimental to waterways and the species that depend on it. In order to maintain habitat functionality and species diversity it is imperative to preserve the remaining riparian areas and keep our commitments to replant vegetation in locations when existing vegetation has been removed.

### 3.4 Environmental Analysis References

Evans, Rob; Gaffney, Karen. 2003. California salmonid Stream Habitat Restoration Manual.

Garland, R.D., K.F. Tiffan, D.W. Rondorf, and L.O. Clark. 2002. Comparison of subyearling fall Chinook salmon's use of riprap revetments and unaltered habitats in Lake Wallula of the Columbia River. North American Journal of Fisheries Management. 22:1283-1289.

Griggs, F. Thomas. 2008. California Riparian Habitat Restoration Handbook.

National Marine Fisheries Service. 1996. Factors for decline: a supplement to the notice of determination for west coast steelhead under the Endangered Species Act. National Marine Fisheries Service, Protected Resource Division, Portland OR and Long Beach  BA.

National Marine Fisheries Service. 1997. NMFS Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon. National Marine Fisheries Service Southwest Region, Long Beach, California. August 1997.

National Marine Fisheries Service. 1998. Factors Contributing to the Decline of Chinook Salmon: An Addendum to the 1996 West Coast Steelhead Factors For Decline Report. Protected Resources Division, National Marine Fisheries Service. Portland Oregon.

National Marine Fisheries Service. 2003. Updated status of Federally listed ESUs of West Coast salmon and steelhead. Northwest and Southwest Fisheries Science Centers. July 2003.

Schmetterling, D.A., C.G. Clancy, and T.M. Brandt. 2001. Effects of riprap bank reinforcement on stream salmonids in the Western United States. Fisheries. 26:8-13.

Stillwater Sciences. 2006. Biological Assessment for five critical erosion sites, river miles: 26.9 left, 34.5 right, 72.2 right, 99.3 right, and 123.5 left. Sacramento River Bank Protection Project. May 12, 2006.

USACE 2003. ERDC/EL TR-03-4  Effects of Riprap on Riverine and Riparian Ecosystems

USFWS. 1993. Endangered and threatened wildlife and plants; determination of threatened status for the Delta Smelt. USDI, FWS, Endangered Species Division, Washington, D C. Final Rule for 50 CFR Part 17.

USFWS. 1999. Service lists Sacramento splittail as threatened under Endangered Species Act. USDI, FWS, Sacramento, CA. 11 pp.

USFWS. 2000. Impacts of Riprapping to Ecosystem Functioning, Lower Sacramento River, California.

# CHAPTER 4 ENGINEERING ANALYSIS

This chapter discusses the engineering analysis performed by the Sacramento District to demonstrate that the proposed willow pole plantings will not adversely affect the structural integrity of the levee, the functionality of the levee, or accessibility for maintenance, inspection, and monitoring.

## 4.1 Planting Methodology

As mentioned previously, willow poles will be planted to satisfy mitigation requirements for endangered species habitat impacts affected by the vegetation removal and riprap placement. The Sacramento District is proposing to plant willow poles within the 15 foot waterside vegetation free zone for 14,122 linear feet in several reaches of the SRFCP. These plantings will be placed six feet apart in two alternating rows, as seen in the figure in the Introduction, and will consist of arroyo and/or sandbar willow species.

In the past, planting of un-rooted poles have been tediously planted by hand which is highly labor intensive and expensive. The Stinger planting method was selected for its suitability for riprap applications, efficiency, and ability to improve the survival rate of the plantings. The Stinger, as seen in the Photo 1 below, is a modified track excavator that can be placed on a barge to access the site from water, or can travel on its own on smooth or rocky terrain. The Stinger is a hydraulically actuated needle shaped clamshell tool with a hollow core where an un-rooted pole can be placed, as shown in Photo 2 below. Once inserted to the desired depth, the hydraulically actuated Stinger can be opened to allow the pole to drop into the hole, at which point the Stinger is removed. The remaining void around the pole is then filled with soil. Other Stingers are designed using a solid bar instead of a clamshell devise which simply punches a hole and hand labor must place the pole into the hole. Further information on the Stinger method can be found in Chapter 9.

In October of 2008, the Sacramento District tested the Stinger methodology on a site that was previously repaired under PL 84-99 following the 1997 flood event. This demonstration was conducted to evaluate the Stinger tool and planting methodology with three different planting patterns to test productivity, effectiveness, and impact to the repaired slope. The test site was a levee located in Reclamation District 3, along the Sacramento River on a slope of approximately 2H:1V. Mr. Kevin Hazleton, a geotechnical engineer in the Sacramento District, was asked to review and evaluate the October 2008 demonstration of the Stinger planting method to determine if this method would be acceptable without compromising the structural integrity of the repaired slope. Mr. Hazleton's findings and recommendations are found in his Memorandum for Record *PL84-99: Structural Impacts of Willow Pole Planting using the Stinger*, which is included in chapter 9. Mr. Hazleton's recommendation is summarized below:

> Impact to the repaired slope can be minimized by planting one row along the toe.
>
> An acceptable alternative would be to increase the distance between plantings and install a second row, offset from the first. The level of impact to the repaired section with this offset approach, indicated by the demonstration, is considered to be acceptable.

The MFR produced by Mr. Hazleton was solely to evaluate the effects of the use of the Stinger equipment and not the effects of the willows growing in a particular pattern. Mr. Hazelton only reviewed the immediate effects at the time of planting and did not evaluate any long term effects. The statement that three rows were determined to be detrimental to the levee integrity and stability were in reference to the use of the Stinger to plant in that particular pattern. This is reasonable considering that the Stinger displaces the riprap immediately around it and therefore when the stinger is inserted nearly side by side, a continuous zone of riprap is disturbed. The displacement of the riprap from the Stinger is believed to have a temporary affect on the stability of the riprap, as we have not experienced riprap stability failures at sites previously constructed with the stinger. In preparing the VVR, the Sacramento District considered these findings with respect to plant spacing and the number of rows and the impact that each had on the riprap. The planting pattern identified for use in the VVR is essentially one row with plants spaced three feet parallel to the levee with every other plant offset down the slope three feet. Note that we have changed the spacing between the rows from two feet to three feet. In effect, this pattern was described in the VVR as two rows separated two feet apart, plants spaced six feet apart in the direction parallel to the levee, and the rows offset from each other by three feet such that it would appear to be in a zigzag pattern. In any case, no willows would be planted above the levee toe.

As of October 2010, when the Corps last visited the demonstration site, the repaired slope appeared to be stable with no apparent loss of rock, even where three rows were installed. Photos 1 and 2 below were taken in October 2008 during the Sacramento District's Stinger demonstration project in RD3. Photos 3 and 4 were taken at the 10th Street Bridge in Yuba City, California in June 2009. The arroyo willows planted in Photos 3 and 4 were planted in 2000.

**Photo 1**: Stinger excavator on a barge

**Photo 2:** Stinger clamshell needle

**Photo 3:** Arroyo willows planted in 2000 after  9years of growth.

**Photo 4**: Same arroyos planted in 2000. Approximately 6 feet in height in 2009.

Installers will identify the toe in the field by taking the elevation point of the landside toe and shooting that to the waterside. Maintenance workers and inspectors will be able to identify the boundaries of the variance zone as the contractor installing the poles will be taking these points through GPS. Growth of the willows up the slope is unlikely as they typically grow towards a water source, but the maintenance plan will also require them to maintain the variance zone by prohibiting growth beyond the up-slope and end boundaries. Planting of the willows will occur in October when water levels are typically at their lowest. This VVR is to plant within the 15 foot vegetation free zone and not above the toe. Should the water levels be such that they are above the toe, planting will be postponed.

## 4.2 Hydraulic Analysis

### 4.2.1 Method

The purpose of the hydraulic analysis performed was to determine whether planting willows on the bank of a river would have any hydraulic impacts, most importantly if they would change the water surface elevation for a given flow.

The addition of the willows may cause an increase to the roughness or resistance of the channel banks which would cause the water to slow down; this would increase the water surface elevation. To account for this added roughness, we can increase the roughness coefficient, known as Manning's roughness, in existing hydraulic models.

At the time of the analysis, the exact length of plantings and the need for a variance at each site was unknown. Furthermore, because the Corps failed to complete the mitigation in the designated time frame, there was a possibility that the resource agencies might require additional mitigation for the temporal losses. As such, the analysis assumed the willow plantings were going to be planted twice the length of levee repair at each site (2 to 1 ratio). We have since determined that approximately 10,000 linear feet will be purchased at a mitigation bank, and the resource agencies will not require any additional plantings due to temporal losses; therefore, the analysis described here characterizes a condition with significantly more plantings than what is being requested in this variance. From Table 4.1 the total length of repair sites in this request is over 21,500 linear feet. This is compared to almost 45,000 linear feet of riverbank that was estimated to have willow poles in the hydraulic model.

**Table 4.1:** Hydraulic Roughness and Repair Lengths

| River | RD | Length of Roughness Change | Length of Repair |
|---|---|---|---|
| Sacramento River | RD 150 | 13794 | 6897 |
| Sacramento River | RD 765 | 1722 | - |
| Sacramento River | RD 551/755 | 9004 | 4502 |
| Sacramento River | RD 3 | 13674 | 6837 |
| Steamboat Slough | RD 3 | 6764 | 3382 |
| | | | |
| Total Length Feet | | 44958 | 21618 |
| Total Length Miles | | 8.5 | 4.1 |

The willow poles have very few leaves when planted; therefore, they would not have the same impact as mature willows with several years of growth. The hydraulic analysis was conducted assuming the presence of mature willow plants. Using Table 3 in USGS Scientific Investigation Report, “Selection of Manning’s Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona,” the mature willow plants would block 10-30% of flow up on the bank where they are located. This USGS report is a Western United States site specific update to the 1989 USGS Water Supply Paper 2339 with the same title that serves are the reference for selection of hydraulic reference in Chapter 5 of EM 1110-2-1601, Hydraulic Design of Flood Control Channels. This partial blockage was represented in the hydraulic analysis by an increase in manning’s roughness for the overbank area only.

The reference used to describe the roughness contains limited weeds and brush among the willow plantings while the Vegetation Management Plan described in Chapter 7 requires all the vegetation except the Arroyo and Sandbar willows to be removed. This roughness condition will be maintained by the removal of all willows with a diameter over 4 inches or obstructing the levee toe as specified by the Vegetation Management Plan. Any update to the Vegetation Management Plan should also include an update to the hydraulic analysis supporting the Vegetation Management Plan.

The discussion below includes the information relating to the analysis itself and not just the sites included in this vegetation variance request. Again, only sites included within RD 3, 150, and 551 are subject to this vegetation variance request.

#### 4.2.2 Organizing Sites

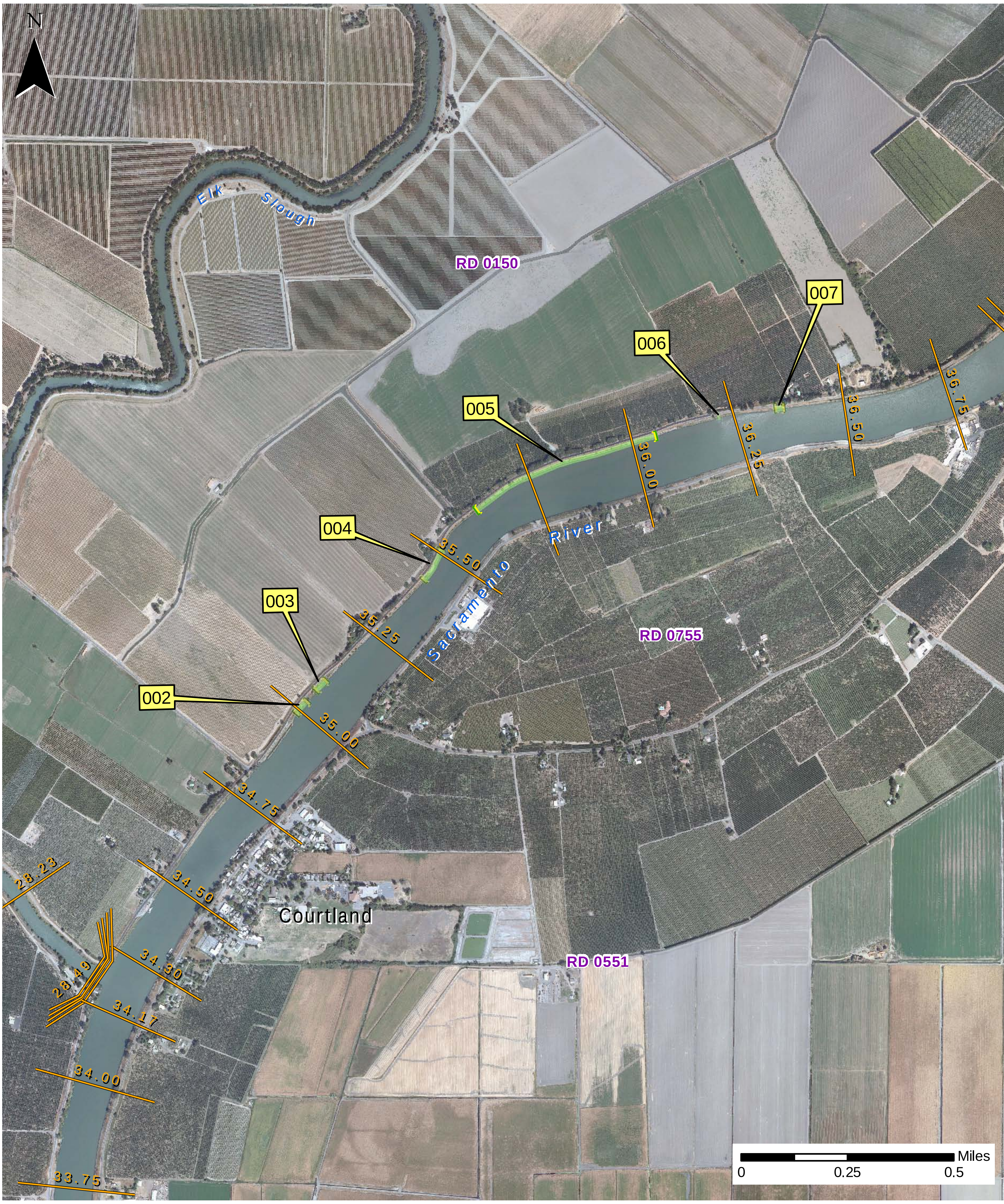
The sites were sorted by Reclamation District and then broken into four groups for the Sacramento River. This grouping of sites allowed specific areas to be changed in the hydraulic model. To model each individual site would have taken a significant amount of time, and it was difficult to determine how much additional accuracy could be gained with site specific analysis given the already large assumptions about vegetation. All sites subject to this vegetation variance request are in the Sacramento River watershed. Table 4.2 below shows the breakdown of the groups. The upstream and downstream limits of the river modified for this analysis were 42.3 and 26.8, respectively, therefore, the total length of river miles was 15.5 miles.

**Table 4.2:** Site Groupings for Hydraulic Modeling

| Group | River | Reclamation District |
|---|---|---|
| 1 | Sacramento River | RD 150 |
| 2 | Sacramento River | RD 551 |
| 3 | Sacramento River | RD 3 |

### 4.2.3 Hydraulic Models

Existing hydraulic models were used to conduct this analysis. All the sites included in this vegetation variance request are in the Sacramento River system and are located within the extent of a basin wide unsteady Hydrologic Engineering Centers River Analysis System (HEC-RAS) model from the American River Common Features and West Sacramento General Re-evaluation studies. HECRAS cross sections are spaced about 0.25 miles apart and are part of a larger system model for the whole Sacramento River Basin. A map, Figure 2, shows the hydraulic cross sections over a selection of the sites.

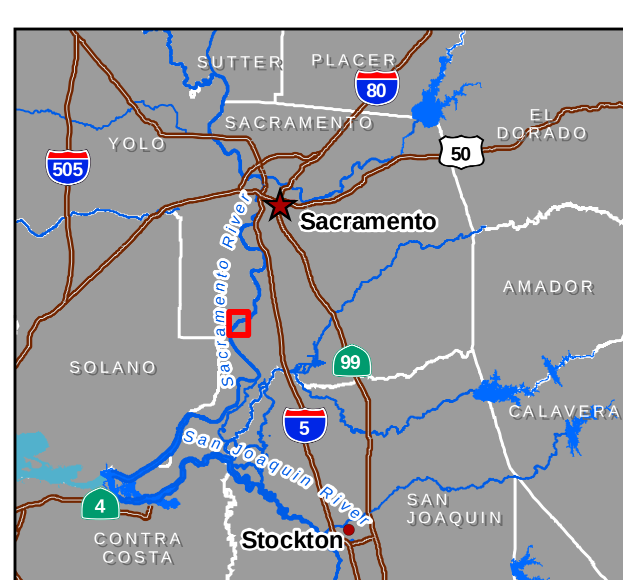



**Map Legend**

Model Cross Section

Planting Site

Aerial Background: Digital Globe 2008




FEDERAL LEVEE PROJECTS
SYSTEM MAP

**WILLOW PLANTING SITES WITH HYDRAULIC MODEL CROSS SECTIONS**

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

FIGURE 2

#### 4.2.4 Scenarios

The existing hydraulic models have hydrology based on the frequency of the storm event occurring. For this effort the 50 year and the 200 year events were modeled to analyze medium and large sized floods. The 1957 design flows and corresponding water surface profiles, which are the minimum design standard used in the Sacramento River system, do not have a specific return period but are mostly bounded by the 50 year and 200 year events.

The without project and with-project conditions represent before and after the willow poles are placed. The comparison of the two conditions over different flood events will display the differences that the willow poles will have on the project.

The without project condition is based on a hydraulic model that has topography and bathymetry collected between 1997 and 2002. This model was calibrated to the 1997 flood event. There has been very little change in the geometry of the system in the last 20 years so the levee alignments were assumed to be same as they are for this effort. The willow poles are not in these hydraulic model runs. The levee damage was assumed to be caused by the 2005-06 flood event, so the hydraulic model represents a condition before the damage to the levees occurred.

The with-project condition uses the same hydraulic model as the without project condition but this now includes willow poles. The PL 84-99 levee repairs are designed to restore the levees back to their pre-flood event condition. Using this assumption we used the same hydraulic model geometry for the with-project condition.

Velocities used in the hydraulic analysis originated from an 1-D unsteady HECAS model. Therefore, the velocity is an average across the channel. The three RDs included in this request are within the same reach of the Sacramento River so a maximum velocity of 7.2 feet per second was used for analysis.

All the sites in one RD are on the same side of the river so with regards to channel cross sections in the hydraulic model, the roughness values of only one bank will change. Figure 3 shows how the roughness was changed on a representative cross section from the HECRAS model. A total of four conditions were analyzed, including the base condition and a maximum growth condition for each watershed

From the USGS Scientific Investigation Report, “Selection of Manning’s Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona,” the maximum increase in roughness for willows with 8 to 10 years of growth is 0.05. This value was used for the second roughness increase scenario. Table 4.3 has the list of hydraulic model scenarios that will be performed for this effort and Table 4.4 has the specific changes made to the roughness variable for each reach of river.

**Table 4.3:** Modeling Scenarios

| Frequency | Changes to Roughness |
| --- | --- |
| 50-year | Base Condition |
| 50-year | .05 Max Increase in Manning's n (Roughness) |
| 200-year | Base Condition |
| 200-year | .05 Max Increase in Manning's n (Roughness) |

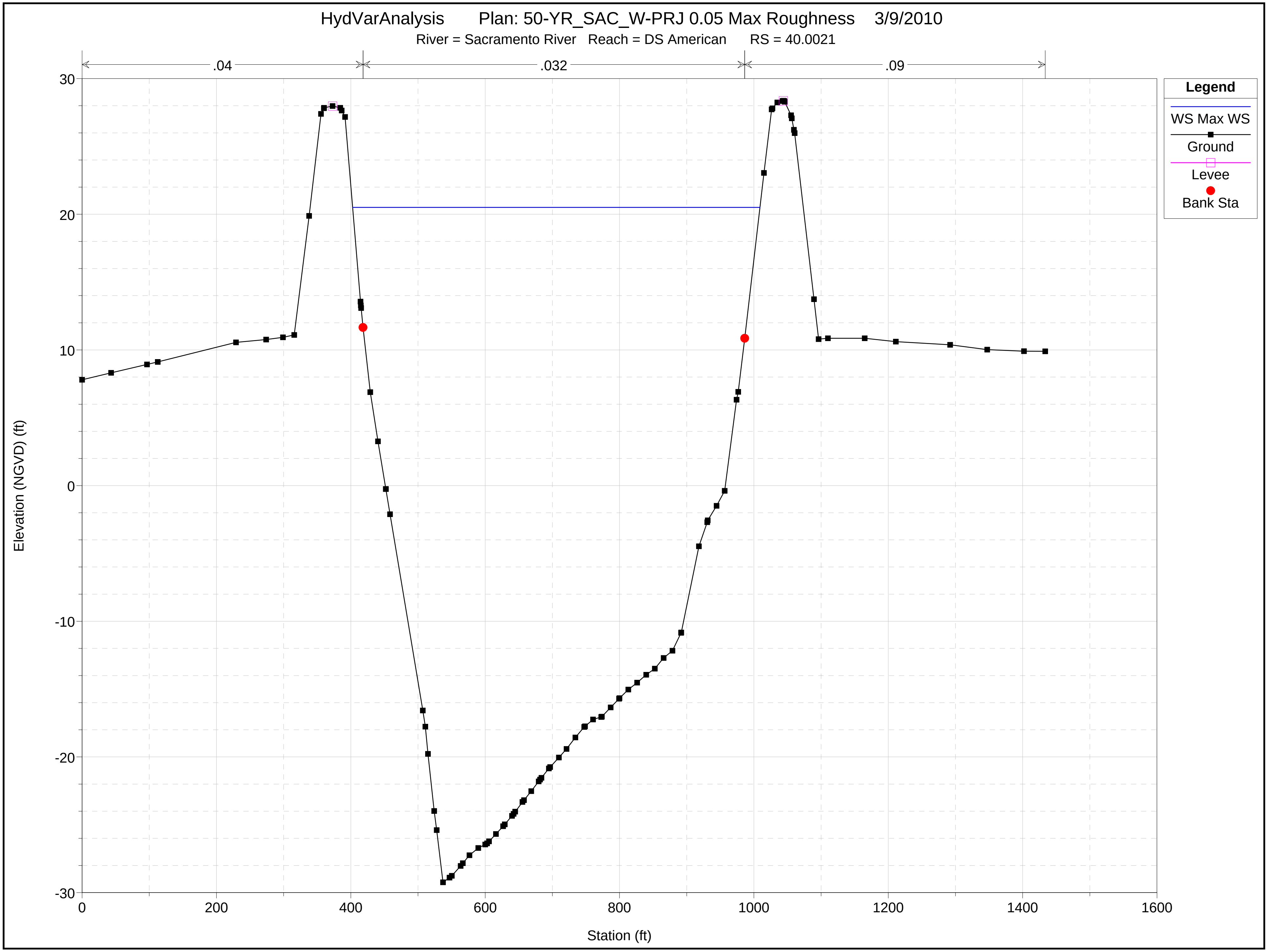



Figure 3 HECRAS Roughness Cross Section

**Table 4.4:** Model Adjustments to Account for Willow Poles

| Sacramento River | | | | | Increased Roughness By: | |
|---|---|---|---|---|---|---|
| Rivermile | Bank | Left Overbank | Channel | Right Overbank | 20% | 0.05 |
| 42.00 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 41.75 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 41.50 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 41.25 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 41.00 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 40.75 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 40.50 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 40.25 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 40.00 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 39.75 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 39.50 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 39.25 | Right | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 36.50 | Left | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 36.25 | Left | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 36.00 | Left | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 35.75 | Left | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 33.50 | Left | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 33.25 | Left | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 33.00 | Left | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 32.75 | Left | 0.040 | 0.032 | 0.040 | 0.048 | 0.090 |
| 29.75 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |
| 29.50 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |
| 29.25 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |
| 29.00 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |
| 28.75 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |
| 28.50 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |
| 28.25 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |
| 28.00 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |
| 27.75 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |
| 27.50 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |
| 27.35 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |
| 27.25 | Right | 0.035 | 0.032 | 0.035 | 0.042 | 0.085 |

*Shaded Roughness implies it was the side of the bank that was changed.

Shading denotes the roughness value that was modified to account for the willows. The four hypothetical scenarios were then modeled and compared to the base conditions to determine changes in water surface elevation.

### 4.2.5 Results

Table 4.5 shows the results from the analysis with the changes in water surface elevation for each model run at the various reaches listed.

**Table 4.5:** Water Surface Differences

| Sacramento River Max Change in Stage (feet) | | | | |
|---|---|---|---|---|
| | 50-yr Event | | 200-yr Event | |
| XS Rivermile | 50-yr .05 Max | 50-yr 20% Inc | 200-yr .05 Max | 200-yr 20% Inc |
| Miles | FT, NGVD 29 | FT, NGVD 29 | FT, NGVD 29 | FT, NGVD 29 |
| 42.00 | 0.051 | 0.002 | 0.012 | 0.001 |
| 41.75 | 0.050 | 0.001 | 0.011 | 0.001 |
| 41.50 | 0.052 | 0.002 | 0.010 | 0.001 |
| 41.25 | 0.052 | 0.001 | 0.010 | 0.002 |
| 41.00 | 0.052 | 0.001 | 0.009 | 0.001 |
| 40.75 | 0.053 | 0.001 | 0.008 | 0.001 |
| 40.50 | 0.054 | 0.001 | 0.007 | 0.001 |
| 40.25 | 0.055 | 0.001 | 0.006 | 0.001 |
| 40.00 | 0.055 | 0.001 | 0.004 | 0.001 |
| 39.75 | 0.054 | 0.000 | -0.002 | -0.002 |
| 39.50 | 0.056 | 0.001 | 0.002 | 0.000 |
| 39.25 | 0.056 | 0.000 | 0.000 | -0.001 |
| 36.50 | 0.066 | 0.000 | -0.010 | -0.001 |
| 36.25 | 0.065 | -0.001 | -0.012 | -0.002 |
| 36.00 | 0.067 | 0.000 | -0.012 | -0.001 |
| 35.75 | 0.067 | -0.001 | -0.015 | -0.002 |
| 33.50 | 0.067 | -0.002 | -0.020 | -0.002 |
| 33.25 | 0.065 | -0.002 | -0.021 | -0.002 |
| 33.00 | 0.061 | -0.002 | -0.023 | -0.003 |
| 32.75 | 0.059 | -0.003 | -0.023 | -0.003 |
| 29.75 | 0.028 | -0.002 | -0.027 | -0.003 |
| 29.50 | 0.025 | -0.003 | -0.028 | -0.004 |
| 29.25 | 0.022 | -0.002 | -0.029 | -0.004 |
| 29.00 | 0.020 | -0.002 | -0.029 | -0.003 |
| 28.75 | 0.016 | -0.002 | -0.030 | -0.004 |
| 28.50 | 0.013 | -0.003 | -0.030 | -0.004 |
| 28.25 | 0.009 | -0.003 | -0.031 | -0.003 |
| 28.00 | 0.005 | -0.003 | -0.032 | -0.004 |
| 27.75 | 0.003 | -0.003 | -0.032 | -0.004 |
| 27.50 | -0.001 | -0.003 | -0.032 | -0.004 |
| 27.35 | -0.003 | -0.003 | -0.033 | -0.004 |
| 27.25 | -0.007 | -0.003 | -0.033 | -0.004 |

| Sacramento River Max Change in Stage (feet) | | | | |
|---|---|---|---|---|
| | 50-yr Event | | 200-yr Event | |
| | 50-yr .05 Max | 50-yr 20% Inc | 200-yr .05 Max | 200-yr 20% Inc |
| | FT, NGVD 29 | FT, NGVD 29 | FT, NGVD 29 | FT, NGVD 29 |
| **Max** | 0.067 | 0.002 | 0.012 | 0.002 |
| **Min** | -0.007 | -0.003 | -0.033 | -0.004 |
| **Range** | 0.074 | 0.005 | 0.045 | 0.006 |
| **Std Dev** | 0.025 | 0.002 | 0.017 | 0.002 |

The change in water surface elevation for all conditions is less than 0.1 feet. The change in stage decreases with a larger, less frequent storm event. The 50-year event (+0.07 ft) has a greater change in stage than the 200-year event (+0.04 ft). Even with this increase, the water surface elevation is over 3 feet below the top of levee for the 200-year event. The results show potential impacts to the stage locally around the plantings but this change in stage does not travel significantly upstream or downstream. Even with this increase, the water surface elevation is over 3 feet below the top of levee for the 200-year event. It is unlikely that this localized increase will impact the overall performance of the system to pass flood events through this section of levee. The potential impacts in stage have been determined using conservative estimates of roughness length and magnitude.

### 4. 3 Riprap analysis

This analysis compares the riprap designs in PL 84-99 levee rehabilitation specifications to the minimum design criteria based on EM 1110-2-1601 and determined using Channel Protection Software (ChanlPro) along with other existing input information. It can then be determined if the PL 84-99 riprap designs meet or surpass this minimum criteria.

Riprap analysis was performed on a representative site within RD 150. This site was selected based on its proximity to a river bend where velocities would be higher. The conditions at this site approximate an extreme case in terms of hydraulic variables such as channel velocity and roughness as compared to other RD's in this vegetation variance request which are in the vicinity of RD 150.

#### 4.3.1 Background

The intent of the PL 84-99 Program is to repair the levee to the preflood condition and not an improvement as measured by level of protections. The process for designing and constructing repairs under PL 84-99 is different than the standard civil works process and does not include final surveys. The design did not include a geotechnical or hydraulic analysis to support the construction of these sites.

Specifically, the Note on as-built drawings for RD 150 summarizes the intent well:

> *"The levee repairs described by these construction documents are only intended to rehabilitate each site to its preflood condition. These repairs have not been formulated to provide protection against any specific flood event. As directed by the government, no geotechnical or hydraulic data collection or analysis was conducted as part of this effort. Preliminary levee repair cross sections and*

*material specifications were furnished by the government. Final levee repair cross sections shall match existing grade".*

For all of the repair sites, the riprap material was placed by barge from the waterside of the levee. As the material was loaded onto the barge, it was sampled to ensure it met construction specifications. Quality control and assurance were performed on site. The contractor was required to submit a gradation curve for the source material they used; additionally, the contractor collected samples every 10,000 tons during construction. Corps of Engineer Quality Assurance representatives were on site during placement to visually verify the riprap gradation met specifications and segregation of riprap did not occur.

### 4.3.2 Methods

The riprap gradation was taken out of the RD 150 as-built drawings and specifications for stone protection then graphed on a riprap gradation curve with on "weight versus percent lighter" and "weight of stones" as the axes.

The ChanlPro was used to determine the gradation needed to meet the minimum design requirements in EM 1110-2-1601. Input data (Table 4.6) was taken from existing data. The site used on the Sacramento River in RD 150 was also located on the tightest river bend. Average channel velocity and top width data was taken from the American River Common Features HECRAS Model. A range of synthetic events, 2-yr thru 500-yr, was used to determine the average channel velocity through means of a hydraulic model. The system's design water elevation is not based on frequency so it was assumed that most flood stages and design water surface elevations would fall within the range of synthetic events( 2-yr thru 500-yr).

**Table 4.6:** ChanlPro Input Values

| **ChanlPro Input Values for Minimum Design** | |
|---|---|
| **Natural Channel, Side Slope Riprap, Bendway** | |
| Specific Weight of Stone, pcf | 165 |
| Minimum Center Line Bend Radius, ft | 1525 |
| Water Surface Width, ft | 526 |
| Local Flow Depth, ft | 19.7 |
| **Channel Side Slope, 1 Ver: 2.0 Horz** | |
| Average Channel Velocity. Fps | 7.2 |
| Computed Local Depth Avg Velocity, fps | 10.8 |
| Riprap Design Safety Factor | 1.1 |

Based on the inputs in Table 4.6, the results of the analysis are shown in Table 4.7.

**Table 4.7:** Selected Stable ETL 1110-2-120 Gradations

| | ETL Gradation | | PL 84-99 Gradation | |
|---|---|---|---|---|
| **Computed Rock Size** | | | | |
| $D_{30}$ | 7.1 | N/A | N/A | N/A |
| **Equivalent Spherical Diameter Size** | **Min, inches** | **Max, inches** | **Min, inches** | **Max, inches** |
| $D_{15}$ | 6.0 | 7.9 | 3.0 | 10.0 |
| $D_{50}$ | 8.8 | 10.0 | 10.0 | 16.0 |
| $D_{100}$ | 11.1 | 15.0 | 16.0 | 18.0 |
| **Limits of Stone Weight(lb), for Percent Lighter by Weight** | | | | |
| **% Lighter by Weight** | **Min Rock Size lb.** | **Max Rock Size lb.** | **Min Rock Size lb.** | **Max Rock Size lb.** |
| 100% | 67 | 169 | 100 | 200 |
| 50% | 34 | 50 | 20 | 50 |
| 15% | 11 | 25 | 5 | 20 |
| **Riprap Thickness** | **Min. Thickness, in** | | **Min. Thickness, in** | |
| Minimum Layer | 22.5 | | 24 | |

### 4.3.3 Hydraulic Conclusions

The riprap has been constructed and has a minimum factor of safety of 1.1. In the development of the ChannelPro model, several Factors of Safety were evaluated to see how sensitive the gradation is to the factor of safety and it was found that they don't significantly impact the riprap gradation. The main goal was to check the PL 84-99 gradations after they were built to make sure they met the minimum criteria of a minimum factor of safety of 1.1.

From the results in Table 4.7, the riprap gradation used in the PL 84-99 construction is similar to, and either meets or exceeds, the minimum design criteria specified in EM 1110-2-1601 and determined using ChanlPro along with other existing input information. The site used for this analysis was chosen as the worst case of the sites because it had the highest channel velocity and was on a tight bend in the river. Both of these conditions represent the extreme case and the PL 84-99 Gradation used still meets and exceeds the minimum design criteria.

The hydraulic evaluation was based on Sacramento District's experience gained from the 2008 demonstration project. This experience indicates that there will likely be minimal disturbance to the riprap blanket or compromise of its integrity during planting, and that the riprap is to be re-compacted once the willow poles are installed (see Hazleton memo in Chapter 9).

## 4.4 Geotechnical Evaluation

### 4.4.1 Method and Assumptions for Evaluation

The geotechnical engineering evaluation presented below considers all conditions thought to have influence on the structural integrity of the levee or provide functionally equivalent accessibility for maintenance, inspection, monitoring, and flood-fighting. The individual geotechnical structural integrity components identified for consideration were seepage through the levee embankment and foundation, wind throw toppling, and scour potential. It is important to note that none of the sites listed in the vegetation variance request were reported to have stability or seepage issues during the floods of 2005 and 2006. These are the storms which caused the damage to the slopes which triggered the PL84-99 repairs and placement of the riprap currently on the sites. Repairs completed were due to localized surface scour damage to the levee section that was determined to be unsatisfactory for future performance. Deep seated erosion or bank erosion were not the basis for the repairs.

The proposed willow poles will be planted on the waterside below the projected landside toe elevation of the levee. Because the plantings will be located below the toe, the Sacramento District determined that a qualitative analysis of each potential failure mechanism was sufficient for the purposes of the vegetation variance request.

Specific assumptions regarding the geotechnical evaluation include:

(1) The geotechnical evaluation assumes that the trunk diameter of the willows will not be greater than four inches. This was based on the requirements as stated in the vegetation maintenance plan (Chapter 7).
(2) The geotechnical evaluation assumes that riprap is at a minimum depth of two feet at the planting sites and that the riprap remains in place during a flood event.
(3) No plantings will occur in unprotected soil.

### 4.4.2 Soil Characteristics

Geotechnical data for these reaches of the Sacramento River is limited. However, comparison of soil characteristics identified in the available geotechnical investigations reveals that the embankments and foundation soils for the sites identified in the vegetation variance are very similar. Embankment soils generally consist of poorly graded sand (SP) and silty sand (SM) with less than 12 percent fines. Foundation soils are similar, comprised of silty sand (SM) and poorly graded (SP) to fine sand (SM). Occasionally, in the reaches of RD 150, RD 755 and RD551, silt (ML) and sandy silt (ML) were identified. Silt layers were typically relatively thin layers and were intermittently encountered less than 15 feet below ground.

### 4.4.3 Consideration of Effects of Vegetation on Riprap Structures

The soil characteristics in Section 4.4.2 and site characteristics including riprap depth and size, willow spacing, and site access to the sites have been considered for this variance request. The most apparent concern with planting willows through riprap is the potential effects that it may have on the integrity of the levee. Root growth, specifically, has been considered and evaluated. These concerns have been associated with root growth in the rocks as well as in the underlying embankment soils. Root growth in soils has been thought to leave voids when they decay, potentially leaving a seepage path which could evolve in to an internal erosion problem and jeopardize the levee. Note that the root structure of proposed species is known to be shallow, and will be located below the landside toe elevation. Furthermore, the roots will not increase permeability as the founding soil and slope is comprised of riprap protection and granular soils. A technical report, *The Effects of Vegetation on the Structural Integrity of Sandy Levees*, prepared by Donald H. Gray, F. Douglas Shields, Jr. et al has been added to Chapter 9 as a reference document. This report documents a field study performed on a non-engineered, sandy Sacramento River levee which identified root distribution and concentrations using the profile-wall method in transect trenches both parallel and perpendicular to the crest of the levee at areas supporting woody plant species, including an area of willow species. This report further identifies voids produced by burrowing animals and insects, and concludes that no voids were observed to be attributable to decayed or rotted roots. Pedotubules (infilled holes or conduits) were identified and mapped in the vertical faces of the trenches. It was concluded that root holes, as they slowly decay, are likely to evolve directly in to pedotubules as opposed to voids. Additionally, the study was able to demonstrate, through analysis, improvements in the shear strength in a measurable manner for the condition containing roots as opposed to no roots. Considering these findings, leaving decaying stumps and roots in place will likely not have any adverse effects on the integrity of the levee.

Further research and discussions within the District concluded that roots will likely not survive solely within the riprap due to the inapt conditions. The seasonal fluctuation of river elevations will likely result in significantly dry conditions for roots to prosper within the riprap. The lack of sedimentation within the riprap does not provide a source or ability to retain or convey moisture within the rock. However, it is understood that sedimentation within the riprap may encourage root growth in to the riprap structure, if significant sedimentation were to occur. While some sedimentation may occur, the amount will likely be minimal due to the “gap” in gradation between the sediment and the riprap rocks. However, in the case that roots due manage to grow into the riprap, it is likely that the roots will tend to hold the rocks together when they would otherwise be susceptible to displacement. Since the riprap was not designed to launch, the tethering of rocks together by the roots should not be considered a negative factor.

Removal of decaying vegetation, including remnant stumps and roots, were considered but found to be too detrimental to the integrity of the levee and any surrounding vegetation. Considering the depth of riprap, willow spacing, and limited access to the sites with heavy equipment, it is understood that it would be a challenge to remove the entire root ball and associated roots. The relative spacing of willows to the expected lateral root spread would likely result in the intertwining of roots between adjacent willow tree roots. An attempt to remove a decaying rootball will likely damage the root system of those adjacent trees, jeopardizing their survival. Consideration of how to deal with remnant stumps suggest leaving the dead root ball and associated shallow root system in place. Though not ideal, the removal of the rootball can prove to be logistically challenging, costly, and can cause unnecessary damage to the riprap structure (specifically to the gradation of rock) and disturbance of the underlying embankment soils.

#### **4.4.4** Seepage

Since the root system of the willow-pole plantings will be below the landside levee toe, there is very little, if any, opportunity for tree induced increased levee through-seepage. Furthermore, the willow roots are highly unlikely to penetrate through the levee foundation to the landside as this is away from the primary water source. Thus, there is very little, if any, chance of increased induced underseepage either.

The most apparent geotechnical concern with leaving roots in place is the shortened seepage path through potential voids caused by the decomposition of roots. The root structure of proposed species is known to be shallow, and located below the landside toe elevation. Furthermore, the roots will not increase permeability as the founding soil and slope is comprised of permeable riprap and granular soils. A technical report, *The Effects of Vegetation on the Structural Integrity of Sandy Levees*, prepared by Donald H. Gray, F. Douglas Shields, Jr. et al has been added to Chapter 9 as a reference document. This report documents a field study performed on a non-engineered, sandy Sacramento River levee which identified root distribution and concentrations using the profile-wall method in transect trenches both parallel and perpendicular to the crest of the levee at areas supporting woody plant species, including an area of willow species. This report further identifies voids produced by burrowing animals and insects, and concludes that no voids were observed to be attributable to decayed or rotted roots. Pedotubules (infilled holes or conduits) were identified and mapped in the vertical faces of the trenches. It was concluded that root holes, as they slowly decay, are likely to evolve directly in to pedotubules as opposed to voids. Furthermore, it is unlikely that the willow pole plantings roots will penetrate through to the levee. This is mostly due to the location of the plantings being outside the levee prism as well as the tendency for willow roots to grow towards the water source and to a very shallow depth. The root system for both proposed species is concentrated in the upper two feet of soil and the lateral roots tend to grow towards the water source (Gray, MacDonald, Blatz, & Shields, 1991). Seepage through the levee and its foundation are judged to be unaffected.

Another potential factor that can cause piping is burrowing animals. The ETL's vegetation policy seeks to indirectly address this problem by limiting vegetation on much of the levee system, thus reducing the habitat and food source for many burrowing animals. One of the reasons for the selection of willow trees was to minimize the attraction of the usual levee burrowing animals (squirrels and skunks); although it is recognized that it may provide habitat for some other burrowing animals such as beavers. The presence of two feet of riprap will discourage the burrowing animals as they will seek areas that are not rock covered. Furthermore, the local sponsor will also continue performing regular levee maintenance and will be looking for evidence of burrowing animals and will take approved measures to deter or reduce populations as prescribed in the O&M Manual.

#### **4.4.5** <u>Wind throw toppling of proposed vegetation</u>

The proposed willow pole species present a reduced profile to wind forces and therefore are unlikely to topple due to wind. Additionally, the weight of the riprap aids in keeping the willows in place, thus reducing the likelihood of toppling. Further, the location of the willow pole plantings below the projected landside levee toe affords some protection for the willow trees against high, straight-line winds blowing perpendicularly across the levee by the presence of the levee embankment blocking and deflecting those winds. During windy events, willows would bow and if winds are strong enough, would break. During a high water event, the willows would be submerged under several feet of water and thus would be unlikely to topple. If the willow did uproot, the root ball resulting from the toppling would be relatively shallow even for a very mature tree. Specifically, it is unlikely that the root pit would exceed a depth of 18-24 inches. The root ball could extend up to 24 inches outward. Additionally, the root system of the willows may add to the tensile strength of the underlying levee soil material and thus further reducing the likelihood of wind throw. Toppling of the proposed willows due to wind throw is not likely, and is therefore not a significant concern to levee safety.

#### **4.4.6** <u>Scour potential</u>

The scour potential around some vegetation can at times be a significant concern for levee safety. However, the scour potential in the proposed vegetation variance zone is not a significant concern because willow roots tend to improve tensile strength and the soil is covered with recently placed existing riprap.

#### 4.4.7 Accessibility

Accessibility for maintenance, monitoring, and inspections are all important. The proposed plantings will not affect the space available for vehicle and personnel access. All sites will be easily accessible and observable from the levee crown. With the proper O&M, inspection and monitoring, the levees should remain uncompromised when compared to the current condition. Chapter 7 discusses the vegetation maintenance plan to ensure that proper O&M, inspection and monitoring can be performed.

### 4.5 Engineering Conclusions

Chapter 4 of this document was prepared to determine if the proposed plantings would jeopardize the safety, structural integrity, and functionality of the levee, and to ensure accessibility for inspection and flood-fighting is retained.

The Sacramento District has determined through hydraulic analysis that the rirprap in place exceeds the minimum design standard, and the insignificant water surface elevation changes would allow for the planting of willows without changing the capacity of the channel.

The Sacramento District has also determined through geotechnical judgment that the proposed plantings are highly unlikely to adversely affect structural integrity resulting from impacts associated with seepage, wind throw, scour, and slope stability.

Therefore, the Sacramento District has determined that the proposed plantings are not expected to jeopardize safety, structural integrity, and functionality of the levee, and have determined that with specified maintenance the accessibility for inspection and flood-fighting is retained.

### 4.6 Engineering Analysis References


Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona. 2007

ChanlPro. Channel Protection Software and User Manual

Gray, D.H., MacDonald, A., Thomann, T., Blatz, I., Shields, F.D.Jr. (1991). The effect of vegetation on the structural integrity of sandy levees. Technical Report REMR-EI-5.

Hazelton, K.J. 2009. PL 84-99 structural impact of willow pole planting using the Stinger. Memorandum for Record CESPK-ED-GS.

Hoag, J.C.,& Ogle, D. (2008). The Stinger: A tool to plant unrooted hardwood cuttings. USDA Natural Resources Conservation Service Technical Note No. 6, Boise, Idaho.

Phillips, Jeff V. and Tadayon, Saeid. 2006. Scientific Investigations Report.

USACE. 1971. Engineering Technical Letter 1110-2-120. Engineering and Design Additional Guidance for Riprap Channel Protection.

USACE. 1994. Engineering Manual 1110-2-1601. Engineering and Design – hydraulic Design of Flood Control Channels.

USACE. 2001. Engineering Regulation 500-1-1. Civil Emergency Management Program.

USACE. 2009. American River Common Features HECRAS Model. With updates for ongoing West Sacramento GRR.

USACE. 2009. Engineering Technical Letter 1101-2-571. Guidelines for landscape planting and vegetation management at floodwalls, levees, embankment dams, and appurtenant structures.

USACE. San Joaquin River Comprehensive Study UNET Model.

USACE. 2010. American River Common Features GRR HECRAS Model.

USACE. 2010. PL 84-99 Reclamation District 150 As-built Plans and Specifications.

## CHAPTER 5 INSPECTION REPORTS

Responsibility for routine inspections was transferred to the State of California under 33 CFR 208.10. Due to the program size and agreements made decades ago with the State of California, the State is responsible for the primary inspections of the over 1,600 miles of levees in the Sacramento and San Joaquin River Systems. The Sacramento District conducts QA inspections annually in highly urban areas; the Reclamation Districts listed in this request are not in highly urban areas. The State's 2010 Inspection Report was published in December 2010 and compiles inspection information for the entire Central Valley.

Current O&M Manuals for the Sacramento River Flood Control Project allow for brush and small trees when present for the purposes of preventing wave wash and scour. It is known that the California Central Valley has region-wide concerns regarding vegetation. As such, the California Levee Roundtable, a collaborative partnership of Federal, state, and local officials, has developed the Framework. This Framework outlines both short and long term flood management improvements. In part, the Framework includes interim criteria for vegetation management, which allows California levee systems to maintain eligibility for Federal rehabilitation aid for levees under PL 84-99, while improvements are made. Annual inspections are performed by the California Department of Water Resources which identifies deficiencies, including unacceptable vegetation. In addition, Periodic Inspections of project levees will be performed and may be used to enforce corrective actions for maintenance deficiencies. While it is recognized that vegetation concerns are widespread, these concerns vary in severity and are highly dependent upon location within the system.

The following pages are the inspection results for RD 3, 150, and 551 from the State's 2010 Inspection Report. At the time of the flood event for which the repairs were constructed, RD3, 150, and 551 were active in the PL 84-99 Rehabilitation and Inspection Program. Below, is a brief listing of previous and current PL 84-99 statuses and overall levee rating.RD3 received unacceptable ratings in both the 2007 and 2008 state inspections. In 2009 their rating improved to minimally acceptable and in 2010 their rating was reduced to unacceptable. RD 3 is currently active in the PL 84-99 Rehabilitation and Inspection Program, however, the Sacramento District's inspection in October 2010 identified slope stability deficiencies.

RD150 received an unacceptable rating in the 2007 state inspections which was later improved to minimally acceptable in 2008 and 2009. RD150 was not inspected in 2010 due to State budget shortfalls but is currently rated as acceptable. RD 150 is currently listed as unacceptable and inactive in the PL 84-99 Rehabilitation and Inspection Program.

RD551 received unacceptable ratings in both the 2007 and 2008 state inspections. Rating in 2009 improved to acceptable and was reduced to unacceptable in 2010. RD551 is currently active in the PL 84-99 Rehabilitation and Inspection Program.

# State of California

**The Natural Resources Agency**
**Department of Water Resources**
**Division of Flood Management**

# 2010
# INSPECTION REPORT

## OF THE
## CENTRAL VALLEY STATE-FEDERAL
## FLOOD PROTECTION SYSTEM

**PUBLISHED IN DECEMBER 2010**

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Arnold Schwarzenegger
Governor
State of California

Lester A. Snow
Secretary for Natural Resources
The Natural Resources Agency

Mark W. Cowin
Director
Department of Water Resources

# 2 2010 LEVEE MAINTENANCE INSPECTION RESULTS

The results of the 2010 levee maintenance inspections show that many LMAs made significant improvements since the 2007 inspections. FPIIB continues to improve the accuracy and usability of its tools and data to inspect and rate LMAs. Each local maintaining agency received one of three possible ratings based on the state of its levees:

- **Acceptable (A)** – No immediate work required, other than routine maintenance. The flood protection project will function as designed and intended, with a high degree of reliability, and necessary cyclic maintenance is being adequately performed.
- **Minimally Acceptable (M)** – One or more deficient conditions exist in the flood protection project that need to be improved or corrected. However, the project will essentially function as designed with a lesser degree of reliability than what the project could provide.
- **Unacceptable (U)** – One or more deficient conditions exist that may *prevent* the project from functioning as designed, intended, or required.

In 2010 FPIIB introduced an additional rating used to identify individual issues noted during inspections, Watch/Monitor (W). This rating is used to identify issues that are not yet severe enough to be rated as M or U but that should be monitored and maintained to prevent a future deficiency. The use of this rating is an example of FPIIB's efforts to work with the LMAs to improve the overall maintenance of the system.

Appendix B describes the rating criteria and methodology used for levees. Table 2-1 and Figure 2-1 show the numbers of LMAs receiving each rating for the years 2007, 2008, 2009, and 2010. While the length of maintenance deficiencies throughout the system stayed about the same from 2009 to 2010, in general the LMAs have significantly improved levee maintenance since 2007.

Unit lengths of some LMAs were updated in 2010 and reflect recently surveyed alignments for many of the levees. Some minor differences in some of the results can be seen due to these changes.

In 2009, NA0007 and NA0020, East and West Interceptor Canals were combined into NA0020, East-West Interceptor Canals. This change has been shown retroactively for purposes of comparing from year to year.

**Table 2-1: Summary of Levee Maintenance Ratings for 2007 through 2010**

| | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| **A=Acceptable** | 24 | 42 | 51 | 49 |
| **M=Minimally Acceptable** | 18 | 25 | 25 | 19 |
| **U=Unacceptable** | 64 | 39 | 30 | 38 |

Ratings for each LMA are included in Table 2-2. The number of LMAs receiving Unacceptable ratings increased by eight, the number of LMAs receiving Acceptable ratings decreased by two, and the number of LMAs receiving Minimally Acceptable ratings decreased by six.

Thirty-one LMAs encompassing 382 miles were not inspected because of State budget related resource challenges. Data from fall 2009 inspections was used to rate the LMAs as Acceptable for comparison purposes in this report and they are differentiated with a footnote in Table 2-2. None of these LMAs had an USACE Periodic Inspection Report issued in 2009 or 2010. Though these priorities could have been determined using more recent spring 2010 inspection results, because of the timing and nature of spring inspections and because overall unit and LMA ratings are not determined during the spring, fall 2009 results were used. Inspections of these LMAs may be conducted as time allows, but no additional data was available for this report. This prioritization allowed inspectors to focus on the maintenance status of LMAs with more significant threats to the integrity of the flood protection system but may impact the results contained in this report.

The length of maintenance deficiencies remained about the same from 2009 to 2010 with improvements to the maintenance of vegetation, trim/thin trees, animal control, crown surface, and other items while lengths of levees with encroachments and erosion deficiencies increased. Erosion deficiencies increased primarily due to an increase in the amount erosion noted in the Sacramento River Basin by the USACE while the length of levee with encroachment deficiencies increased primarily due to an increase in the amount of encroachments noted in the San Joaquin River Basin. Further discussion regarding the supplemental Levee Waterside Erosion Surveys conducted by DWR and the USACE can be found in section 6.3.

Another change from 2009 to note is a decrease in the length of levees with vegetation issues in the Sacrament River Basin while the length of levees with vegetation issues in the San Joaquin River Basin increased. Like 2009, during 2010 LMAs experienced unusual weather patterns which presented challenges to maintenance with late and early rains. Multiple LMAs reported an increase in squirrel activity causing animal control to be more challenging in 2010 than in recent years; however, the length levee with noted animal control deficiencies saw a significant decrease.

Figure 2-2 shows the number of agencies that received better, unchanged, or worse ratings in 2010 compared with 2009, 2008, and 2007. The number of LMAs receiving positive ratings decreased as nine more LMAs were rated as Unacceptable and three fewer LMAs were rated as Acceptable compared to 2009 despite the similar length of maintenance deficiencies. This is likely due to several LMAs who had threshold percentages close to break points for ratings who experienced a slight increase in the length of levees with deficiencies while other LMAs continued to improve their maintenance. More information can be found in the detailed LMRs and explanation of threshold percentages and the determination of overall ratings is located in Appendix B. Despite the decline in positive ratings, the LMAs continue to generally receive better ratings than 2007 and 2008.

Vegetation deficiencies make up the majority of deficient levee miles for 2010 followed by a significant amount of erosion and trim/thin trees. The remainder of deficient miles comes from animal control, encroachments, crown surface, and other items. Appendix I shows supplemental figures showing further analysis for the various basins and types of deficiencies including comparisons of the lengths of levee with deficiencies of each category compared each year since 2007.

LMAs may not be able to address some encroachments posing safety concerns due to limitations in resources and relationships with the landowners. Inspectors document these encroachments and rate them as Partially Obstructing (PO) or Completely Obstructing (CO). In 2010, 83.60 miles of PO and 7.68 miles of CO encroachments were identified. PO and CO ratings are explained in Appendix B.

A summary report showing the length of maintenance deficiencies noted in 2009 and 2010 for each LMA can be found in Appendix D. This report also shows the change in threshold percent for each of these maintenance deficiency categories. Detailed reports showing the inspections for each LMA, including photos, can be found at http://cdec.water.ca.gov/fsir.html.

The following photos show examples of Acceptable, Minimally Acceptable, and Unacceptable maintenance of vegetation and trees.

Acceptable Vegetation Maintenance: Good grass coverage with no grass or brush over 12" tall

Minimally Acceptable Maintenance: Grass or brush partially obstruct visibility and access

Unacceptable Maintenance: Grass or brush completely obstruct visibility and access

Acceptable Tree Maintenance: No limbs within 5’ of the levee obstruct visibility or access

Minimally Acceptable Tree Maintenance: Moderate density of tree limbs partially obstruct visibility and access


Unacceptable Tree Maintenance: Significant density of tree limbs completely obstruct visibility and access

# Appendix D: Fall 2010 Levee Maintenance Inspection Summary Reports

# Fall 2010 Levee Maintenance Deficiency Summary Report

## Overall LMA Ratings, Compare 2009 & 2010

### *Sacramento River Basin (cont.)*

| **NA0022** | Total LMA Miles | **5.97** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Yolo County Service Area 6** | **Fall 2009** | | | | **Fall 2009** | | | | **Change** | | | |
| **Fall 2010 : Not Inspected** | Overall LMA Rating | | **A** | | Overall LMA Rating | | **A** | | | | | |
| Rated Item | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % |
| *Earthen Levee* | | | | | | | | | | | | |
| Vegetation | 0.44 | | 0.44 | **7.37** | 0.44 | | 0.44 | **7.37** | | | | |
| Trim / Thin Trees | 0.02 | | 0.02 | **0.34** | 0.02 | | 0.02 | **0.34** | | | | |
| Encroachments | 0.06 | | 0.06 | **1.01** | 0.06 | | 0.06 | **1.01** | | | | |
| Animal Control | 0.03 | | 0.03 | **0.50** | 0.03 | | 0.03 | **0.50** | | | | |
| *LMA Totals:* | 0.55 | 0.00 | 0.55 | **9.21** | 0.55 | 0.00 | 0.55 | **9.21** | | | | |

| **RD0003** | Total LMA Miles | **28.65** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reclamation District No. 0003 Grand Island** | **Fall 2009** | | | | **Fall 2010** | | | | **Change** | | | |
| | Overall LMA Rating | | **M** | * | Overall LMA Rating | | **M** | * | | | | |
| Rated Item | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % |
| *Earthen Levee* | | | | | | | | | | | | |
| Vegetation | | 0.01 | 0.04 | **0.14** | 1.12 | 0.03 | 1.24 | **4.33** | 1.12 | 0.02 | 1.20 | **4.19** |
| Trim / Thin Trees | 0.55 | 0.11 | 0.99 | **3.46** | 0.67 | 0.04 | 0.83 | **2.90** | 0.12 | -0.07 | -0.16 | **-0.56** |
| Encroachments | 0.01 | | 0.01 | **0.04** | 0.10 | | 0.10 | **0.35** | 0.09 | | 0.09 | **0.31** |
| Erosion / Bank Caving | | | | | 0.02 | | 0.02 | **0.07** | 0.02 | | 0.02 | **0.07** |
| *Supplemental* | | | | | | | | | | | | |
| USACE Erosion Survey | 0.29 | | 0.29 | **1.01** | 0.20 | 0.07 | 0.48 | **1.68** | -0.09 | 0.07 | 0.19 | **0.66** |
| *LMA Totals:* | 0.85 | 0.12 | 1.33 | **4.64*** | 2.11 | 0.14 | 2.67 | **9.32*** | 1.26 | 0.02 | 1.34 | **4.68** |

| **RD0010** | Total LMA Miles | **21.93** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reclamation District No. 0010 Honcut** | **Fall 2009** | | | | **Fall 2009** | | | | **Change** | | | |
| **Fall 2010 : Not Inspected** | Overall LMA Rating | | **A** | | Overall LMA Rating | | **A** | | | | | |
| Rated Item | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % |
| *Earthen Levee* | | | | | | | | | | | | |
| Vegetation | 0.44 | | 0.44 | **2.01** | 0.44 | | 0.44 | **2.01** | | | | |
| Trim / Thin Trees | 0.04 | | 0.04 | **0.18** | 0.04 | | 0.04 | **0.18** | | | | |
| Encroachments | 0.03 | | 0.03 | **0.14** | 0.03 | | 0.03 | **0.14** | | | | |
| Animal Control | 0.08 | | 0.08 | **0.37** | 0.08 | | 0.08 | **0.37** | | | | |
| *LMA Totals:* | 0.59 | 0.00 | 0.59 | **2.69** | 0.59 | 0.00 | 0.59 | **2.69** | | | | |

| **RD0070** | Total LMA Miles | **23.57** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reclamation District No. 0070 Meridian** | **Fall 2009** | | | | **Fall 2009** | | | | **Change** | | | |
| **Fall 2010 : Not Inspected** | Overall LMA Rating | | **A** | | Overall LMA Rating | | **A** | | | | | |
| Rated Item | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % |
| *Supplemental* | | | | | | | | | | | | |
| USACE Erosion Survey | 0.29 | | 0.29 | **1.23** | 0.29 | | 0.29 | **1.23** | | | | |
| *LMA Totals:* | 0.29 | 0.00 | 0.29 | **1.23** | 0.29 | 0.00 | 0.29 | **1.23** | | | | |

* Overall LMA Threshold Percent is less than 10.00%; however, U Rated Miles are present, so the Overall LMA Rating is M instead of A.

# Fall 2010 Levee Maintenance Deficiency Summary Report

## Overall LMA Ratings, Compare 2009 & 2010

### *Sacramento River Basin (cont.)*

| **RD0108** | Total LMA Miles | **20.59** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reclamation District No. 0108 River Farms** Fall 2010 : Not Inspected | **Fall 2009** | | | | **Fall 2009** | | | | **Change** | | | |
| | Overall LMA Rating | | **A** | | Overall LMA Rating | | **A** | | | | | |
| Rated Item | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % |
| *Earthen Levee* | | | | | | | | | | | | |
| Vegetation | 0.02 | | 0.02 | **0.10** | 0.02 | | 0.02 | **0.10** | | | | |
| Trim / Thin Trees | 0.89 | | 0.89 | **4.32** | 0.89 | | 0.89 | **4.32** | | | | |
| Animal Control | 0.06 | | 0.06 | **0.29** | 0.06 | | 0.06 | **0.29** | | | | |
| Cracking | 0.03 | | 0.03 | **0.15** | 0.03 | | 0.03 | **0.15** | | | | |
| *LMA Totals:* | 1.00 | 0.00 | 1.00 | **4.86** | 1.00 | 0.00 | 1.00 | **4.86** | | | | |

| **RD0150** | Total LMA Miles | **18.07** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reclamation District No. 0150 Merrit Island** | **Fall 2009** | | | | **Fall 2010** | | | | **Change** | | | |
| | Overall LMA Rating | | **M** | | Overall LMA Rating | | **M** * | | | | | |
| Rated Item | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % |
| *Earthen Levee* | | | | | | | | | | | | |
| Vegetation | 0.19 | | 0.19 | **1.05** | 0.09 | | 0.09 | **0.50** | -0.10 | | -0.10 | **-0.55** |
| Trim / Thin Trees | 0.37 | | 0.37 | **2.05** | 0.51 | | 0.51 | **2.82** | 0.14 | | 0.14 | **0.77** |
| Encroachments | 0.30 | | 0.30 | **1.66** | 0.28 | | 0.28 | **1.55** | -0.02 | | -0.02 | **-0.11** |
| Animal Control | 0.05 | | 0.05 | **0.28** | | | | | -0.05 | | -0.05 | **-0.28** |
| Slope Stability | 0.08 | | 0.08 | **0.44** | 0.07 | | 0.07 | **0.39** | -0.01 | | -0.01 | **-0.06** |
| Erosion / Bank Caving | 0.14 | | 0.14 | **0.78** | 0.11 | | 0.11 | **0.61** | -0.03 | | -0.03 | **-0.17** |
| Crown Surface / Depressions / Rutting | 0.43 | | 0.43 | **2.38** | 0.04 | | 0.04 | **0.22** | -0.39 | | -0.39 | **-2.16** |
| *Interior Drainage & Piping Systems* | | | | | | | | | | | | |
| Metal Pipes | 0.01 | | 0.01 | **0.06** | 0.01 | | 0.01 | **0.06** | | | | **0.00** |
| *Supplemental* | | | | | | | | | | | | |
| USACE Erosion Survey | 0.03 | 0.09 | 0.39 | **2.16** | 0.12 | 0.03 | 0.24 | **1.33** | 0.09 | -0.06 | -0.15 | **-0.83** |
| *LMA Totals:* | 1.60 | 0.09 | 1.96 | **10.85** | 1.23 | 0.03 | 1.35 | **7.47*** | -0.37 | -0.06 | -0.61 | **-3.38** |

| **RD0307** | Total LMA Miles | **6.65** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reclamation District No. 0307 Lisbon** | **Fall 2009** | | | | **Fall 2010** | | | | **Change** | | | |
| | Overall LMA Rating | | **U** | | Overall LMA Rating | | **U** | | | | | |
| Rated Item | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % |
| *Earthen Levee* | | | | | | | | | | | | |
| Vegetation | 4.71 | 0.81 | 7.95 | **119.55** | 0.81 | 0.09 | 1.17 | **17.59** | -3.90 | -0.72 | -6.78 | **-101.95** |
| Trim / Thin Trees | 3.86 | 0.70 | 6.66 | **100.15** | 3.86 | 0.05 | 4.06 | **61.05** | 0.00 | -0.65 | -2.60 | **-39.10** |
| Encroachments | 0.06 | 0.02 | 0.14 | **2.11** | 0.04 | | 0.04 | **0.60** | -0.02 | -0.02 | -0.10 | **-1.50** |
| Animal Control | 0.06 | | 0.06 | **0.90** | 0.08 | | 0.08 | **1.20** | 0.02 | | 0.02 | **0.30** |
| *Supplemental* | | | | | | | | | | | | |
| USACE Erosion Survey | | 0.01 | 0.04 | **0.60** | | | | | | -0.01 | -0.04 | **-0.60** |
| *LMA Totals:* | 8.69 | 1.54 | 14.85 | **223.31** | 4.79 | 0.14 | 5.35 | **80.45** | -3.90 | -1.40 | -9.50 | **-142.86** |

* Overall LMA Threshold Percent is less than 10.00%; however, U Rated Miles are present, so the Overall LMA Rating is M instead of A.

# Fall 2010 Levee Maintenance Deficiency Summary Report

## Overall LMA Ratings, Compare 2009 & 2010

### *Sacramento River Basin (cont.)*

| **RD0536** | Total LMA Miles | **10.63** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reclamation District No. 0536 Egbert** | **Fall 2009** | | | | **Fall 2010** | | | | **Change** | | | |
| | Overall LMA Rating | | **U** | | Overall LMA Rating | | **U** | | | | | |
| Rated Item | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % |
| *Earthen Levee* | | | | | | | | | | | | |
| Vegetation | 8.43 | | 8.43 | **79.30** | 1.03 | | 1.03 | **9.69** | -7.40 | | -7.40 | **-69.61** |
| Trim / Thin Trees | 0.08 | | 0.08 | **0.75** | | | | | -0.08 | | -0.08 | **-0.75** |
| Encroachments | 0.01 | | 0.01 | **0.09** | 0.05 | | 0.05 | **0.47** | 0.04 | | 0.04 | **0.38** |
| Erosion / Bank Caving | 0.01 | | 0.01 | **0.09** | 0.01 | | 0.01 | **0.09** | | | | **0.00** |
| Crown Surface / Depressions / Rutting | 2.05 | | 2.05 | **19.29** | 2.38 | | 2.38 | **22.39** | 0.33 | | 0.33 | **3.10** |
| *LMA Totals:* | 10.58 | 0.00 | 10.58 | **99.53** | 3.47 | 0.00 | 3.47 | **32.64** | -7.11 | 0.00 | -7.11 | **-66.89** |

| **RD0537** | Total LMA Miles | **5.95** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reclamation District No. 0537 Lovdal** | **Fall 2009** | | | | **Fall 2010** | | | | **Change** | | | |
| | Overall LMA Rating | | **M** | | Overall LMA Rating | | **U** | | | | | |
| Rated Item | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % |
| *Earthen Levee* | | | | | | | | | | | | |
| Vegetation | 0.69 | | 0.69 | **11.60** | 1.39 | | 1.39 | **23.36** | 0.70 | | 0.70 | **11.76** |
| Trim / Thin Trees | 0.02 | | 0.02 | **0.34** | 0.06 | | 0.06 | **1.01** | 0.04 | | 0.04 | **0.67** |
| Encroachments | | | | | 0.06 | | 0.06 | **1.01** | 0.06 | | 0.06 | **1.01** |
| Erosion / Bank Caving | 0.01 | | 0.01 | **0.17** | 0.01 | | 0.01 | **0.17** | | | | **0.00** |
| *Supplemental* | | | | | | | | | | | | |
| USACE Erosion Survey | 0.01 | | 0.01 | **0.17** | 0.03 | 0.04 | 0.19 | **3.19** | 0.02 | 0.04 | 0.18 | **3.03** |
| *LMA Totals:* | 0.73 | 0.00 | 0.73 | **12.27** | 1.55 | 0.04 | 1.71 | **28.74** | 0.82 | 0.04 | 0.98 | **16.47** |

| **RD0551** | Total LMA Miles | **6.84** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reclamation District No. 0551 Pierson** | **Fall 2009** | | | | **Fall 2009** | | | | **Change** | | | |
| **Fall 2010 : Not Inspected** | Overall LMA Rating | | **A** | | Overall LMA Rating | | **A** | | | | | |
| Rated Item | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % |
| *Earthen Levee* | | | | | | | | | | | | |
| Encroachments | 0.03 | | 0.03 | **0.44** | 0.03 | | 0.03 | **0.44** | | | | |
| *LMA Totals:* | 0.03 | 0.00 | 0.03 | **0.44** | 0.03 | 0.00 | 0.03 | **0.44** | | | | |

| **RD0554** | Total LMA Miles | **1.09** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reclamation District No. 0554 Walnut Grove** | **Fall 2009** | | | | **Fall 2010** | | | | **Change** | | | |
| | Overall LMA Rating | | **U** | | Overall LMA Rating | | **U** | | | | | |
| Rated Item | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % | M Miles | U Miles | M+4U Miles | Thresh. % |
| *Earthen Levee* | | | | | | | | | | | | |
| Vegetation | 0.34 | | 0.34 | **31.19** | 0.14 | | 0.14 | **12.84** | -0.20 | | -0.20 | **-18.35** |
| Trim / Thin Trees | | | | | 0.01 | | 0.01 | **0.92** | 0.01 | | 0.01 | **0.92** |
| Encroachments | | | | | 0.01 | | 0.01 | **0.92** | 0.01 | | 0.01 | **0.92** |
| Animal Control | | | | | 0.02 | | 0.02 | **1.84** | 0.02 | | 0.02 | **1.84** |
| *Supplemental* | | | | | | | | | | | | |
| USACE Erosion Survey | | | | | | 0.09 | 0.36 | **33.03** | | 0.09 | 0.36 | **33.03** |
| *LMA Totals:* | 0.34 | 0.00 | 0.34 | **31.19** | 0.18 | 0.09 | 0.54 | **49.54** | -0.16 | 0.09 | 0.20 | **18.35** |

* Overall LMA Threshold Percent is less than 10.00%; however, U Rated Miles are present, so the Overall LMA Rating is M instead of A.

# CHAPTER 6 LEVEE PERFORMANCE HISTORY

## 6.1 History of Levees in the Central Valley

Levee building in the Central Valley began as early as 1850 when the population of California began to increase dramatically due to the Gold Rush. In 1861 the Board of Swampland Commissioners was established to promote formation of RDs and to oversee reclamation efforts. In 1868, the Board of Swampland Commissioners became known as the State Reclamation Board, which is now called Central Valley Flood Protection Board. Most levees at that time were built of any available (often inferior) material by land owners to protect their agricultural investments from seasonal high tides and annual flooding, and to reclaim land. Levee building continued piecemeal until about 1910 when the Jackson Report took a look at the entire system and made region–wide recommendations, this became known as the “State Plan of Flood Control”. The Reclamation Board was re-established in 1911 by the State of California to direct levee building according to the plan. The Plan was further amended in 1925 and had not been updated on a statewide basis until the current FloodSafe program began in 2007. The program aims to have a new State Plan for Flood Control in place by 2012.

From 1930-1950 several dams were built on the tributaries to the Sacramento and San Joaquin Rivers that included flood control storage. By 1950 most major dams were completed. In 1955 a major flood event occurred that exceeded most published records for stream flow. This event prompted several improvements to the system of flood control.

From 1955-1978, twelve dams were completed in the system including Folsom and Oroville, two of the largest and other minor dams. The defining product of this period was the several hundred miles of levees that were built or upgraded, being substantially complete by 1972. Prior to at least 1972 the mechanisms of the flood control system and its operation were not static, and functioned differently than today. Major flood events occurred in 1862, 1867, 1881, 1890, 1904, 1907, 1909, 1911, 1928, 1955, 1965, 1969, 1970, 1974, 1983, 1986, 1995, 1997, 1998 (CESPK, 1999). For reasons stated above, the flood frequencies quoted below for events prior to 1972 should only be taken for reference. Comparisons between older and more recent events must be seen in light of the changing situation of flood control. Events before 1955 were not included because of the drastic system changes due to increased system-wide flood storage capacity.

**Table 6.1:** Historical Flooding in the Central Valley 1955-Present

| Year | Flood Recurrence Interval (years)* | | Maximum average daily flow (cfs) | | Critical flood duration (days)+ | Wet period (days)+ |
|---|---|---|---|---|---|---|
| | Sacramento River and bypasses at Sacramento | San Joaquin River at Vernalis | Sacramento River and bypasses at Sacramento | San Joaquin River at Vernalis | | |
| 1955 | 10 | 80-90 | 408,000 | 50,900 | 7 | 60 |
| 1965 | 15 | 5 | 450,000 | 22,800 | 5 | 30 |
| 1969 | 1-5 | 80-100 | 230,000 | 34,800** | 10 | 45 |
| 1970 | 5-10 | 5-10 | 340,000 | 25,900 | 4 | 30 |
| 1974 | 5 | minor | 286,000 | 9,810 | 7 | 21 |
| 1983 | 5-10 | 30-50 | 336,000 | 45,100 | 13 | 60 |
| 1986 | 50-80 | 15-25 | 573,300** | 36,900 | 10 | 45 |
| 1995 | 5-10 | 5-10 | 330,000 | 26,100 | 18 | 120 |
| 1997 | 90-110 | 80-110 | 494,000** | 54,300** | 21 | 90 |
| 1998 | 3-5 | 10-20 | 257,000 | 35,000 | 26 | 140 |
| 2006 | 5-10 | 10 | 336,000 | 34,800 | 17 | 180 |

*based on flood frequency curves for regulated flows in the Post Flood Assessment Report for the 1983, '86, '95, '97 events, USACE 1999.
** estimated in channel flow only. Total flow in 1969 was 52,600, 1986 was 640,000 and in 1997 was 75,600 cfs for San Joaquin and unknown for Sacramento, presumably over 600,000.
+ Critical flood duration is the duration of 24-hour Emergency Operations. Wet period is estimated from best available information of period of high water.

## 6.2 System Performance in Major Flood Events

The following sections describe the major flood events from 1955 to the present including the minor 2006 event which prompted this repair and mitigation work. Each event includes a general characterization, flood fighting challenges, failures and outcomes, and a breakdown of impacts at the areas of concern for this variance request.

Levee damage from erosion and breaches has been common throughout history in all major and some minor events. Breaks have occurred in all major events where levees are present, relieving the pressure on neighboring levees. Breached levees were generally made of unsuitable soil materials that were constructed before sound engineering principles were applied. These “legacy levees” were accepted into the system as-is.

### 6.2.1 Flood Event of 1955/56

During the week preceding Christmas 1955, central California was subjected to the greatest flood in the area's history of recorded stream flows. The intense flood-producing precipitation covered an area of about 100,000 square miles, which represents over 60 percent of the gross area of the State. On many streams, the peak discharges are believed to have been greater than the near legendary floods of 1861-62, while most streams exceeded flood stages. Loss of at least 64 lives statewide is attributed to the flood. Statewide damages to public and private property were estimated at more than $200,000,000 in direct losses in 1955 dollars.

High water was observed in the Feather, Yuba, Sacramento, San Joaquin and tributary Rivers, and the Delta. Flooding was widespread mostly as a result of levee overtopping and breaching occurring on the Feather, Yuba, and Bear Rivers, Yolo Bypass, and the San Joaquin River. Some areas were flooded up to 3 times by successive flood peaks. Extreme high tides augmented by offshore winds and storm conditions exacerbated critical flood conditions in the Sacramento-San Joaquin Delta. In total, roughly 600,000 acres of the Central Valley were flooded while some remained wet for over a year. Sacramento was spared flooding as Folsom Dam was filled in its first season.

*Flood Fighting Challenges, Failures and Outcomes*

Erosion was prevalent on river slopes and many breaks occurred on project and non-project levees. Subsidence and slippages in levees were also prevalent, particularly in the Sacramento-San Joaquin Delta.

**Table 6.2:** Relevant Damages in the 1955 Event

| | |
|---|---|
| RD3 | No/minor flooding |
| RD150 | No/minor flooding |
| RD551 | Possible flooding from backside, no levee breaches. |

Other system flooding included:

At approximately midnight on December 23, the west levee of the Feather River failed suddenly at a location immediately southeast of Yuba City in Sutter County. The west levee was newly constructed but was lost despite efforts to provide emergency reinforcement. At that time, the river at Yuba City was essentially at its crest. This occurred before Oroville dam was built and later studies indicated that the dam could have saved much of the damage from high flows. Nearby, Marysville remained dry behind its own ring levee. However, across the Feather River from the breach site, the east levee in Reclamation District (RD) 784, was subjected to major underseepage and fear was high that this section would fail. It is believed that since the west levee failed, the stress on the east levee was relieved and therefore it remained intact.

The combined flows of Cosumnes and Mokelumne Rivers and other local streams caused widespread flooding of lowlands near their confluence in Sacramento and San Joaquin Counties. There were a number of levee failures which resulted in the inundation of all or portions of several RDs along the branches of the Mokelumne River.

Along the San Joaquin River from the head of the Delta to the Merced River and along the lower reaches of Stanislaus, Tuolumne, and Merced Rivers, there was considerable flooding of unprotected agricultural lands adjacent to the streams which caused the levees of several reclaimed tracts to be breached. However, the extent of the inundation in this area was not as great as that which occurred during November and December of 1950.

Two major tracts, Empire and Quinby, located in the heart of the Delta, were completely flooded when levees failed. Other tracts suffered extensive damage; land side slopes of levees were scarred by overtopping and sand levees were badly eroded with vertical faces approaching and sometimes extending into the levee crown. Typical of conditions throughout the Delta was that of Bouldin Island, one of the larger tracts, where overflow of levees occurred at eleven different locations. A total of about fifty thousand dollars was expended in a period of about five days in the successful effort to prevent complete flooding of the tract.

Similar situations prevailed and minor breaches were successfully closed on many other Delta islands. It is safe to assume, on the basis of reports and requests for assistance during the critical high-tide period, that most Delta islands were in imminent danger of suffering complete failure of their levee systems.

### **6.2.2** Flood Event of 1965

The resultant floods in the Sacramento and the northern San Joaquin were the second most destructive in recorded history, exceeded only in dollar-damage by the great flood of December 1955. Damages during the December 1964 - January 1965 floods were mostly limited to unprotected areas and those lands in the bypasses. However, damages could have exceeded those of 1955 if it were not for improvements made in the flood control systems in the intervening nine years. Oroville Dam filled, thereby significantly reducing the flow into the Feather River, which is a tributary to the Sacramento River. Statewide, thirty-four counties were designated disaster areas and twenty-four deaths occurred. The worst damage occurred not in the Central Valley, but in northwestern California. Central Valley damages were estimated at $29M.

The December 1964-January 1965 floods demonstrated that a coordinated system of dams and levees is the most feasible method of preventing widespread flooding and damage. Where such a system existed, damages were minor despite record flows. Where such a system did not exist, there was extensive flooding and major flood damage. Black Butte, Comanche and New Hogan reservoirs were all completed that year. Also, several miles of the lower San Joaquin River flood protection system were built through 1967.

*Flood Fighting Challenges, Failures and Outcomes*

High tide and high inflow to the Delta created near flooding conditions on several islands. A major flood fighting program was mobilized through the joint efforts of Federal, State, and local agencies, with the aid of many local volunteers. Strenuous flood-fighting efforts were required, but this massive effort succeeded in preventing flooding in the Delta, except for 400 acres east of Bishop Tract. Some erosion was noted in the San Joaquin system, but no breaches occurred in either main stem of the Sacramento or San Joaquin Rivers.

Four sites out of 82 applications were repaired under PL 84-99 costing $700,000. Damages were related to levee erosion, dredging, and replacement of flood control facilities. Under PL 81-875, work was also conducted by USACE at 30 sites costing $3.5M. Work included channel realignment and debris clearing.

**Table 6.3:** Relevant Damages in the 1965 Event

| | |
|---|---|
| RD3 | No/minor flooding |
| RD150 | No/minor flooding |
| RD551 | Possible flooding from backside, no levee breaches. |

Other system flooding included:

Liberty and Prospect Islands, Little Holland and Egbert tract in the Yolo bypass were flooded. The partially built Hell Hole dam failed in upper American River watershed causing damage to the construction site, destroying four bridges, and increased downstream flooding. Folsom Dam was able to control the outflow to the downstream channel capacity of 115,000 cfs after it received a record 280,000 cfs inflow.

The partial failure of Daguerre Point Dam, a debris barrier on Yuba River, added significantly to damages on Yuba River.

Substantial damage occurred on Thomes and Cottonwood Creeks in the Sacramento Basin, and on Cosumnes and Stanislaus Rivers in the San Joaquin Basin. In the foothill and mountain areas, roads, bridges, and other improvements on tributaries of Feather, Yuba, and American Rivers were badly damaged. Substantial damages occurred on streams tributary to Clear Lake, on the North Fork of Feather River at Chester.

### **6.2.3** Flood Event of 1969

Intense and prolonged precipitation over the Central Valley resulted in widespread flooding in late January and early February 1969. The heavy precipitation also built a record snowpack in many areas of the Sierra Nevada range, particularly in the San Joaquin Basin. Melting of this snowpack created flooding problems from April to July, long after the rains were gone.

*Flood Fighting Challenges, Failures and Outcomes*

As a result of the coordinated operation of flood control reservoirs and conveyance facilities, and the cooperation of various local interests, the State of California, and the Bureau of Reclamation, damage was greatly minimized, especially during the snowmelt season.

Due to the record snowpack, the President initiated 'Operation Foresight'. This effort focused on the San Joaquin Valley including the Tulare Lake Basin to reduce flood damage from snowmelt by temporary emergency fixes. It succeeded in preventing $12M in damages.

In the San Joaquin basin, 59 sites out of 111 applications were repaired under PL 84-99 costing $2.5M. Problems were related to seepage through saturated levees, wave wash, and erosion. Under PL 81-875, work was also conducted by the Corps in 10 municipalities, costing $500k, and local work was reimbursed at 68 sites costing $2.4M. This work included realigning meandering streams, in-stream debris removal, replacing irrigation, water and sanitation facilities, and repairing an airport runway.

For the Sacramento basin, of the 35 applications, 19 sites were repaired under PL 84-99 costing $836k for levee erosion and replacement of FC facilities. Under PL 81-875, work was also conducted by the Corps in 4 municipalities, costing $477k, and local work was reimbursed at 27 sites costing $715k. This work included realigning meandering streams, restoration of county roads, in-stream debris removal, and replacing irrigation, water, and sanitation facilities.

**Table 6.4:** Relevant Damages in the 1969 Event

| LMA | Damages |
|---|---|
| RD3 | No/minor flooding |
| RD150 | No/minor flooding |
| RD551 | No/minor flooding |

Other system flooding included:

During the afternoon of 20 January, the levee on the San Joaquin River side of Sherman Island failed and 10,000 acres of agricultural land were flooded. By noon of 21 January, flooding to some degree was occurring along every major tributary to San Joaquin River and along streams on the east slopes of the Coast Ranges

By 28 January, all streams had peaked and the flood situation began to ease. However, extensive flood fighting continued in the Delta and a levee on Grizzly Island broke. Flows on the San Joaquin were near project design amounts and water was reported to be near the top of levees in some locations. The San Joaquin River saw extensive damage along its length. Many Delta levees remained in critical condition for several days.

### 6.2.4 Flood Event of 1970

The January 1970 floods in the Sacramento River Basin resulted from an extremely unusual series of intense storms that involved the passage of eight closely spaced but separate frontal systems. By far the largest portion of total flooding and flood damage, over 80 percent, occurred in valley-floor areas, and about one-half of the flood damage on the valley floor was in dedicated floodways or natural overflow basins seasonally used for varied agricultural activities.

The intense rain and flood conditions were concentrated in the Northern part of the State so that by the time waters reached the Delta the peaks had dissipated significantly. Therefore the Delta was not threatened. Likewise, heavy rains did not hit the San Joaquin Basin so it was not affected significantly by this flood.

*Flood Fighting Challenges, Failures and Outcomes*

A flood fighting effort was mobilized to patrol levees and investigate erosion sites. Eleven counties were declared disaster areas. Three people died while riding the rapids of the flood-swollen river. No major levees failed and overtopping was minimal in the Central Valley.

30 sites out of 64 applications were addressed under PL 84-99 for a total of $1.8M. The Corps also responded to debris removal and public infrastructure repairs under PL 81-875, 17 direct assistance missions costing $1.7M, and 46 technical assistance missions with reimbursement for $576k.

**Table 6.5:** Relevant Damages in the 1970 Event

| LMA | Damages |
|---|---|
| RD3 | No/minor flooding |
| RD150 | No/minor flooding |
| RD551 | No/minor flooding |

Other system flooding included:

Communities that suffered varying degrees of flood damage included Adin, Alturas, Anderson, Burney, Chester, East Red Bluff, Fairfield, Nubieber, Lakeport, Redding, and Tehama. All were in the northern Sacramento Basin.

### 6.2.5 Flood Event of 1974

Moderate to heavy precipitation over the Upper Sacramento River Basin for a 9-day period in mid-January 1974, and a 4-day precipitation period in late March, caused extensive flooding along the Sacramento River and certain tributaries. The 1974 storms resulted in flooding of about 209,000 acres in the Sacramento River Basin, 96 percent of which was in valley floor areas. About 72 percent of the flooding occurred within the confines of designated floodway and natural overflow basins, and a substantial part of the remainder was in low-lying areas adjacent to major river channels or on the water side of levees.

The San Joaquin River and Delta were not significantly affected.

*Flood Fighting Challenges, Failures and Outcomes*

As mentioned above, the flood control system worked well to contain the flooding to pre-designated areas. Four counties were declared disaster areas. Of 61 applications for PL 84-99, 26 were accepted for flood-fighting and repair work, costing $2.2 M.

**Table 6.6:** Relevant Damages in the 1974 Event

| LMA | Damages |
|---|---|
| RD3 | No Flooding |
| RD150 | No Flooding |
| RD551 | No Flooding |

Other system flooding included:

The Sacramento River experienced some significant erosion damage along its length. Murphy Slough Plug and Parrot Plug were both overtopped flooding small areas adjacent to the Sacramento River.

A private levee in the Hamilton City area ruptured, flooding residential structures, trailers, and agricultural lands.

There were also reports of sewage and diesel fuel spills.

### 6.2.6 Flood Event of 1983

The 1983 floods were not caused by a single large event, but by several moderate events from November 1982 to March 1983. Soil conditions were exceptionally wet causing higher runoff rates. Total precipitation was one of the highest in the last century. It also followed on the heels of an unusually wet 1982. There were several levee breaches and flooded areas throughout the Central Valley.

The storm pattern produced a series of smaller rainfall-runoff events that did not heavily stress the flood control capabilities of tributary projects. Most high water was after the rain flood period during snowmelt runoff, May through June 1983.

*Flood Fighting Challenges, Failures and Outcomes*

The problem in the 1983 event was not the peak flood wave, but the sheer volume of water. Roughly four times the normal volume of water passed through the Delta. All major reservoirs were encroached in their flood control space by March of 1983. Luckily they were able to control the events with no spills.

Failures in the Sacramento River Basin were limited to a private levee on the Sacramento River and one failure on Cache Creek in addition to the flooded land within the bypasses. In the San Joaquin River Basin, levee breaks caused flooding at four locations along the San Joaquin River. In addition, four levees failed in the Delta resulting in partial or total flooding of some Delta islands. Evacuations of a few thousand people were required.

In Glenn County, flood fighters saved Hamilton City, although valuable farmland was flooded.

**Table 6.7:** Relevant Damages in the 1983 Event

| LMA | Damages |
|---|---|
| RD3 | No/minor Flooding |
| RD150 | No/minor Flooding |
| RD551 | No/minor Flooding |

Other system flooding included:

The south levee of Cache Creek failed in Yolo County inundating 600 acres.

Prior to the high flows of the 1982-83 water year, two islands, McDonald and Venice, were flooded when there levees suddenly failed. The State was aware of the degrading non-project levees throughout the delta at the time and was just finishing a report on the issue (DWR, 1982).

### 6.2.7 Flood Event of 1986

Due to an unusually dry few months, all flood control reservoirs in the Sacramento Basin had ample flood control storage capacity before the storm hit. Within a couple days that capacity was quickly filled and two reservoirs had uncontrolled releases.

Much of the San Joaquin River Basin was spared the full impact of the 1986 storms. The major flood control projects in the basin did not encroach into their flood control pools. Still, the Basin sustained $15M in damage.

*Flood Fighting Challenges, Failures and Outcomes*

Statewide, thirty-nine counties had emergency declarations. One person was killed in Placer County. Roughly 7,200 homes were damaged or destroyed in the Central Valley.

**Table 6.8:** Relevant Damages in the 1986 Event

| LMA | Damages |
|---|---|
| RD3 | Minor flooding in the southwest corner |
| RD150 | Some minor flooding, no breaches reported |
| RD551 | No/minor Flooding |

Other system flooding included:

The south levee of the Yuba River breached east of its confluence with the Feather River in March of 1986 flooding over 10,000 residences in the Linda and Olivehurst areas.

The Auburn Dam on the American River was under construction at the time and had a cofferdam that failed causing damage to the construction site. This caused spillway releases at the downstream Folsom Dam. The Auburn project was never revived.

The city of Thornton was inundated when the Mokelumne River breached its levee. Three nearby islands also had overtopped levees (some by design) flooding at least 10,000 acres.

### 6.2.8 Flood Event of 1995

Flooding in 1995 came in two distinct waves. First, the flooding of early January 1995 was attributed to a series of two storms originating 500 miles north of Hawaii. Flooding in the Sacramento basin was mostly localized drainage related flooding or on small unregulated streams. The San Joaquin River did not reach flood stage. In general Federal levees were not threatened by this event.

With the wet antecedent conditions set by the January event, another less powerful series of storms came ashore in March causing wider flood damages, but still not threatening Federal levees. During March 1995 most locations in the southern San Joaquin River Basin received several times their normal precipitation for the month. In all, the Sacramento River was above flood stage for 18 days while the San Joaquin River did not reach its flood stage but was above monitoring stage for 3 months.

Statewide 58 of 58 counties were declared disaster areas. Twenty-eight people lost their lives due to the flooding. Total damages exceeded $1.8B, the highest ever for a Californian flood event up to that time. However, the most extensive damages were in Southern California. The Sacramento and San Joaquin Basins had $21M and $84M in damage, respectively.

*Flood Fighting Challenges, Failures and Outcomes*

Over 100 percent of the flood control reservation was available for all the major San Joaquin basin projects and most of the Sacramento basin projects. Runoff from major Sierra Rivers was mostly stored in the reservoirs with no uncontrolled flows in January. By the end of the March event much of that capacity was filled, but only Black Butte Dam spilled.

**Table 6.9:** Relevant Damages in the 1995 Event

| LMA | Damages |
|---|---|
| RD3 | No/minor Flooding |
| RD150 | No/minor Flooding |
| RD551 | No/minor Flooding |

Other system flooding included:

A private levee in Hamilton City failed.

Levees were overtopped on two small creeks in the Sacramento Basin flooding up to 300 homes.

In the San Joaquin basin a levee breach inundated RD 2100 and RD 2102 flooding mostly farmland. And in Arroyo Pasajero seven people were killed when flood waters collapsed a section of the I-5 Bridge.

### 6.2.9 Flood Event of 1997

The majority of the flooding in early January 1997 resulted from a trio of subtropical storms producing intense warm rain. Basins conditions were already wetter than normal before arrival of the first storm. Reservoirs began to encroach on their flood control space in December 1996 and continued through early January causing many to near the spillway or overtop. The brunt of the storm hit the San Joaquin basin stressing its reservoirs and levees to their limits. The flood came fast and ferocious.

The damages that resulted from the flooding of 1997 were some of the largest in State history, estimated at $2B. Several towns were devastated forcing 55,000 people from their homes.

*Flood Fighting Challenges, Failures and Outcomes*

A massive flood fighting effort was coordinated between the Federal, State, and local authorities, but their efforts were not enough to prevent more than 30 breaches along the San Joaquin system and on several critical levees in the Sacramento basin. Levees were damaged by wave wash, erosion, overtopping and subsequent landside erosion, slumping, piping, sinkholes and other failure modes. In many areas multiple locations breached at nearly the same time.

**Table 6.10:** Relevant Damages in the 1997 Event

| LMA | Damages |
|---|---|
| RD3 | No/minor Flooding. A total of thirty-six damaged sites were reported. Fourteen damaged sites were identified on the left bank levee of Steamboat Slough (Unit 1) and twenty-two damaged sites were identified on the right bank levee of the Sacramento River (Unit 2). Damage consisted of erosion and sloughing. Except for three sites with boils and seepage, no damages were observed on the landside of the levees within RD 3. The cost for rehabilitation of all sites was estimated to be $1,631,071. |
| RD150 | No/minor Flooding. Nine sites along the Sacramento River were damaged and were repaired at an estimated cost of $287,000. Damages consisted of wave-wash, erosion and sloughing on the east levee of the Sacramento River. This RD also received previous assistance in 1996 during a minor event. |
| RD551 | No/minor Flooding. On 01 August 1997, the State of California requested assistance for 19 sites, but only 9 along the Sacramento River qualified and received assistance in 1997. Damage consisted of levee sloughing on the waterside of the east levee of the Sacramento River. The estimated cost for rehabilitation for the 1997 repairs was over $1M. No other sites had been repaired under P.L. 84-99 prior to the January 1997 event. |

Other system flooding included:

The town of Arboga was inundated after levees failed in multiple places on the Bear River and Feather River. However, across the Feather River from the breach site, south of Yuba City the west levee in Levee District (LD) 1, was subjected to major underseepage and fear was high that this section would fail. It is believed that since the east levee failed, the stress on the west levee was relieved and therefore it remained intact. Locals called this stretch of west levee at Star Bend “the weakest link” of the system. It was finally improved by constructing a setback levee and removing the original in 2009.

Sutter bypass west levee failed, flooding RD 70 and RD 1660 and the town of Meridian.

Private and non-project levees on the Cosumnes River failed in numerous locations inundating hundreds to thousands of acres.

### 6.2.10 Flood Event of 1998

A strong tropical El Niño event resulted in an excessively wet winter over much of California, bringing widespread urban flooding and mudslides in February 1998, with impacts continuing throughout spring and early summer. Precipitation totals were more than three times higher than average for February. Unseasonable rains in late May caused renewed overflow into the Sacramento Basin bypass channels.

Statewide damages exceeded $550M, 17 people were killed in flood-related deaths, and 40 of 58 counties were declared Presidential disaster areas. An estimate by the Department of Food and Agriculture stated that agricultural losses alone accounted for $532M. No people were killed as the result of a levee failure.

*Flood Fighting Challenges, Failures and Outcomes*

Implementation of several lessons learned from the 1997 floods allowed the local, State and Federal emergency response to progress more efficiently. The agencies worked together to monitor and/or repair 142 damaged sites within the Central Valley flood control system. Forty successful flood-fights were conducted statewide.

**Table 6.11:** Relevant Damages in the 1998 Event

| LMA | Damages |
|---|---|
| RD3 | Rehabilitation work completed at cost of $684,000 |
| RD150 | unknown |
| RD551 | unknown |

Other system flooding included:

High stages, winds, and tides experienced during the storms caused an emergency situation resulting from significant levee breaches, overtopping, and erosion on Montezuma Slough and the northern shores of Honker, Suisun, and Grizzly Bays. Flood waters completely inundated public and private lands on Van Sickle, Wheeler, Simmons, and Hammond Islands; and partially inundated Grizzly, Joice, and Lower Joice Islands. Local and RD flood fighting was insufficient to combat 11 major levee breaches and additional overtopping. These breaches in the lower portion of the Delta had the potential to influence state water deliveries by the influx of saline water into the Delta.

Erosion damage to levees was reported throughout the Central Valley flood control system and in the Delta.

### 6.2.11 Flood Event of 2006

A series of storms struck Northern California and Nevada in late December 2005 and early January 2006. The Sacramento River and several tributaries reached flood stage. In addition to high flows, high tides and winds were experienced in the Sacramento-San Joaquin Delta. The Sacramento Weir was opened for the first time since 1998 to reduce water levels near the City of Sacramento. A Federal Disaster Declaration was issued for thirty-one counties for the severe storms, flooding, mudslides and landslides. The severity of the 2005/2006 storms coupled with melting snow packs in the Sierra mountains resulted in unusually long periods of sustained river levels on the Sacramento River. The sustained loading coupled with increased flows resulted in localized surface scouring , no deep seated erosion or bank erosion were included in the repair sites. Available geotechnical data for the damaged reaches within RD 3, 150, and 551 indicates that the embankment and foundation soils are granular. Generally, the soils consist of poorly graded sand with occasional silt mixed in to it.

In addition another series of storms struck the southern Sierra Nevada Range and San Joaquin Valley beginning April 2006. The reservoirs on the San Joaquin River system have limited abilities to release water quickly because of restricted channel capacity below the reservoirs. Faced with rapidly filling reservoirs, officials were left with little choice but to release more water downstream as inflows continued to be high. In the following days, part of the San Joaquin River system exceeded design capacity (Chowchilla Bypass), increasing the strain on levees and elevating the risk of levee failures. With the snowmelt season following just on the heels of this heavy precipitation event and the snow pack well above normal, high flows were expected to continue on the San Joaquin River system for quite some time. Some areas experienced high water through mid-June. Releases from upstream reservoirs had remained elevated to make room for the impending snowmelt, which usually peaks in late May or early June. Another Federal Disaster Declaration was issued in June 2006 for sixteen counties for the severe storms, flooding, mudslides and landslides.

*Flood Fighting Challenges, Failures and Outcomes*

Coordinated reservoir operation is largely credited with keeping the San Joaquin River at a manageable level.

Detailed damage reports relevant to the specified LMA's can be found in the appendices.

**Table 6.12:** Relevant Damages in the 2006 Event

| LMA | Damages |
|---|---|
| RD3 | High water stages produced heavy damage to the levee embankment. Some of the damages have reduced the stability of the levee below the acceptable limits and may result in potential breaches in the embankment and flooding the protected area. |
| RD150 | High water on Sacramento River, Elk Slough and Sutter Slough in December 2005/January 2006 saturated the waterside slope and removed the slope protection causing up to 15 feet high erosion of the waterside slope from wave wash, reducing the level of protection of the levee. Some of the damages to the levee slopes are extensive and may produce loss of the levee before the next flood event. |
| RD551 | The levee part of RD 551 on the left bank of the Sacramento River was damaged by high water stages and high wind induced waves. Damage was also sustained to the levee protecting RD 755. The water level went above the existing rock protection and saturated and destabilized the waterside slope, resulting in wave wash scarps of 3 to 5 feet with a few places up to 8 feet on the levee slope. The damages on RD 551 levee do not reduce the levee stability to an imminent threat but may be exacerbated during the next flood becoming critical. The sites that will be rehabilitated are not the same sites requested in 1997. |

Other system flooding included:

System bypasses were flooded per design and many other sites were repaired under PL 84-99 assistance for damage due to erosion and/or seepage. System flooding was relatively minimal.

## 6.3 Levee Performance History References

CESPK, 1999. *Sacramento and San Joaquin River Basins, California - Post-Flood Assessment 1983, 1986, 1995, 1997.*

DWR, 1956. *California Floods of December 1955*.

CESPK, 1956. *Report on December 1955 floods.*

USGS, 1965. Floods of December 1964 in the Far Western States. By S.E. Rantz and A.M. Moore.

CESPK ,1966. *Report on Floods of Dec 1964, Jan. 1965.*

DWR, 1966. *California High Water 1964-65*, Bulletin 69-65.

CESPK, 1970. *Report on Floods, Central Valley of California, 1968-69 Flood Season*.

CESPK, 1971. *Report on the January 1970 Floods, Sacramento River Basin California*.

CESPK, 1975. *Office Report on the January, March-April 1974 Rain Floods in the Sacramento River Basin California*.

DWR, 1982. *Delta Levees Investigation*, Bulletin No. 192-82.

DWR Public Information Office, 1986. *The Floods of February 1986.*

CESPD, 1996. *Northern and Southern California Floods of January and March 1995*.

DWR, 1998. *After Action Report, February 1998 Floods*.

CESPD, 1998. Internal Documentation/memos regarding the 1998 Flood.

DWR, 2006. *DWR News,* Fall 2006.

DWR, 2009. Historical Reference Document for the State Plan of Flood Control, Draft Technical Memorandum.

USGS, 2010. USGS mean daily flow records. Via website: http://waterdata.usgs.gov/ca/nwis/sw.

## CHAPTER 7 VEGETATION MAINTENANCE PLAN

This vegetation variance, if approved, would apply to arroyo and sandbar willow species only. Existing trees located within the boundaries of the variance sites are not covered by this request. The existing vegetation is covered by the California Central Valley Framework which includes interim standards for vegetation management and is not part of this request for a variance. Additionally, the willow pole plantings associated with this variance request are not to be covered by the California Central Valley Framework document. Existing Operation and Maintenance (O&M) Manuals would remain in full effect but would be revised to include additional information for the arroyo and sandbar willow species, if approved. Specifically, sections similar to the below will be added to appropriate sections of the Supplemental O&M Manuals included in Table 7.1:

> "Arroyo and Sandbar willow species planted within the vegetation variance zone identified below will be permitted to grow without intervention until the willows (a) reach between two and four inches in diameter as measured 12 inches above ground, or (b) impair visibility of the levee toe. Willow trunks shall be severed 12 inches above ground when between two and four inches. Willows shall not be permitted to grow in diameter greater than four inches when measured 12 inches above ground. When visibility of the toe is impaired or lost, willow branches shall be trimmed vertically, from the ground up, at the levee toe until the toe is visible for inspection. Proper maintenance will ensure that willows will not be trimmed in such a way that threatens their survival (i.e., 'heading', trimming branches shorter or higher than what is reasonably necessary to monitor and inspect). Vertical trimming of branches to restore visibility of the levee toe shall not exceed eight feet in height from the ground up. This trimming is necessary to ensure an adequate access corridor without unnecessarily over trimming the willows. Decaying stumps and roots shall not be removed. Care should be taken to minimize disturbance to the riprap structure during maintenance."
>
> "Further, with the exception of arroyo and sandbar willows, the vegetation variance zone shall be maintained in accordance with normal maintenance standards. No other non-grass vegetation shall be permitted within the vegetation variance zone except for arroyo and sandbar willows. The arroyo and sandbar willows shall be maintained such that the vegetation does not grow beyond the boundaries of the vegetation variance zone as described below (following installation, the contractor will record the location of the plantings and this will be included in the revision to the O&M manual)."
>
> "Due to the increased difficulty in visually observing levee scour beneath the vegetation plantings installed following the 2006 flood event, the sponsor shall conduct waterward soundings as a mechanism to ensure the riprap placed below the plantings has not eroded, settled, or otherwise scoured. Repair of any noted scour shall be conducted in accordance with Section 4-05. Examples of waterward soundings are included in Engineering Manual 1110-2-1003 or the most current USACE publication regarding hydrographic surveying."

Maintenance of the variance zone will be performed from both the water and the top of levee. In light of concerns surrounding scour and riprap movement, the following maintenance guidelines, which are already included in the Standard O&M Manual, will be reiterated to the sponsor:

(a) The levee shall be inspected at intervals not to exceed ninety days which will ensure that at least one inspection is performed at the low river stage, to allow for visual inspection of the greatest amount of the structure. (Standard O&M Manual 4-02(b)(1));

(b) Inspections shall also be conducted as soon as practical following major flood events. (Standard O&M Manual 4-02(b)(1));

(c) Where scour of a portion of the stone protection has been noted, or where inspection indicates that such damage may result during the next flood or high water period, the scour shall be filled and additional stone shall be placed upon the fill to bring the stone protection to its original section. (Standard O&M Paragraph 4-05(a)(1)).

If maintained in accordance with this vegetation management plan and O&M manual, the sponsor is not obligated to replant willow poles under any circumstances as a result of this project.

Following installation of the plantings, the Supplemental O&M Manuals will be updated and will specifically identify the “variance zone” and the above maintenance requirements. The affected manuals are listed in the table below. All are supplemental to a regional standard manual.

**Table 7.1:** Operations and Maintenance Manual Supplements Requiring Updates

| LMA | Supplements to the Sacramento River Flood Control Project Standard O&M Manual |
|---|---|
| RD 3 | Unit No. 104 - Levees Around Grand Island - Reclamation District No. 3 |
| RD 150 | Unit No. 112 – Levee Around Merritt Island |
| RD 551 | Unit No. 111 – East Levee of Sacramento River from Freeport to Walnut Grove |

# CHAPTER 8 NEPA AND ESA COMPLIANCE

Projects constructed under the PL 84-99 Rehabilitation Assistance Program are required to comply with Federal laws including NEPA, and ESA, as well as state, and local laws. Consultation with NMFS and USFWS was required due to the listed species within the project area. Since the storms in 2006 caused different degrees of damage to the levees which resulted in different levels of priority, consultation with the agencies was separated by RD and the severity of damage. Cumulatively, 40,000 lf of SRA habitat was impacted as a result of project repairs. Of the 40,000 lf required for mitigation, approximately 24,000 lf fall within the vegetation free zone. Specifically, this variance for 14,000 lf is to meet our mitigation requirements for sites at RD 3, RD 150, and RD 551.

## 8.1 NEPA Compliance

Title I of NEPA contains a Declaration of National Environmental Policy which requires the federal government to use all practicable means to create and maintain conditions under which man and nature can exist in productive harmony. To comply with NEPA, an evaluation of the environmental effects for the PL84-99 emergency repairs sites was examined including project alternatives.

In accordance with Section 102, environmental considerations were incorporated during the planning, and decision-making process through a systematic interdisciplinary approach. The possible consequence of conducting the work was studied with consideration given to environmental, socioeconomic, cultural, and engineering feasibility. Environmental effects were coordinated with the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the Central Valley Flood Protection Board.

An environmental assessment (EA) was prepared detailing the environmental impacts of the levee repair work. The EA included brief discussions of the following: the need for the proposal; alternatives; the environmental impacts of the proposed action and alternatives; conservation measures; and a listing of agencies and persons consulted. The public had opportunity to provide input on what issues should be addressed in the EA and on the Corps findings during a 30 day comment review period; no comments were received. Through multiple site visits and coordination efforts with agencies it was determined that with the implementation of conservation measures, the project activities would not result in permanent adverse effects on endangered species within the project area. The onsite conservation measures developed to help avoid and minimize effects to endangered species and their designated critical habitat were as follows:

- Stockpiling of construction materials such as portable equipment, vehicles, and supplies, including chemicals, were restricted to the designated construction staging areas and barges, exclusive of any riparian and wetlands areas.
- If any spill of hazardous materials occurred it would have been cleaned up immediately and reported to the resource agencies within 24 hours. The post-construction compliance reports would have reported any spills and the success of the clean up efforts.
- A Corps representative was appointed to be the point-of-contact for any Corps employee, contractor, or contractor employee, who might cause incidental take or found a live, dead,

injured, or entrapped threatened or endangered species during project construction and operations. The representative was identified to the employees and contractors during an all-employee education program conducted by the Corps. During the education program the Corps representative also reviewed the federally listed species that had the potential to be encountered on the construction sites.

- If requested by the resource agencies, during or upon completion of construction activities, a Corps biologist/environmental manager or contractor would accompany USFWS or NMFS personnel for an on-site, post-construction inspection tour to review project impacts and mitigation success.
- A Corps representative worked closely with the contractor(s) through all construction stages to ensure that any living riparian vegetation or in-water woody material within vegetation clearing zones could reasonably be avoided without compromising basic engineering design and safety to be avoided and left undisturbed to the extent feasible.
- Supervision by a qualified biologist of all construction activities; including clearing, pruning, and trimming of vegetation, to ensure activities had a minimal effect on natural resources.
- Committed to the placement of willow poles along the water's edge at each project site and seeding of all areas disturbed by project activities.

Based on the above measures, the EA determined the levee repair work would not significantly affect the environment and a finding of no significant impact (FONSI) could be issued. A FONSI was prepared for RD 3, RD 551, and RD 150 addressing measures which the Corps took to reduce potentially significant impacts. The FONSIs were signed by the Sacramento District Engineer on July 14, 2008 for RD 3 and RD 551 and on October 1, 2009 for RD 150. The FONSIs may be found in Chapter 9.

## 8.2 ESA Compliance - National Marine Fisheries Service

### 8.2.1 RD 3 and RD 551

Consultation under Section 7 of the ESA was initiated with NMFS on August 22, 2007 for repairs at RD 3 and RD 551. A letter of concurrence was received July 2, 2008 with a "may affect, not likely to adversely affect" determination based on an in-depth analysis of environmental impacts and a mitigation plan to plant willow poles along the toe at each of the repaired sites. Construction began on August 4, 2008 and repairs were completed by September 30 at RD 551. Construction was concluded at RD 3 on October 23, 2008.

In order to reach a "may affect, not likely to adversely affect" determination on the federally listed green sturgeon (*Acipenser medirostris*), Central Valley steelhead (*Oncorhynchus mykiss*), Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*), and Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) and their designated critical habitat, the Corps proposed initially to plant three rows of willow poles along the waterline. Each row was separated by two feet, with the cuttings spaced in three foot intervals.

To install the willows poles a stinger-equipped excavator was selected because it could easily penetrate the rip-rap allowing the cutting to reach soil. After the initial implementation using the stinger, the Corps determined the three row planting specification was detrimental to levee integrity and stability and; therefore, could not be used. The Corps revised the planting specifications to consist of two rows of willow poles in three foot intervals along the waterline for the length of each repair site.

Since the project was changed after the repairs were completed, the previous consultation no longer encompassed the full scope of project impacts. NMFS withdrew their concurrence January 2009, after the planting specification was revised. Although consultation was requested in May 2009, NMFS did not respond since the request was made after the fact and impacts had occurred and NMFS does not conduct after-the-fact consultations. However, during the process of developing this vegetation variance request, the Sacramento District initiated informal consultation with NMFS October 27, 2010 requesting concurrence to the proposed mitigation plan at all PL84-99 sites. NMFS responded December 21, 2010 with concurrence that the proposed actions (i.e., the proposed variance plantings, the non-variance plantings, and the purchase of mitigation credits) are not likely to adversely affect Federally listed species. Documentation of this consultation is included in Chapter 9.

#### 8.2.2 RD 150

Consultation under Section 7 of the ESA for repairs at RD 150 was completed separately from the other RDs. Formal consultation was initiated with NMFS April 13, 2009 and a BO with a “not likely to jeopardize the continued existence and not likely to destroy or adversely modify the designated critical habitat ” of listed fish was received August 18, 2009 based on a mitigation plan to plant willow poles in two rows, spaced in three foot intervals along the waterline at each of the repaired sites. Construction began on November 2, 2009 and was completed by January 20, 2010. In this case, with the implementation of the ETL, planting willow poles along the repair sites is not allowed without an approved vegetation variance.

### 8.3 ESA Compliance - US Fish and Wildlife Service

#### 8.3.1 RD 3 and RD 551

Consultation under Section 7 of the ESA was initiated with USFWS February 19, 2008 for repairs at RD 3 and RD 551. A letter of concurrence with a “may affect but not likely to adversely affect” determination regarding delta smelt were received for repairs at RD 3 and RD 551 based on a mitigation plan to plant willow poles in three rows of willow pole cuttings along the levee toe. Each row was separated by two feet, with the cuttings spaced in three foot intervals. After the change in project description, as described in the NMFS consultation above, the Corps reinitiated consultation on March 26, 2009 with a revised planting specification of planting two rows of willow poles, spaced in three foot intervals. USFWS responded with a concurrence letter stating the change in project description would not affect the original determination. In this case, with the implementation of the ETL, planting willow poles along the repair sites is not allowed without an approved vegetation variance.

#### 8.3.2 RD 150

Consultation for repairs at RD 150 was initiated with USFWS April 13, 2009. A concurrence letter with a “may affect, not likely to adversely affect” determination was received August 26, 2009 for repairs at RD 150 based on a mitigation plan to plant willow poles in two rows, spaced in three foot intervals along the waterline at each of the repaired sites. In this case, with the implementation of the ETL, planting willow poles along the repair sites is not allowed without an approved vegetation variance.

The table below summarizes coordination efforts for the three RD's pertaining to this variance.

**Table 8.0** Summary of NEPA and ESA Compliance

| RD | USFWS | NMFS |
|---|---|---|
| 3 | Biological Opinion received July 8, 2008.<br>After change in planting specification -<br>Concurrence Letter received May 15, 2009 with a may affect, not likely to adversely affect. | Concurrence Letter received July 2, 2008 with a may affect, not likely to adversely affect. Withdrawal of concurrence January 20, 2009. May 18 2009, Corps requests formal consultation. October 27, 2010 Corps request informal consultation. Concurrence letter received December 21, 2010. |
| 551 | Biological Opinion received June 10, 2008.<br>After change in planting specification -<br>Concurrence Letter received May 11, 2009 with a may affect, not likely to adversely affect. | Concurrence Letter received July 2, 2008 with a may affect, not likely to adversely affect. Withdrawal of concurrence January 20, 2009. May 18 2009, Corps requests formal consultation. October 27, 2010 Corps request informal consultation. Concurrence letter received December 21, 2010. |
| 150 | Concurrence Letter received August 26, 2009 with a may affect, not likely to adversely affect. | Biological Opinion received August 18, 2009 with a not likely to jeopardize the above species or adversely modify designated or proposed critical habitat. |

Note: The SAM model evaluates the response of each life stage to habitat features affected by bank protection projects and compares responses to different project scenarios. Biological simulation relies upon conceptual models that relate measured habitat conditions into life stage specific differences in predation risk, food availability, and growth. The model can then be used to assess species responses as a result of changes to habitat conditions, either by direct quantification of bank stabilization design parameters (e.g., bank slope, substrate) or by separate modeling of long-term habitat evolution due to channel migration at unconstrained sites and/or growth of riparian and aquatic plants.

As part of this vegetation variance request, the Sacramento district met with NMFS and USFWS in March 2010 to discuss options on how to meet our ESA obligations. A Memorandum for Record of the meeting can be found in Chapter 9. At this meeting, NMFS and USFWS stated onsite mitigation is best for species. However, if willow poles needed to be planted off-site, both agencies recommended the alternate locations should be riprapped or un-vegetated and along primary migratory corridors to reestablish connectivity in habitat. Another suggested alternative to planting at off-site locations would be to purchase credits at an approved mitigation bank. Consultation was based on a SAM analysis that included a survivability rate of the willow poles. During the meeting, when asked what would happen if the willow pole survival success rate is not met within the required timeline, NMFS reiterated the Corps is required to ensure an 80-95 percent success rate based on the SAM model.

Temporal losses continue to occur since the Corps has failed to provide the required mitigation in the committed timeframe. Plantings were to occur after project completion but no later than fall of

2008 for sites at RD 3 and RD 551 and no later than fall of 2009 for RD 150 sites. At the time of the meeting, neither NMFS nor USFWS are requiring mitigation for temporal losses. An agreement was reached in the meeting that both agencies will receive written notification of the type of mitigation and the location, quantity, and species of willow planted along each RD once the work has been completed.

We are continuing to work with both agencies to find an amenable solution that meets Corps requirements and restores lost SRA habitat. This variance is an essential part of our coordination efforts in developing a solution. Copies of the consultation documents can be found in Chapter 9.

## CHAPTER 9 OTHER INFORMATION

In addition to the several documents previously mentioned and found in this request, other valuable information may also be found in this chapter.

Chapter 9 includes the following documents:

9. a. BA's and/or FONSI's
- 9. a. 1. RD3 FONSI, June 2007
- 9. a. 2. RD551/755 FONSI, June 2007
- 9. a. 3. RD 150 FONSI, October 2009
- 9. a. 4. RD 3 and 551 Biological Assessment, undated

9. b NMFS Consultation Documents
- 9. b. 1. RD 3 and 551 NMFS Concurrence Letter, July 2008
- 9. b. 2. NMFS Letter Revoking Concurrence, January 2009
- 9. b. 3. SPK Letter Requesting Formal Consultation, May 2009
- 9. b. 4. RD150 NMFS Biological Opinion, August 2009
- 9. b. 5. RD551 NMFS Concurrence Letter, July 2009
- 9. b. 6. SPK Letter Requesting Informal Consultation, October 2010
- 9. b. 7. NMFS Letter of Concurrence, December 2010

9. c. USFWS Consultation Documents
- 9. c. 1. RD3 and 551 USFWS Biological Opinion, July 2007
- 9. c. 2. RD3 and 551 USFWS Biological Opinion Amendment, September 2007
- 9. c. 3. RD551 USFWS Concurrence Letter June 2008
- 9. c. 4. RD3 USFWS Biological Opinion, July 2008
- 9. c. 5 RD150 USFWS Biological Opinion, August 2009

9. d Consultation MFRs
- 9. d. 1. L. Holland MFR, March 2010
- 9. d. 2. J. LeFevre MFR, March 2011

9. e. Stinger Information
- 9. e. 1. Erick Ammon Stinger brochure
- 9. e. 2. K. Hazelton MFR, January 2009

9. f Willow Species Information
- 9. f. 1. USDA Fact Sheet for Coyote Willow (Sandbar)
- 9. f. 2. Trees of the California Landscape for Arroyo Willow
- 9. f. 3. Trees and Shrubs of California for Arroyo and Narrowleaf (Sandbar) Willow

**DEPARTMENT OF THE ARMY**
**DEPARTMENT OF ARMY**
**U.S. ARMY ENGINEER DISTRICT, SACRAMENTO**
**1325 J STREET**
**SACRAMENTO, CALIFORNIA, 95814-2922**

Environmental Resources Branch

FINDING OF NO SIGNIFICANT IMPACT
For the
PUBLIC LAW 84-99 RECLAMATION DISTRICT 3,
SACRAMENTO COUNTY, CALIFORNIA

I have reviewed and evaluated information presented in this environmental assessment/initial study (EA/IS) prepared for the proposed levee repairs under Public Law 84-99 within Reclamation District 3, Sacramento County, California. I have considered the views of other interested agencies, organizations, and individuals concerning these proposed sites.

The possible consequences of conducting the work described in the EA/IS have been studied with consideration given to environmental, socioeconomic, cultural, and engineering feasibility. All areas disturbed by construction would be revegetated for erosion control. The environmental effects have been thoroughly coordinated with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the Reclamation Board of the State of California.

Based on my review, I have determined that the proposed modifications, including access routes and staging areas, will have no significant effects on environmental or cultural resources. Endangered species in the project area may include delta smelt (*Hypomesus transpacificus*), Central Valley spring-run chinook salmon (*Oncorhychus tshawytscha*), winter-run chinook salmon (*Oncorhychus tshawytscha*), and Central Valley fall/late-run chinook salmon (*Oncorhychus tshawytscha*). We are working with U.S. Fish and Wildlife Service and the National Marine Fisheries Service to determine on-site compensation measures that would be used to avoid adverse effects to the listed species in the project area.

Based on these considerations, I am convinced that there is no need to prepare an environmental impact statement. Therefore, an EA and finding of no significant impact provide adequate environmental documentation for the proposed action.

6 June 2007
Date

Ronald N. Light
Colonel, U. S. Army
District Engineer

**DEPARTMENT OF THE ARMY**
**U.S. ARMY ENGINEER DISTRICT, SACRAMENTO**
**CORPSOF ENGINEERS**
**1325 J STREET**
**SACRAMENTO, CALIFORNIA 95814-2922**

Environmental Resources Branch

FINDING OF NO SIGNIFICANT IMPACT
For the
PUBLIC LAW 84-99 RECLAMATION DISTRICT 551/755,
SACRAMENTO CALIFORNIA

I have reviewed and evaluated information presented in this Environmental Assessment/Initial Study (EA/IS) prepared for the proposed levee repairs under Public Law 84-99 within Reclamation District 551/755, Sacramento County, California. I have considered the views of other interested agencies, organizations, and individuals concerning these proposed sites.

The possible consequences of conducting the work described in the EA/IS have been studied with consideration given to environmental, socioeconomic, cultural, and engineering feasibility. The environmental effects have been thoroughly coordinated with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and The Reclamation Board of the State of California. All areas disturbed by construction would be revegetated for erosion control.

Based on my review, I have determined that the proposed modifications, including access routes and staging areas, will have no significant effects on environmental or cultural resources. Endangered species that may occur in the project area include delta smelt (*Hypomesus transpacificus*), Central Valley spring-run chinook salmon (*Oncorhychus tshawytscha*), winter-run chinook salmon (*Oncorhychus tshawytscha*), and Central Valley fall/late-run chinook salmon (*Oncorhychus tshawytscha*). U.S. Fish and Wildlife Service and National Marine Fisheries Service conservation measures will be incorporated into the project. Due to the conservation measures mentioned in the EA/IS and construction schedule, the project would not adversely affect endangered species that may occur in the project area.

Based on these considerations, I am convinced that there is no need to prepare an environmental impact statement. Therefore, an EA and finding of no significant impact provide adequate environmental documentation for the proposed action under National Environmental Policy Act.

June 13, 2007
Date

Ronald N. Light
Colonel, U.S. Army
District Engineer

**DEPARTMENT OF THE ARMY**
**U.S. ARMY ENGINEER DISTRICT, SACRAMENTO**
**CORPS OF ENGINEERS**
**1325 J STREET**
**SACRAMENTO, CALIFORNIA 95814-2922**

Environmental Resources Branch

# FINDING OF NO SIGNIFICANT IMPACT
# PUBLIC LAW 84-99 RECLAMATION DISTRICT 150, CALIFORNIA

I have reviewed and evaluated information presented in this environmental assessment/initial study (EA/IS) prepared for the proposed levee repairs under Public Law 84-99 within Reclamation District 150, Yolo County, California. I have considered the views of other interested agencies, organizations, and individuals concerning the proposed sites.

The possible consequences of conducting the work described in the EA/IS have been studied with consideration given to environmental, socioeconomic, cultural, and engineering feasibility. The environmental effects were coordinated with the U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), and the Central Valley Flood Protection Board. The repair work would involve excavating the eroded slopes, then back filling with quarry rock, and covering with rip rap. All areas disturbed by construction would be re-vegetated with native grasses for erosion control. Construction is scheduled to be performed in fall of 2009.

Sensitive species have been surveyed for and avoidance measures will be used to reduce potential impacts to less than significant. Endangered and threatened species in the project area include the valley elderberry longhorn beetle (VELB), delta smelt, green sturgeon, Central Valley steelhead, Central Valley spring-run and winter-run chinook salmon. The Corps has completed consultation with the FWS and NMFS, and has received concurrence of a may affect not likely to adversely affect determination for the VELB, delta smelt, and anadromous fish species. Pursuant to a Memorandum of Agreement (MOA) executed on September 15, 2006, and a second MOA executed on December 20, 2006, the project is in compliance with Section 106 of the National Historic Preservation Act of 1966; as amended. The project will have no adverse affects on National Register listed or eligible properties.

No significant impacts on resources would result from the project. Project activities would not result in permanent adverse effects on endangered species within the project area. Best management practices, avoidance protocols, and minimization and mitigation measures would be utilized during construction to reduce effects related to sensitive biological resources, air quality, water quality, cultural resources, noise, and utility systems. The comment review period for this project ended June 15, 2008, and no comments were received.

Based on my review, I have determined that the proposed modifications, including access routes and staging areas, would have no significant effects on environmental or cultural resources. Based on these considerations, I am convinced that there is no need to prepare an environmental impact statement. Therefore, and EA/IS and finding of no significant impact provide adequate environmental documentation for the proposed action under the National Environmental Policy Act.

1 Oct 09
Date

Thomas C. Chapman, P.E.
Colonel, U.S. Army
District Engineer

**DEPARTMENT OF THE ARMY**
**U.S. ARMY ENGINEER DISTRICT, SACRAMENTO**
**CORPS OF ENGINEERS**
**1325 J STREET**
**SACRAMENTO, CALIFORNIA 95814-2922**

Environmental Resources Branch

## INTRODUCTION

The purpose of this initiation package is to review the proposed Public Law (PL) 84-99, Rehabilitation of Damaged Flood Control Works, Order 3, 4, and 5 sites in sufficient detail to determine to what extent the proposed action may affect any of the threatened, endangered, proposed species and designated or proposed critical habitats listed below. In addition, the following information is provided to comply with statutory requirements to use the best scientific and commercial information available when assessing the risks posed to listed and/or proposed species and designated and/or proposed critical habitat by proposed Federal actions. This initiation package is prepared in accordance with legal requirements set forth under regulations implementing Section 7 of the Endangered Species Act (ESA) (50 CFR 402; 16 U.S.C. 1536 (c)).

### Threatened, Endangered, Proposed Threatened or Proposed Endangered Species

Sacramento River winter-run chinook salmon (*Oncorhynchus tshawytscha*) **E**

Central Valley spring-run chinook salmon (*O. tshawytscha*) **T**

Central Valley fall-/late fall-run chinook salmon (*O. tshawytscha*) **T**

Central Valley steelhead (*O. mykiss*) **T**

Green sturgeon (*Acipenser medirostris*) **T**

### Critical Habitat

The action addressed within this document falls within Critical Habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, fall-/late-fall run Chinook salmon, Central Valley steelhead, and green sturgeon.

## CONSULTATION TO DATE

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. As a result, 33 critical levee repairs were undertaken between July and November 2006.

On June 21, 2006, National Marine Fisheries Service (NMFS) provided a biological opinion for 29 critical levee repair projects.

On August 25, 2006, the U.S. Army Corps of Engineers (Corps) determined that PL 84-99 Order 1 and 2 sites present an imminent threat to public life and property and authorized immediate emergency levee repair actions.

On September 30, 2006, the California Department of Water Resources (CDWR) determined that the Governor's proclamation encompassed PL 84-99 Order 1 and 2 sites and provided State funding to implement their repairs.

On October 13, 2006, NMFS met with the Corps to begin discussions about project locations, designs, and ESA Section 7 consultation processes.

On October 16, 2006, NMFS accompanied Corps environmental and engineering staff for field reviews of Corps-led sites. NMFS also provided the Corps with project recommendations for Corps-led sites to avoid, minimize, and compensate for potential adverse effects to aquatic resources and Federally listed marine fish species and their habitat.

On October 18, 2006, NMFS amended the June 21, 2006 biological opinion to add three sites and extend the length of a project already under construction.

On October 19, 2006, NMFS accompanied staff from the URS Corporation for field reviews of CDWR-led sites.

On October 20, 2006, NMFS accompanied Corps environmental and engineering staff for other field reviews of Corps-led sites.

On October 24, 2006, NMFS sent a memo to the Corps. The memo contained discussions of our October 13, 2006 meeting, field review notes of October 16 and 20, 2006, NMFS comments, and recommendations regarding each project site visit, a list of general project effects, and a list of additional comments.

On October 25, 2006, NMFS staff provided the Corps with an electronic version of the memo both in Word and PDF format.

On November 2, 2006, NMFS received an email from the Corps regarding three concerns from the memo. NMFS responded on November 6, 2006.

On November 15, 2006, NMFS conducted a site inspection on Reclamation District (RD) 2103, RD 70, and RD 3.

On November 27, 2006, NMFS received a fax copy of the Corps initiation letter with an alternative consultation process for the PL 84-99 Corps-led sites.

On November 28, 2006, NMFS conducted a site inspection on Deer and Elder Creek in Tehama County.

On November 29, 2006, NMFS conducted a site inspection on RD 785.

On December 4, 2006, NMFS conducted a site inspection on RD 3.

On December 5, 2006, NMFS conducted a site inspection on RD 551/755.

On July 7, 2007, NMFS conducted a site inspection on RD 150

On July 11, 2007, the Corps requested concurrence of a may affect - not likely to adversely affect (NLAA) determination from NMFS for project impacts to anadromous fish species at RD 17.

On July 18, 2007, the Corps requested concurrence of a NLAA determination from NMFS for project impacts to anadromous fish species at RD 150.

On August 10, 2007, NMFS conducted a site inspection on RD 1001.

On August 22, 2007, the Corps sent the Biological Assessment to NMFS requesting initiation of formal consultation for levee work conducted under the authority of PL 84-99. This consultation was for work planned for Steamboat Slough and the Sacramento River in RD 3, Yuba River and Deer Creek in RD 784, Yolo and Sacramento Bypasses in RD 827, Natomas Cross Canal in RD 765 and RD 1001, Yankee Slough and Bear River in RD 1001, Middle Creek in Maintenance Area (MA) 17, Deer Creek and Elder Creek in Tehama County, and the Sacramento River in RD 150, RD 551/755, RD 827, RD 900, and MA 1 in Tehama, Sacramento, Lake, Yolo, Yuba, Sutter, and Colusa Counties.

On August 30, 2007, the Corps received a non-concurrence letter from NMFS for a NLAA determination for impacts of project activities at RD 17.

On September 5, 2007, the Corps received a non-concurrence letter from NMFS for a NLAA determination for impacts of project activities at RD 150.

On September 7, 2007, a site inspection and meeting with the Corps occurred at RD 1001 to discuss environmental concerns regarding construction of site 5C on Yankee Slough in RD 1001. Additionally, environmental concerns surrounding construction of Tehama County sites and RD 3 site 16 on Steamboat Slough were discussed. During this meeting/site inspection NMFS agreed to extend the work windows for 4 project sites: site 16 in RD 3, site 5C in RD 1001, and Deer and Elder Creeks in Tehama County. Work windows for all sites were extended to November 15, 2007 except the Tehama County sites which were extended until October 31, 2007.

On September 14, 2007, Corps requested initiation of formal consultation and extension of work windows until November 15, 2007. This date was agreed upon during the field visit with NMFS and the Corps on September 7, 2007 for Deer and Elder Creeks in Tehama County and site 5C on Yankee Slough in RD 1001.

On October 2, 2007, NMFS issued a letter of concurrence for the consultation on the Order 3, 4, and 5 sites planned for Steamboat Slough and the Sacramento River in RD 3, Yankee Slough and Bear River in RD 1001, and Deer Creek and Elder Creek in Tehama County.

On October 11, 2007 NMFS issued a request for more information for PL 84-99 Order 3, 4, and 5 sites for work planned for Steamboat Slough and the Sacramento River in RD 3, Yuba River and Deer Creek in RD 784, Yolo and Sacramento Bypasses in RD 827, Natomas Cross Canal in RD 765 and RD 1001, Yankee Slough and Bear River in RD 1001, Middle Creek in MA 17, Deer Creek and Elder Creek in Tehama County, and the Sacramento River in RD 551/755, RD 827, RD 900, and MA 1 in Tehama, Sacramento, Lake, Yolo, Yuba, Sutter, and Colusa Counties.

From October 30, 2007, to November 15, 2007, the Corps repaired site 5C on Yankee Slough in RD 1001.

On November 13, 2007, the Corps met with representatives from NMFS to discuss what PL 84-99 project sites were appropriate for conducting a Standard Assessment Methodology (SAM) analysis. NMFS and the Corps agreed that Elder Creek in Tehama County, the Yolo Bypass in RD 785, and the Natomas Cross Canal in RD 1001 did not require a SAM analysis. The remainder of sites where construction would occur on the waterside of the levee required a SAM analysis.

On November 2007 through January 2008, Corps biologists gathered the required data for the SAM analysis.

On January 31 2008, the Corps provided the requested additional information for the PL 94-99 Order 3, 4, and 5 sites located on Steamboat Slough and the Sacramento River in RD 3, Yuba River and Deer Creek in RD 784, Yolo and Sacramento Bypasses in RD 827, Natomas Cross Canal in RDs 765 and 1001, Yankee Slough and Bear River in RD 1001, Middle Creek in MA 17, Deer Creek and Elder Creek in Tehama County, and the Sacramento River in RDs; 551/755, 827, 900, and MA 1 in Tehama, Sacramento, Lake, Yolo, Yuba, Sutter, and Colusa Counties.

On February 11, 2008, the Corps sent NMFS a letter providing additional information, as requested, for RD 17.

On March 4, 2008, NMFS sent a letter to the Corps stating that they did not concur with the NLAA determination and provided comments as to why.

On March 26, 2008, the Corps and NMFS met to discuss the assumptions and results of the SAM conducted by the Corps.

On April 23, 2008, the Corps sent a letter to NMFS with the additional information requested to complete the consultation package for the PL 84-99 Order 3, 4, and 5 repairs.

On May 5, 2008, NMFS sent the Corps a letter inquiring about the status of the PL 84-99 Order 1 and 2 levee repairs.

On May 14, 2008, the Corps sent NMFS a formal request for concurrence with a NLAA determination for RD 150.

On June 5, 2008, the Corps sent NMFS a letter addressing NMFS's March 4, 2008 and May 5, 2008 letters.

On June 25, 2008, the Corps retracted their consultation with NMFS for RD 150.

On July 2, 2008, NMFS issued a concurrence letter to the Corps for construction on sites located on Steamboat Slough and the Sacramento River in RD 3, Yuba River and Deer Creek in RD 784, Yolo and Sacramento Bypasses in RD 827, Natomas Cross Canal, Yankee Slough and Bear River in RD 1001, Middle Creek in MA 17, Deer Creek and Elder Creek in Tehama County, and the Sacramento River in RD 551/755, RD 827, RD 900, and MA 1 in Tehama, Sacramento, Lake, Yolo, Yuba, Sutter, and Colusa Counties.

On July 10, 2008, NMFS issues a concurrence letter to the Corps for construction on RD 2098.

On July 24, 2008, NMFS issued a concurrence letter to the Corps for RD 536.

On July 24, 2008, NMFS issued a concurrence letter to the Corps for RD 765.

On August 8, 2008, NMFS issued a concurrence letter to the Corps for RD 17.

On January 20, 2009, NMFS retracted its concurrence of NLAA for all PL 84-99 Order 3, 4, and 5 sites included in the large package consultation of January 31$^{st}$, 2008, the RD 765 consultation and the RD 17 consultation.

## DESCRIPTION OF THE PROPOSED ACTION

Between December 28, 2005 and January 9, 2006, the State of California experienced a series of severe storms, which damaged the levees within the Sacramento District's boundaries. Water rose a second time in April 2006 and high water remained in some parts of the system until June. Many rivers and streams within the Sacramento and San Joaquin River Basins ran above flood stage during these events, and there were significant erosion and seepage problems with the levees. The State Department of Water Resources and/or their maintaining agencies conducted flood fight activities while the Corps has been working with the State to restore the levee systems to pre-storm level of protection. These efforts have been conducted under the authority of PL 84-99, Rehabilitation of Damaged Flood Control Works.

High water stages resulted in heavy damage to the levee embankments. Some of the damages reduced the stability of the levee and may result in potential breaches in the levee and flooding in protected areas. The damages that may contribute to breaches in the levee were considered Order 1 and 2 for repair, since the protected area includes a developed urban area. Other damages that may be exacerbated during the next flood season and repaired under PL 84-99 authority are considered Order 3 and 4 for repair. Minor damages not affecting the levee stability are considered Order 5 for repair. This document will address the Order 3, 4, and 5 sites under PL 84-99 authority.

The Corps proposes to use the PL 84-99 authority to repair levees along Steamboat Slough and the Sacramento River in Reclamation District (RD) 3; the San Joaquin River in RD 17; the Sacramento River in RD 551 and RD 755; the Yolo Bypass in RD 785; the Natomas Cross Canal, the Bear River, and Yankee Slough in RD 1001; and Elder Creek and Deer Creek in Tehama County. The details of each project are provided below under General Construction Activities.

**General Construction Activities and Specifications for all Sites**

Construction began on August 4, 2008, and all construction was completed by September 30, except for the extension on RD 3 which ended on October 13, 2008. The size of rock used at each site was average 9 inch diameter rip rap (Appendix A). Initially the Corps consulted with 16-inch-minus and 18-inch-minus rock, while NMFS recommended use of 12-inch-minus rock to repair the levees.

A rock and soil mixture was not used at the project sites. The Corps has found that soil placed on rock following repairs has only washed away during the next phase of high waters as a result of the velocity of the water in the channel, resulting in increased turbidity. The rock mixtures used in construction of the sites consist of 10 percent fines. In addition to the fines in the larger rock, the Corps cast 4-inch-minus smooth infill rock over the larger rock used for repairs. The fines in the large rock mixture and the use of the 4-inch-minus infill rock filled the interstitial space between the rocks thus eliminating habitat for predators to hide in and creating a better habitat for the listed anadromous fish.

Prior to initiation of construction activities, the Corps visited the project sites with a contractor to identify trees that may be protected and worked around. The Corps protected in place (where possible) trees and shrubs that provide habitat for anadromous fish species in the project area. A certified arborist was present during the clearing and grubbing phases of the construction activities.

NMFS recommended that the Corps incorporate techniques described in the Federal Interagency Stream Restoration Working Group's Stream Corridor Restoration Handbook (Handbook) into project activities. The Corps, under PL 84-99, is only authorized to restore the levee to the pre-flood conditions; betterments are not authorized under this authority. For these reasons the Corps did not include techniques from the Handbook for levee repairs. The total proposed and actual lengths of sites in each RD are provided in Table 1.

**Table 1. Total Proposed and Actual Lengths for All Sites in Linear Feet (LF).**

| Site | Proposed Construction | Actual Construction |
|---|---|---|
| **Reclamation District 3** | 9,536 LF | 9,023 LF |
| **Reclamation District 17** | 9,786 LF | 6,845 LF |
| **Reclamation District 551/755** | 4,467 LF | 4,502 LF |
| **Reclamation District 765** | 1,160 LF | 861 LF |
| **Reclamation District 785** | 4,000 LF | 3,976 LF |
| **Reclamation District 1001** | 3,350 LF | 3,255 LF |
| **Tehama County** | 595 LF | 594 LF |
| **TOTAL** | **32,299 LF** | **28,462 LF** |

- The general construction plan for each site consisted of excavating the damaged area and then reconstructing the levee to return it to its pre-flood condition. However, each site also consisted of specific differences that affected construction plans. Some of these differences included waterside versus landside repairs, the height of the repair on the levee slope, whether the repair was in-water, and whether there was vegetation in the project area. Site specific construction details for each RD are provided in section below. All sites will have willows planted six feet apart in two, two-foot, off center rows, this pattern was required as the original planting specifications were found to be detrimental to levee stability, please see Appendix I.

**Site Specific Construction Details (please see Appendix B for as built plans for each RD)**

**RECLAMATION DISTRICT 3**

**General Construction Activities**

Construction began on August 4, 2008, and all construction was completed by September 30, except for the extension which ended on October 13, 2008. Erosion of the waterside levee slope was observed at 9 sites along Steamboat Slough and 20 sites along the Sacramento River.

Steamboat Slough had 3,693 feet of intermittent slope erosion above the existing rock protection. Damages to the Sacramento River levees consisted of 5,870 feet of intermittent slope erosion above the existing rock protection.  Damage depth varied from 1 to 5 feet and extended between 55 to 855 feet-long.

The damages repaired consisted of wave wash erosion of the waterside levee slope with loss of existing rock protection.  The damaged areas were cleared and grubbed approximately 0.5 foot beyond the damaged levee surface.  The cleared slope then had lost rock protection replaced to the height and thickness of adjacent undamaged areas.  Willow pole cuttings will be planted along the waterline using the stinger method as outlined in the USDA-Natural Resources Conservation Service's Technical Notes, June 1994, TN Plant Materials NO. 6 (Appendix C). The stinger will be on a large platform boat on the water side of the levee, as the topography of these sites makes landside use impossible. The Corps has proposed to plant these pole cuttings in fall or winter of 2009.

**Table 2. Proposed repairs and damage table.**

| SN | Order | Scarp Depth (feet) | Damage Length (feet) | River Mile | Latitude (north point) | Longitude (north point) |
|---|---|---|---|---|---|---|
| 20051230-002-008 | 3 | 3 | 600 | 21.2 | 38.24528 | -121.60093 |
| 20051230-002-009 | 3 | 5 | 185 | 20.0 | 37.22834 | -121.60181 |
| 20051230-002-010 | 5 | 2 | 978 | 19.5 | 38.22345 | -121.60122 |
| 20051230-002-011 | 5 | 1 | 270 | 19.3 | 38.21863 | -121.60265 |
| 20051230-002-012 | 5 | 2 | 225 | 19.0 | 38.21549 | -121.60477 |
| 20051230-002-013 | 5 | 1 | 145 | 17.6 | 38.19602 | -121.61398 |
| 20051230-002-014 | 5 | 2 | 283 | 17.5 | 38.19504 | -121.61555 |
| 20051230-002-015 | 5 | 3 | 235 | 17.1 | 38.19248 | -.121.62329 |
| 20051230-002-016 | 5 | 2 | 772 | 15.8 | 38.18814 | -121.64194 |
| **Total Steamboat Slough** | | | **3,693** | | | |
| 20051230-002-017 | 4 | 2 | 90 | 15.3 | 38.17372 | -121.64600 |
| 20051230-002-018 | 4 | 3 | 80 | 15.4 | 38.17359 | -121.64517 |
| 20051230-002-019 | 4 | 2 | 725 | 16.2 | 38.17040 | -121.63047 |
| 20051230-002-020 | 4 | 3 | 90 | 17.6 | 38.16457 | -121.60850 |
| 20051230-002-021 | 5 | 1 | 90 | 17.9 | 38.16535 | -121.60423 |
| 20051230-002-022 | 5 | 1 | 355 | 18.6 | 38.17172 | -121.59531 |
| 20051230-002-024 | 3 | 4 | 855 | 21.9 | 38.20549 | -121.55847 |
| 20051230-002-025 | 4 | 3 | 75 | 22.6 | 38.21524 | -121.55852 |
| 20051230-002-026 | 3 | 5 | 55 | 22.7 | 38.21764 | -121.55835 |
| 20051230-002-027 | 4 | 3 | 220 | 22.9 | 38.22007 | -121.55798 |
| 20051230-002-028 | 4 | 2 | 100 | 23.0 | 38.22117 | -121.55763 |
| 20051230-002-029 | 4 | 4 | 360 | 24.9 | 38.24187 | -121.54644 |
| 20051230-002-030 | 4 | 3 | 590 | 25.3 | 38.23994 | -121.53751 |
| 20051230-002-031 | 4 | 2 | 590 | 25.4 | 38.23994 | -121.53751 |
| 20051230-002-033 | 3 | 5 | 460 | 27.7 | 38.25525 | -121.51544 |
| 20051230-002-035 | 3 | 5 | 40 | 28.0 | 38.25761 | -121.51839 |
| 20051230-002-036 | 3 | 5 | 570 | 28.1 | 38.25875 | -121.52009 |
| 20051230-002-037 | 3 | 4 | 120 | 28.3 | 38.26099 | -121.52290 |
| 20051230-002-039 | 4 | 2 | 300 | 28.6 | 38.26352 | -121.52630 |
| 20051230-002-041 | 4 | 3 | 105 | 32.1 | 38.30209 | -121.57197 |
| **Total Sacramento River** | | | **5,870** | | | |

California Highway 160 is supported by the levee on the Sacramento River. This route is a major thoroughfare and is heavily used by motorists. Repairing the sites from the crown of the levee resulted in some traffic delays and required active traffic control during construction. All construction occurred via barge due to the inability to remove the water side guard rails from the highway. Best management plans were implemented at each site to protect listed species and to the assure water quality is not affected by construction activities.

There were three proposed construction methods for the RD 3 work: 3'-10' Erosion Depth Slope Repair (A1), 3' and Less Erosion Depth Slope Repair (A2), and 3'-6' Erosion Depth In-Water Slope Repair (B). The following sites were all constructed as A2 as opposed to their proposed construction:

- Site 011 – Proposed A1,
- Site 017 – Proposed B,
- Site 028 – Proposed A1,
- Site 029 – Proposed A1,
- Site 030 – Proposed A1,
- and Site 035 – Proposed A1.

Table 3 below compares the proposed construction to the details of the actual construction work preformed.

**Table 3. RD 3: Proposed and Actual Construction Lengths.**

| **Proposed Construction** | **Actual Construction** |
|---|---|
| The proposed lengths of the sites were as follows: | The actual lengths of the project sites were as follows: |
| Site 008 – 600 LF | Site 008 – 600 LF |
| Site 009 – 185 LF | Site 009 – 185 LF |
| Site 010 – 978 LF | Site 010 – 978 LF |
| Site 011 – 270 LF | Site 011 – 270 LF |
| Site 012 – 225 LF | Site 012 – 225 LF |
| Site 013 – 145 LF | Site 013 – 145 LF |
| Site 014 – 283 LF | Site 014 – 240 LF |
| Site 015 – 235 LF | Site 015 – 235 LF |
| Site 016 – 772 LF | Site 016 – not constructed |
| Site 017 – 90 LF | Site 017 – 90 LF |
| Site 018 – 80 LF | Site 018 – 80 LF |
| Site 019 – 725 LF | Site 019 – 725 LF |
| Site 020 – 90 LF | Site 020 – 90 LF |
| Site 021 – 90 LF | Site 021 – 90 LF |
| Site 022 – 355 LF | Site 022 – 355 LF |
| Site 024 – 855 LF | Site 024 – 855 LF |
| Site 025 – 75 LF | Site 025 – 75 LF |
| Site 026 – 55 LF | Site 026 – 55 LF |
| Site 027 – 220 LF | Site 027 – 220 LF |
| Site 028 – 100 LF | Site 028 – 100 LF |
| Site 029 – 360 LF | Site 029 – 360 LF |
| Site 030 – 590 LF | Site 030 – 590 LF |
| Site 031 – 590 LF | Site 031 – 590 LF |
| Site 033 – 460 LF | Site 033 – 460 LF |
| Site 035 – 40 LF | Site 035 – 340 LF |
| Site 036 – 570 LF | Site 036 – 570 LF |
| Site 037 – 120 LF | Site 037 – 120 LF |
| Site 039 – 300 LF | Site 039 – 290 LF |
| Site 041 – 105 LF | Site 041 – 90 LF |
| **Total: 9,563 LF** | **Total: 9,023 LF** |

**RD 3 Remediation Work.**

The contractor, DD-M Crain and Rigging (DD-M), over-rocked several sites on RD 3. Based on field notes from the Quality Assurance representative on-site, the remediation work started on October 3, 2008 and ended on October 13, 2008. To remedy this situation, DD-M removed approximately 307 tons of riprap from the levee face.

A work plan was submitted to USACE (Appendix D) by the contractor to remedy the eight overbuilt sites, which included sites 8, 21, 22, 29, 30, 31, 33, and 41. Since construction was outside of the expected construction window, extra conservation measures were used to ensure no rocks fell into the water as agreed to by NMFS. Figures 3-2 and 3-3 show the extra conservation measures which included netting, silt fencing, and landed barge. Remediation work included removal of over placed riprap, leveling existing riprap and reworking upstream and downstream transitions. All work was done from the water using a haul barge and a long-reach excavator on a crane barge.

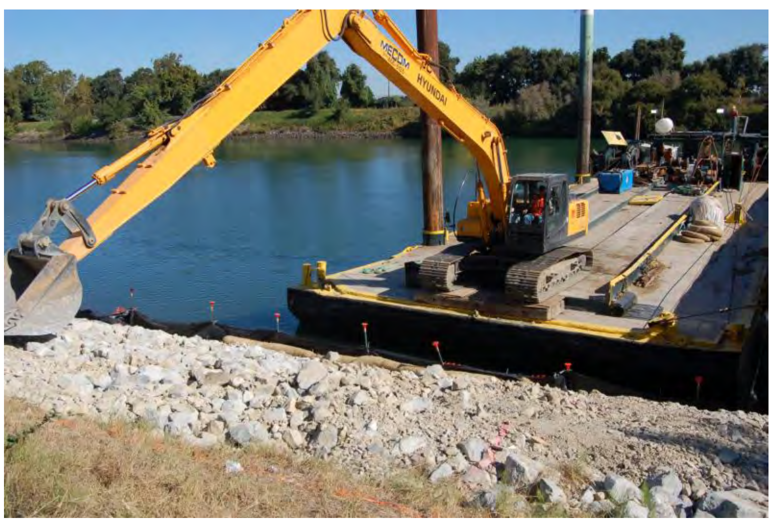

**Figure 3-2. RD 3 Bank Conservation Measures.**

**Figure 3-3. RD 3 Barge Conservation Measures.**

**Descriptions of Action Area**

The Steamboat Slough and the Sacramento River levees in RD 3 protect Grand Island in the California Delta region. Grand Island is approximately 25 miles southwest of downtown Sacramento, California and 12 miles west of Galt, California. The waterside levee slopes at the majority of the project sites on the Sacramento River and Steamboat Slough are dominated by nonnative grasses and forbs. The dominant vegetation on most sites is horsetail (*Equisetum sp.*). This grows so dense that little to no other vegetation persists on the slopes. The only woody vegetation found at most sites are small, shrubby native trees that grow along the toe of the levee approximately 2 to 3 feet from the water's edge. At a few projects sites there are mature trees growing along the upper levee slope. All of the sites were repaired without impacting any of the tress or woody vegetation.

**Species Accounts and Status of the Species in the Action Area**

Five fish species/evolutionarily significant units (ESUs) and designated critical habitat for the listed species are found in or near the project area. These species include the Central Valley spring-run Chinook salmon, fall-/late-fall run chinook salmon (*Oncorhynchus tshawytscha*), Sacramento River winter-run chinook salmon (*O. tshawytscha*), Central Valley steelhead (*O. mykiss*), and green sturgeon (*Acipenser medirostris*). Species accounts and status of these species can be found in the species account section below.

**Effects of the Action**

Construction for the project sites occurred between August 4, 2008 and September 30, except for the extension which ended on October 13, 2008. The Standard Assessment Methodology (SAM) model was used to determine the effects to the listed fish species for this project with willow pole cuttings planted in a pattern of two off set rows of willow poles placed six feet apart. The result illustrated no negative effects and a net beneficial effect (Appendix E).

This conclusion is based on the Corps' commitments to minimize temporary habitat losses through the incorporation of onsite conservation features (e.g. willow pole cuttings, avoiding as many trees and shrubs as possible, casting of 4-inch-minus on top of the rip rap, etc.) in the project design. Concurrent implementation of these conservation measures will adequately avoid, minimize, and mitigate adverse effects to the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, as well as adverse impacts to their designated critical habitats.

Once construction is complete, the shoreline will return to favorable habitat conditions for aquatic species as a result of the conservation measures and riparian vegetation establishment. Willows are being planted where no vegetation is placed along the fast moving Sacramento river system and slowing of the current will occur. This will result in some deposition of sediments and in turn will improve surrounding potential habitat areas and encourage riparian vegetation recruitment in the area. While this will not re-establish the once vast flood plains of the historic Sacramento River Valley, it will enhance the current conditions found in the mostly barren Lower Sacramento River.

The overall net effect of this project will make temporary construction effects less than significant. The Corps has made a may affect - not likely to adversely affect determination for this project regarding the RD 3 sites. We request your concurrence of a may affect - not likely to adversely affect determination for project impacts to listed species.

## RECLAMATION DISTRICT 17

### General Construction Activities

Construction activities took place between August 4 and September 30, 2009. The damage consisted of intermittent areas of existing rip rap loss and up to 3 feet high toe erosions on the water side levee slope. Damages did not threaten the levee integrity, but had the possibility of being exacerbated during future flood events. The damages were consistent through all of the repair sites in the RD. A summary of damage is shown in Table 4.

For all of these sites the same repair was used. The repair consisted of restoring the levee toe with quarry run rock and replacing the lost rip rap on the levee slope. The repair included clearing the eroded area to one foot in depth, backfilling the levee toe with quarry run rock and restoring the rip rap protection on the cleared and grubbed area. The repair alternative is illustrated in Appendix B.

**Table 4 - RD 17 Proposed Repairs and Damage Table.**

| SN | Order | Scarp Depth (feet) | Damage Length (feet) | River Mile | Latitude (north point) | Longitude (north point) |
|---|---|---|---|---|---|---|
| 20060404-005-001a | -------- | 1-3 | 62 | 43.3 | 37.91448 | -121.32224 |
| 20060404-005-001b | -------- | 1-3 | 30 | 43.3 | 37.91378 | -121.32300 |
| 20060404-005-002a | -------- | 1-3 | 67 | 43.6 | 37.91074 | -121.32426 |
| 20060404-005-002b | -------- | 1-3 | 190 | 43.6 | 37.90998 | -121.32446 |
| 20060404-005-002c | -------- | 1-3 | 110 | 43.6 | 37.90903 | -121.3243 |
| 20060404-005-003 | -------- | 1-3 | 337 | 43.9 | 37.90662 | -121.32380 |
| 20060404-005-004 | -------- | 1-3 | 260 | 44.2 | 37.90323 | -121.32467 |
| 20060404-005-005 | -------- | 1-3 | 40 | 44.4 | 37.90126 | -121.32559 |
| 20060404-005-006a | -------- | 1-3 | 352 | 44.4 | 37.89995 | -121.32560 |
| 20060404-005-006b | -------- | 1-3 | 138 | 44.4 | 37.89902 | -121.32595 |
| 20060404-005-006c | -------- | 1-3 | 65 | 44.4 | 37.89734 | -121.32678 |
| 20060404-005-006d | -------- | 1-3 | 182 | 44.4 | 37.89863 | -121.32617 |
| 20060404-005-006e | -------- | 1-3 | 217 | 44.4 | 37.89623 | -121.32738 |
| 20060404-005-006f | -------- | 1-3 | 288 | 44.4 | 37.89587 | -121.32768 |
| 20060404-005-006g | -------- | 1-3 | 170 | 44.4 | 37.89503 | -121.32822 |
| 20060404-005-007a | -------- | 1-3 | 48 | 45.3 | 37.88967 | -121.32877 |
| 20060404-005-007b | -------- | 1-3 | 115 | 45.3 | 37.88952 | -121.32879 |
| 20060404-005-009 | -------- | 1-3 | 260 | 45.4 | 37.88609 | -121.33106 |
| 20060404-005-010a | -------- | 1-3 | 593 | 45.8 | 37.88002 | -121.33196 |
| 20060404-005-010b | -------- | 1-3 | 110 | 45.8 | 37.87292 | -121.32990 |
| 20060404-005-010c | -------- | 1-3 | 140 | 45.8 | 37.86503 | -121.325008 |
| 20060404-005-011a | -------- | 1-3 | 106 | 47.4 | 37.865178 | -121.324111 |
| 20060404-005-011b | -------- | 1-3 | 133 | 47.4 | 37.86444 | -121.32219 |
| 20060404-005-011c | -------- | 1-3 | 668 | 47.4 | 37.86403 | -121.32153 |
| 20060404-005-011d | -------- | 1-3 | 90 | 47.4 | 37.86173 | -121.32024 |
| 20060404-005-011e | -------- | 1-3 | 281 | 47.4 | 37.86112 | -121.31973 |
| 20060404-005-012a | -------- | 1-3 | 128 | 48.2 | 37.85657 | -121.31956 |
| 20060404-005-012b | -------- | 1-3 | 711 | 48.2 | 37.85588 | -121.32005 |
| 20060404-005-012c | -------- | 1-3 | 176 | 48.2 | 37.82885 | -121.31031 |
| 20060404-005-013 | -------- | 1-3 | 191 | 52.9 | 37.80851 | -121.32637 |
| 20060404-005-014 | -------- | 1-3 | 1,156 | 53.1 | 37.80677 | -121.31865 |
| 20060404-005-015 | -------- | 1-3 | 436 | 54.4 | 37.79566 | -121.30800 |
| 20060404-005-016 | -------- | 1-3 | 1,093 | 55.6 | 37.78604 | -121.30571 |
| | -------- | 1-3 | 605 | 55.6 | 37.78315 | -121.30228 |
| | -------- | 1-3 | 238 | 55.6 | 37.77753 | -121.29871 |
| **Total Damage San Joaquin River** | | **9,786** | | | | |

Best management plans were implemented at each site to protect listed species and to assure that water quality was not affected by construction activities. Where possible, the Corps has moved sites or changed the method of repair in order to protect in-stream vegetation and woody vegetation that provides shaded riverine aquatic (SRA) habitat.

Construction in RD 17 consisted of the rehabilitation of 35 erosion sites along the San Joaquin River in San Joaquin County, California. Table 5 below compares the proposed construction site lengths to the actual construction preformed. Most construction was done as proposed including: the damaged areas were excavated approximately 1 foot in depth and backfilled with quarry rock, surface voids in the rock filled by casting 3-inch infill rock onto the rip-rap, and hydroseeding occurred above rock repairs on areas that were cleared and grubbed during actual construction. No bedding material was used in actual construction efforts. Willow pole cuttings will be planted along the waterline using the stinger method as outlined in the USDA-Natural Resources Conservations Service's Technical Notes, June 1994, TN Plant Materials' NO. 6 (Appendix C). The stinger will be on a large platform boat on the water side of the levee, as the topography of these sites makes landside use impossible. The Corps has proposed to plant these pole cuttings in fall or winter of 2009.

**Table 5. RD 17: Proposed and Actual Construction.**

| **Proposed Construction** | **Actual Construction** |
|---|---|
| The proposed lengths of the sites were as follows:<br>Site 001 – 62 LF<br>Site 002 – 30 LF<br>Site 003 – 67 LF<br>Site 004 – 190 LF<br>Site 005 – 110 LF<br>Site 006 – 337 LF<br>Site 007 – 260 LF<br>Site 008 – 40 LF<br>Site 009 – 352 LF<br>Site 010 – 138 LF<br>Site 011 – 65 LF<br>Site 012 – 182 LF<br>Site 013 – 217 LF<br>Site 014 – 288 LF<br>Site 015 – 170 LF<br>Site 016 – 48 LF<br>Site 017 – 115 LF<br>Site 019 – 260 LF<br>Site 020 – 593 LF<br>Site 021 – 110 LF<br>Site 022 – 140 LF<br>Site 023 – 106 LF<br>Site 024 – 133 LF<br>Site 025 – 668 LF<br>Site 026 – 90 LF<br>Site 027 – 281 LF<br>Site 028 – 128 LF<br>Site 029 – 711 LF | The actual lengths of the project sites were as follows:<br>Site 001 – 37 LF<br>Site 002 – No repairs<br>Site 003 – 111 LF<br>Site 004 – 140 LF<br>Site 005 – 143 LF<br>Site 006 – 343 LF<br>Site 007 – 302 LF<br>Site 008 – 70 LF<br>Site 009 – 233 LF<br>Site 010 – 135 LF<br>Site 011 – 77 LF<br>Site 012 – 199 LF<br>Site 013 – No repairs<br>Site 014 – 226 LF<br>Site 015 – 210 LF<br>Site 016– 107 LF<br>Site 017 – 107 LF<br>Site 019 – 267 LF<br>Site 020 – 68 LF<br>Site 021 – 118 LF<br>Site 022 – No repairs<br>Site 023 – 143 LF<br>Site 024 – 76 LF<br>Site 025 – 272 LF<br>Site 026 – 90 LF<br>Site 027 – 350 LF<br>Site 028 – 55 LF<br>Site 029 – 184 LF |

| | |
|---|---|
| Site 030 – 176 LF<br>Site 031 – 191 LF<br>Site 032 – 1,156 LF<br>Site 033 – 436 LF<br>Site 034 – 1,093 LF<br>Site 035 – 605 LF<br>Site 036 – 238 LF<br>**Total: 9,786 LF** | Site 030 – 202 LF<br>Site 031 – 66 LF<br>Site 032 – 1,156 LF<br>Site 033 – 436 LF<br>Site 034 – 121 LF<br>Site 035 – 605 LF<br>Site 036 – 238 LF<br>**Total: 6,887 LF** |

### Descriptions of Action Area

The waterside levee slope at the majority of the project sites on the San Joaquin River are dominated by nonnative grasses, forbs, and blackberries. These plants grow so dense that little to no other vegetation persists on the slopes. At a few of projects sites there are mature trees growing along the upper levee slope. The majority of the sites were repaired without impacting any of the woody vegetation. Table 6 below indicates what vegetation was found at each location. A qualified biologist and arborist were present during clearing and grubbing to ensure proper pruning techniques were used and to ensure the remaining woody vegetation was protected. All trees within sites were protected in-place with burlap.

**Table 6 – Vegetation found at RD 17.**

| Site | Vegetation | Trees |
|---|---|---|
| 20060404-005-001 | Blackberry and grasses | 13 large oaks, 12 pecan trees, 1 black walnut |
| 20060404-005-002 | 1 Elderberry, grasses, wild rose, and blackberry | Box elder and willows |
| 20060404-005-003 | Grasses | 1 large pecan tree |
| 20060404-005-004 | Grasses and wild rose | 1 large English walnut tree |
| 20060404-005-005 | Grasses and blackberry | 2 willows and 1 large almond tree |
| 20060404-005-006 | Grasses, wild rose, and blackberry | Several large willows and large box elders |
| 20060404-005-007 | Grasses and blackberry | 1 large willow |
| 20060404-005-009 | Grasses, 2 elderberry, and blackberry | Large willows |
| 20060404-005-010 | Grasses, wild rose, blackberry, and arrundo | Willows, tobacco, and an almond tree |
| 20060404-005-011 | Grasses | Willows, tobacco, and oak trees |
| 20060404-005-012 | Grasses and wild rose | Willow, 2 box elders, and pecan tree |
| 20060404-005-013 | Grasses | Willows |

| | | |
|---|---|---|
| 20060404-005-014 | Grasses | Willows |
| 20060404-005-015 | Grasses | 3 small-to-medium-sized Valley oaks |
| 20060404-005-016 | Grasses, wild rose | 4 medium-sized Valley oaks |

### Species Accounts and Status of the Species in the Action Area

One fish species/evolutionarily significant unit (ESUs) and its designated critical habitat is found in or near the project area. This species is the Central Valley steelhead (*O. mykiss*). The species account and status of this species can be found in the species account section below. The green sturgeon (*Acipenser medirostris*) is not included in this discussion as there have been no sightings of Green Sturgeon in the San Joaquin River (NMFS 2005).

### Effects of the Action

Construction for the project sites occurred between August 4, 2008 and September 30, 2008. The Corps will plant willow pole cuttings along the water's edge for all areas disturbed by construction activities. The SAM model was used to determine the effects to the listed fish species for this project with willow pole cuttings planted in a pattern of two off set rows of willow poles placed six feet apart (Appendix E).

This conclusion is based on the Corps' commitment to minimize temporary habitat losses through the incorporation of onsite conservation features (e.g., willow pole cuttings, avoiding as many trees and shrubs as possible, casting of 4-inch-minus rock on top of the rip rap, etc.) in the project design. Concurrent implementation of these conservation measures will adequately avoid, minimize, and mitigate adverse effects to the Central Valley steelhead, as well as adverse impacts to their designated critical habitat. There is a caveat to this condition. The Corps learned during construction that herbicide was sprayed on both the land-side and water side of the levee. This may inhibit growth of the willow pole cuttings, but the ultimate effect of that action is unknown. Please see Appendix F for the internal memorandum of the field visit findings concerning this incident.

Once construction is complete, the shoreline will return to favorable habitat conditions for aquatic species as a result of the conservation measures and riparian vegetation establishment. Willows are being planted where no vegetation exists along the San Joaquin river system so some slowing of the current is expected. This will result in some deposition of sediments and in turn will improve surrounding potential habitat areas and encourage riparian vegetation recruitment in the area. While this will not re-establish the once vast flood plains of the historic San Joaquin River Valley, it will enhance the current conditions found in the mostly barren San Joaquin River.

The overall net effect of this project will make temporary construction effects less than significant. The Corps has made a may affect - not likely to adversely affect determination for this project regarding the RD 17 sites. We request your concurrence of a may affect - not likely to adversely affect determination for project impacts to listed species.

**RECLAMTION DISTRICTS 551/755**

**General Construction Activities**

Erosion of the waterside levee slope was observed at 10 sites along the Sacramento River in RD 551 and 5 sites along the Sacramento River in RD 755. The Sacramento River in RD 551 had 3,567 feet of intermittent erosion and 900 feet of intermittent erosion in RD 755. Wave wash damage depth varied from 2 to 4 feet and extended between 4.4 to 723-feet-long. The repairs consisted of restoring levee slopes to their pre-flood conditions. The plans for all of the repairs on both RD 551 and RD 755 were similar.

**Table 7 – RD 551/755 Proposed Sites and Damage Table.**

| SN | Order | Scarp Depth (feet) | Damage Length (feet) | River Mile | Latitude (north point) | Longitude (north point) |
|---|---|---|---|---|---|---|
| 20051230-021-001 | 4 | 2-4 | 240 | 32.3 | 38.30498 | -121.57204 |
| 20051230-021-002 | 4 | 3 | 88 | 32.1 | 38.30147 | -121.56964 |
| 20051230-021-003 | 4 | 3 | 723 | 31.9 | 38.29871 | -121.56733 |
| 20051230-021-004 | 3 | 3 | 104 | 31.5 | 38.29494 | -121.56397 |
| 20051230-021-005 | 4 | 2 | 424 | 31.2 | 38.29159 | -121.56035 |
| 20051230-021-006 | 3 | 3 | 220 | 30.6 | 38.28503 | -121.55299 |
| 20051230-021-008 | 4 | 2 | 174 | 30.4 | 38.28296 | -121.54967 |
| 20051230-021-009 | 4 | 2 | 836 | 30.2 | 38.28181 | -121.54773 |
| 20051230-021-010 | 4 | 2 | 380 | 29.9 | 38.27900 | -121.54405 |
| 20051230-021-011 | 3 | 3 | 378 | 29.8 | 38.27699 | -121.54179 |
| 20060404-008-002a | 4 | 3 | 235 | 36.4 | 38.34612 | -121.54108 |
| 20060404-008-002b | 4 | 3 | 155 | 36.2 | 38.35471 | -121.54395 |
| 20060404-008-002c | 4 | 3 | 174 | 36.1 | 38.34555 | -121.54594 |
| 20060404-008-003a | 4 | 3 | 211 | 35.5 | 38.34295 | -121.55717 |
| 20060404-008-003b | 4 | 3 | 125 | 35.4 | 38.34257 | -121.55852 |
| **Total Repairs RD 551/755** | | | **4,467** | | | |

Table 8 below compares the proposed construction lengths to the actual construction work preformed. All construction activities occurred from the crown of the levee. The damaged levee slopes were excavated approximately 0.5 inch beyond the damaged surface and backfilled with compacted impervious soil. The levee slope was reconstructed to the grade of adjacent undamaged areas. The waterside levee slope was covered with rock protection; bedding material placement was proposed, but no bedding material was used in construction. Construction of sites 003a and 003b in RD 755 consisted of extending construction into the water to re-establish a 2:1 (H: V) waterside levee slope. All disturbed areas without rock protection were mulched to allow for the existing seed bank within the disturbed soil to re-grow. Surface voids were filled by broadcasting 4-inch-minus rock over the rock protection. Willow pole cuttings will be planted along the waterline using the stinger method as outlined in the USDA-Natural Resources Conservation Service's Technical Notes, June 1994, TN Plant Materials NO. 6 (Appendix C). The stinger will be on a large platform boat on the water side of the levee, as the topography of these sites makes landside use impossible. The Corps has proposed to plant these pole cuttings in fall or winter of 2009.

**Table 8. RD 551/755: Proposed and Actual Construction.**

| Proposed Construction | Actual Construction |
|---|---|
| The proposed lengths of the sites were as follows:<br>RD 551:<br>Site 001 –240 LF<br>Site 002 – 88 LF<br>Site 003 – 723 LF<br>Site 004 – 104 LF<br>Site 005 – 424 LF<br>Site 006 – 220 LF<br>Site 008 – 836 LF<br>Site 009 – 380 LF<br>Site 010 – 378 LF<br>RD 755:<br>Site 001 – 235 LF<br>Site 002 – 155 LF<br>Site 003 – 174 LF<br>Site 004 – 211 LF<br>Site 005 – 125 LF<br>**Total: 4,467 LF** | The actual lengths of the project sites were as follows:<br>RD 551:<br>Site 001 –224 LF<br>Site 002 – 87 LF<br>Site 003 – 733 LF<br>Site 004 – 98 LF<br>Site 005 – 436 LF<br>Site 006 – 219 LF<br>Site 008 – 836 LF<br>Site 009 – 383 LF<br>Site 010 – 355 LF<br>RD 755:<br>Site 001 – 235 LF<br>Site 002 – 167 LF<br>Site 003 – 220 LF<br>Site 004 – 211 LF<br>Site 005 – 125 LF<br>**Total: 4,454 LF** |

**Descriptions of Action Area**

The Sacramento River, managed by RD 551 and RD 755, protects agricultural fields, dispersed rural homes, and the towns of Paintersville and Courtland on Randall Island. A breach in the levee system may flood the area with potential for loss of lives and large adverse economic impacts.

The waterside levee slopes at the majority of the project sites in RD 551 are dominated primarily by nonnative grasses and forbs on the upper half of the slope. The lower half of the slope consists of riprap with very sparse to no vegetation. Woody vegetation only exists on the waterside levee slope at site 001 in RD 551. Repairs did not result in any trimming or removal of woody vegetation or trees.

The waterside levee slopes at the majority of the project sites in RD 755 are dominated primarily by nonnative grasses and forbs. Woody vegetation exists on the waterside levee slope at site 003a in RD 755. Repairs did not require trimming of the tree, or root pruning. A qualified biologist and arborist were present while the tree was being protected to ensure that proper techniques were used.

**Status of the Species in the Action Area**

Five fish species/ESUs and designated critical habitat for the listed species are found in or near the project area. These species include the Central Valley spring-run Chinook salmon, fall-/late-fall run chinook salmon (*Oncorhynchus tshawytscha*), Sacramento River winter-run chinook salmon (*O. tshawytscha*), Central Valley steelhead (*O. mykiss*), and green sturgeon (*Acipenser medirostris*). Species accounts and status of these species can be found in the species account section below.

**Effects of the Action**

Construction for the project sites occurred between August 4, 2008 and September 30, 2008. The Corps will plant willow pole cuttings along the water's edge for all areas disturbed by construction activities. The SAM model was used to determine the effects to the listed fish species for this project with willow pole cuttings planted in a pattern of two off set rows of willow poles placed six feet apart. The result illustrated no negative effects and a net beneficial effect (Appendix E).

This conclusion is based on the Corps' commitments to minimize temporary habitat losses through the incorporation of onsite conservation features (e.g. willow pole cuttings, avoiding as many trees and shrubs as possible, casting of 4-inch-minus in top of the rip rap, etc.) in the project design. Concurrent implementation of these conservation measures will adequately avoid, minimize, and mitigate adverse effects to the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, as well as adverse impacts to their designated critical habitats.

Once construction is complete, the shoreline will return to favorable habitat conditions for aquatic species as a result of the conservation measures and riparian vegetation establishment. Willows are being planted where no vegetation exists along the fast moving Sacramento river system so some slowing of the current is expected. This will result in some deposition of sediments and will improve surrounding potential habitat areas and encourage riparian vegetation recruitment in the area. While this will not re-establish the once vast flood plains of the historic Sacramento River Valley, it will enhance the current conditions found in the mostly barren Lower Sacramento River.

The overall net effect of this project will make temporary construction effects less than significant. The Corps has made a may affect - not likely to adversely affect determination for this project regarding the RD 551/755 sites. We request your concurrence of a may affect - not likely to adversely affect determination for project impacts to listed species.

## RECLAMATIN DISTRICT 765

### General Construction Activities

Construction for the project sites occurred between August 4, 2008 and September 30, 2008. Erosion was observed at 5 sites along the Sacramento River in RD 765. The Sacramento River in RD 765 had 1,160 feet of intermittent erosion. Damage depth varied from 3 to 5 feet and extended between 90 to 500 feet in length

The eroded waterside levee slope, for an intermittent 1,015 foot reach, was excavated in steps at least 0.5 foot beyond the damaged surface. Four different levee profiles have been designed for this RD in order to repair the damaged levee slopes. The four repair measures have been created to address the different damages to the levee slopes within the project area, and the environmental concerns within the project footprint. Repair measures A and B would be implemented where wave wash erosion exists on the upper levee slopes. Repair measures C and D would be implemented where toe erosion occurs. Measure D has been designed to protect vegetation along the levee toe that provides shaded SRA. See Appendix B for specifications of the repair measures. Table 9 below compares the proposed lengths of construction to the actual construction work preformed. The Corps will plant willow pole cuttings along the water's edge for all areas disturbed by construction activities. Surface voids were filled by broadcasting 4-inch-minus rock over the rock protection. Willow pole cuttings will be planted along the waterline using the stinger method as outlined in the USDA-Natural Resources Conservation Service's Technical Notes, June 1994, TN Plant Materials NO. 6 (Appendix C). The stinger will be on a large platform boat on the water side of the levee, as the topography of these sites makes landside use impossible. The Corps has proposed to plant these pole cuttings in fall or winter of 2009.

**Table 9. RD 765: Proposed and Actual Construction.**

| **Proposed Construction** | **Actual Construction** |
|---|---|
| The proposed lengths of the sites were as follows:<br>Site 001 – 120 LF<br>Site 002 – 500 LF<br>Site 003 – 130 LF<br>Site 004 – 90 LF<br>Site 005 – 175 LF<br>**Total: 1,160 LF** | The actual lengths of the project sites were as follows:<br>Site 001 – 120 LF<br>Site 002 – 275 LF<br>Site 003 – 90 LF<br>Site 004 – 115 LF<br>Site 005 – 292 LF<br>**Total: 860 LF** |

### Description of Action Area

RD 765 is located in Yolo County and is approximately 5 miles from downtown Sacramento, California. This RD is part of the Sacramento River Flood Control Project. A breach in the levee system may flood the area with the potential for loss of lives and large adverse economic impacts. The vegetation occurring at the majority of the sites consists of riparian forest comprised of trees, shrubs, and woody vines along the levee slope with an understory of grasses and forbs. The lower half of the slope consists of riprap with very sparse to no vegetation. Repairs did not result in any trimming or removal of woody vegetation or trees.

**Species Accounts and Status of the Species in the Action Area**

Five fish species/evolutionarily significant units (ESUs) and designated critical habitat for the listed species are found in or near the project area. These species include the Central Valley spring-run Chinook salmon, fall-/late-fall run chinook salmon (*Oncorhynchus tshawytscha*), Sacramento River winter-run chinook salmon (*O. tshawytscha*), Central Valley steelhead (*O. mykiss*), and green sturgeon (*Acipenser medirostris*). Species accounts and status of these species can be found in the species account section below.

**Effects of the Action**

Small herbatious vegetation along the waterline and levee slope was removed in order to reconstruct the levee. The large trees along the waterline and levee slope were left in place. The SAM model was used to determine the effects to the listed fish species for this project with willow pole cuttings planted in a pattern of two off set rows of willow poles placed six feet apart. The result illustrated an initial negative effect to the habitat due to temporal loss, but it later increased positively (Appendix E). The Corps met and agreed with NMFS to purchase 0.2 acres of SRA habitat from the Wildlands Fremont Landing Mitigation Bank (for the receipt of purchase see Appendix G).

Once construction is complete, the shoreline will return to favorable habitat conditions for aquatic species as a result of the conservation measures and riparian vegetation establishment. Willows are being planted where there was no initial vegetation and where vegetation already exists, there for enhancing the existing conditions along the fast moving Sacramento river system, and so some slowing of the current is expected. This will result in some deposition of sediments and in turn will improve surrounding potential habitat areas and encourage riparian vegetation recruitment in the area. While this will not re-establish the once vast flood plains of the historic Sacramento River Valley, it will enhance the current conditions found in the mostly barren Lower Sacramento River.

This conclusion is based on the Corps' commitment to minimize temporary habitat losses through the incorporation of onsite conservation features (e.g. willow pole cuttings, avoiding as many trees and shrubs as possible, casting of 4-inch-minus in top of the rip rap, etc.) in the project design and the purchase of the mitigation bank credits. Concurrent implementation of these conservation measures will adequately avoid, minimize, and mitigate adverse effects to the

Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, as well as adverse impacts to their designated critical habitats.

The overall net effect of this project will make temporary construction effects less than significant. The Corps has made a may affect - not likely to adversely affect determination for this project regarding the RD 765 sites. We request your concurrence of a may affect - not likely to adversely affect determination for project impacts to listed species.

## RECLAMATION DISTRICT 785

### General Construction Activities

Damages were observed along the Yolo Bypass levees in RD 785. These damages consisted of an intermittent 3,956 feet of wave wash erosion along the waterside levee slope. The southern portion of the levee had damages that consist of wave wash erosion along the upper levee slope for an intermittent 2,494 feet. The erosion depth extends up to 3 feet into the standard waterside levee cross section. Damages along the northern portion of the levee consist of 1,462 feet of intermittent toe erosion above the existing natural bench and wave wash erosion along the upper levee slope. Construction in RD 785 consisted of the rehabilitation of one erosion site along the Yolo Bypass in Yolo County, California. Table 10 below compares the proposed construction lengths to the actual construction work preformed.

**Table 10. RD 785: Proposed and Actual Construction.**

| Proposed Construction | Actual Construction |
|---|---|
| The proposed lengths of the sites were as follows:<br>**Site 001 – 4,000 LF** | The actual lengths of the project sites were as follows:<br>Site 001 – 1,482 LF<br>Site 002 – 2,494 LF<br>**Total : 3,976 LF** |

Repairs to the upper levee slope consisted of excavating the damaged surface in steps and backfilling the excavated area with compacted levee fill. The repaired area was graded to match the existing slope of the surrounding levee. The northern reach of the site was repaired by excavating the damaged levee slope above the existing natural toe bench. The excavated waterside slope was backfilled with compacted impervious fill and graded to match the surrounding levee slope. Herbaceous and woody vegetation growing along the natural toe bench were avoided by construction activities. No trees were removed as a result of construction activities. The repairs along the lower slope of the levee occurred between the dripline of the trees on the lower slope. All areas disturbed by construction were reseeded with native grasses. Willows will be planted along the natural toe of the levee for the 1,462 feet of the northern portion of the site. Willow pole cuttings will be planted using the stinger method as outlined in the USDA-Natural Resources Conservation Service's Technical Notes, June 1994, TN Plant Materials NO. 6 (Appendix E).

**Description of Action Area**

Reclamation District 785 is located in Yolo County, California and protects mostly agricultural lands with scattered rural residences and businesses. A breach in the levee would contribute to a loss of lives and have large, adverse economic impacts. The Yolo Bypass is a critical migratory corridor for Federally listed anadromous fish species. The fishes use the Yolo Bypass during their out migration to the ocean. The vegetation in the Yolo Bypass provides shaded riverine habitat and protection from predators and is critical to the success of the fish as they migrate through the area. Construction activities did not result in a change to the aquatic abiotic habitat conditions and had no impacts on shaded riverine habitat.

**Species Accounts and Status of the Species in the Action Area**

Three fish species/evolutionarily significant units (ESUs) and designated critical habitat for the listed species are found in or near the project area. These species include the Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*), fall-/late- run chinook salmon (*Oncorhynchus tshawytscha*), Sacramento River winter-run chinook salmon (*O. tshawytscha*), and Central Valley steelhead (*O. mykiss*). Species accounts and status of these species can be found in the species account section below.

**Effects of the Action**

Construction for the project sites occurred between August 4, 2008 and September 30. The SAM model was used to determine the effects to the listed fish species for this project with willow pole cuttings planted in a pattern of two off set rows of willow poles placed six feet apart on only the northern 1,462 feet of the northern site. The result illustrated no negative effects and a net beneficial effect (Appendix E).

This conclusion is based on the Corps' commitment to minimize temporary habitat losses through the incorporation of onsite conservation features (e.g. willow pole cuttings, avoiding as many trees and shrubs as possible, casting of 4-inch-minus in top of the rip rap, etc.) in the project design. Concurrent implementation of these conservation measures will adequately avoid, minimize, and mitigate adverse effects to the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, as well as adverse impacts to their designated critical habitats.

Once construction is complete, the shoreline will return to favorable habitat conditions for aquatic species as a result of the conservation measures and riparian vegetation establishment. The overall net effect of this project will make temporary construction effects less than significant. The Corps has made a may affect - not likely to adversely affect determination for this project regarding the RD 785 sites. We request your concurrence of a may affect - not likely to adversely affect determination for project impacts to listed species.

## RECLAMATION DISTRICT 1001

### General Construction Activities

Erosion of the waterside levee slope was observed at seven sites along the Natomas Cross Canal and seven sites along Yankees Slough. The Natomas Cross Canal had 2,880 feet of intermittent wave wash erosion resulting in damage to the levee slope. The first repair site along the Natomas Cross Canal consisted of the damages to the levee adjacent to the main pumping station. Damage depth varied from 1 to 8 feet and extends between 50 to 620-feet-long. Damages to Yankee Slough levees consisted of 950 feet of intermittent erosion of the levee toe and slope. Damage depth along Yankee Slough varied from 5 to 10 feet and damages extended from 45 to 280 feet in length.

**Table 11- RD Proposed Sites and Damage Table.**

| SN | Order | Scarp Depth (feet) | Damage Length (feet) | River Mile | Latitude (east point) | Longitude (east point) |
|---|---|---|---|---|---|---|
| 20051230-007-001a | 3 | 8 | 900 | NA | 38.82184 | -121.54524 |
| 20051230-007-001b | 3 | 1 to 2 | 160 | NA | 38.80093 | -121.58009 |
| 20051230-007-001c | 3 | 1 to 2 | 440 | NA | 38.79654 | -121.58742 |
| 20051230-007-001d | 3 | 1 to 2 | 270 | NA | 38.79553 | -121.58907 |
| 20051230-007-001e | 3 | 1 to 2 | 620 | NA | 38.79290 | -121.59341 |
| 20051230-007-001f | 3 | 1 to 2 | 440 | NA | 38.79206 | -121.59486 |
| 20051230-007-001g | 3 | 1 to 2 | 50 | NA | 38.79039 | -121.59758 |
| **Total Natomas Cross Canal** | | | **2,880** | | | |
| 20051230-007-005a | 4 | 5 | 190 | NA | 38.96752 | -121.50958 |
| 20051230-007-005c | 4 | 7 | 80 | NA | 38.97031 | -121.50230 |
| 20051230-007-005d | 4 | 10 | 45 | NA | 38.97011 | -121.49922 |
| 20051230-007-005e | 4 | 5 | 280 | NA | 38.96978 | -121.49657 |
| 20051230-007-005f | 4 | 5 | 230 | NA | 38.96960 | -121.49503 |
| 20051230-007-005g | 4 | 5 | 80 | NA | 38.97025 | -121.49310 |
| **Total Yankee Slough** | | | **950** | | | |

The Natomas Cross Canal sites, with the exception of the main pumping station repair site (site 001A), were repaired by regrading and compacting the existing soil. The slope was reconstructed to the pre-flood geometry with compacted impervious soil. All areas disturbed by construction activities were reseeded with native grasses. Construction on RD 1001 consisted of the rehabilitation of 11 erosion sites along Yankee Slough and the Natomas Cross Canal in Sutter County, California. Table 12 below compares the proposed construction to the details of the actual construction work preformed.

Damages to the levee adjacent to the main pumping station along the Natomas Cross Canal was repaired by excavating in steps the eroded levee slope at least 0.5 foot beyond the damaged surface and grading the slope to the same geometry of adjacent, undamaged areas. The excavated levee slope was restored with compacted impervious fill. The restored levee slope was covered by a 6-inch layer of bedding material to the crest of the levee. Rip rap was placed on top of the bedding material. The rip rap consisted of 24-inch-minus rock, and 4-inch-minus rock was placed over the rip rap to fill in the interstitial spaces. Rip rap is required to repair this site in order to protect against levee failure, which may result in significant damages to the main pumping station.

The Yankee Slough sites were repaired by placing rip rap at the waterside base of the levee with 4-inch-minus placed on top to fill in the interstitial spaces. The road on the crown of the levee was restored with a 6-inch-thick aggregate course base. The reconstructed levee slope was seeded with native grasses. Construction activities occurred on the upper levee slope and did not result in the removal or trimming of any riparian vegetation, with the exception of Yankee Slough site 005c.

Yankee Slough site 005c was repaired in early November 2007. This site was determined to be a critical erosion site that required immediate repairs since a rural residence was located on the landside of the levee directly opposite the vertical cut in the waterside levee slope. This is one of the four sites the Corps was given an extension in the construction windows for anadromous fish species to repair this site. Repairs consisted of relocating the channel to reconstruct the levee slope. Stone protection was added to the lower half of the levee slope to prevent future scours. The levee slope was reconstructed to match the adjacent undamaged areas. The restored slope was reseeded with native grasses. Riparian vegetation was removed from this location. Removal of this vegetation was agreed upon by NMFS during a field visit on September 7, 2007.

**Table 12. RD 1001: Proposed and Actual Construction.**

| Proposed Construction | Actual Construction |
|---|---|
| The proposed lengths of the sites were as follows:<br>Natomas Cross Canal<br>Site 001 – 50 LF<br>Site 002 – 500 LF<br>Site 003 – 440 LF<br>Site 004 – 270 LF<br>Site 005 – 620 LF<br>Site 006 – 440 LF<br>Site 007 – 160 LF<br>Yankee Slough<br>Site 005a – 190 LF<br>Site 005c– 45 LF<br>Site 005d – 80 LF<br>Site 005e– 45 LF<br>Site 005f– 280 LF<br>Site 005g– 230 LF<br>**Total: 3,350 LF** | The actual lengths of the project sites were as follows:<br>Natomas Cross Canal<br>Site 001 – 500 LF<br>Site 002 –160 LF<br>Site 003 – 440 LF<br>Site 004 – 270 LF<br>Site 005 – 620 LF<br>Site 006 – 440 LF<br>Site 007 – same site, not constructed<br>Yankee Slough<br>Site 005a – 190 LF<br>Site 005c – 45 LF<br>Site 005d – not constructed<br>Site 005e– 280 LF<br>Site 005f– 230 LF<br>Site 005g – 80 LF<br>**Total: 3,255 LF** |

**Descriptions of Action Areas**

All of the Natomas Cross Canal sites, excluding the main pump station site, are dominated by grasses, forbs, and other herbaceous vegetation. Willows (*Salix spp.*), oaks (*Quercus spp.*), and cottonwoods (*Populus spp.*) are found along the water's edge. The levee crown consists of a patrol road and is consequently void of vegetation. Project activities did not result in the removal or trimming of the woody vegetation at the water's edge. The main pump station on the Natomas Canal is void of vegetation as a result of levee maintenance. Since the levee slope is void of vegetation, construction had no effect to vegetation or fish habitat.

During a meeting on November 13, 2007, the Corps and NMFS agreed that applying the SAM model to the sites along the Natomas Cross Canal was not appropriate since construction would only occur on the upper levee slope, away from the water. Best management practices would be used to prevent impacts on water quality, such as silt fences to prevent debris from entering the water and creating turbidity.

The Yankee Slough levee slopes are dominated by grasses, forbs, and other herbaceous vegetation. The lower waterside levee bench is dominated by various riparian trees, shrubs, and woody vegetation. No trees were removed. The Corps will plant willow pole cuttings at sites where tree trimming and/or removal occurred as a conservation measure to compensate for the adverse affects to vegetation and fish habitat resulting from project actions.

Yankee Slough Site 005c was determined to be a critical erosion site that required immediate repairs. Construction activities were completed in the beginning of November 2007. Data for the SAM was gathered prior to initiation of construction. The results of the SAM for this site are included with the results for all the sites.

**Status of the Species in the Action Area**

Three fish species/ESUs and critical habitat for these species are found in the Natomas Cross Canal and Bear River project areas. These species include the Central Valley spring-run chinook salmon (*Oncorhynchus tshawytscha*), Sacramento River winter-run chinook salmon (*O. tshawytscha*), and Central Valley steelhead (*O. mykiss*). Yankee Slough does not support populations or associated critical habitat for listed anadromous fish species. During multiple site visits by Corps biologists throughout 2007 multiple beaver dams were found along Yankee Slough in the project areas. The water level is very low during the summer and in many levels the water is completely stagnant and overgrown with algae and plants. However, the fish may enter Yankee Slough during high flow events. Fish that remain in Yankee Slough as the water recedes would likely die as a result of the poor water conditions. Species accounts and status of the above listed species can be found in the species account section below.

**Effects of the Action**

Construction for the project sites occurred between August 4, 2008 and September 30, 2008. Yankee Slough has a very narrow levee crown which is too small for the heavy equipment required by the Stinger method of planting willow pole cuttings in addition to the slope being too steep for the stinger to safely reach the levee toe with out damaging surrounding mitigation. Due to these conditions, it would be too difficult to use a stinger device to plant the willows in this area. Instead, the Corps will purchase 0.07 acres of SRA habitat from a mitigation bank. This amount was derived from the disturbed area of the Yankee Slough sites.

The shoreline will return to favorable habitat conditions for aquatic species as a result of the conservation measures and riparian vegetation establishment. The overall net effect of this project will make temporary construction effects less than significant. The Corps has made a may affect - not likely to adversely affect determination for this project regarding the RD 1001 sites. We request your concurrence of a may affect - not likely to adversely affect determination for project impacts to listed species.

## CONSERVATION MEASURES

- Stockpiling of construction materials such as portable equipment, vehicles, and supplies, including chemicals, were restricted to the designated construction staging areas, exclusive of any riparian and wetlands areas.

- Measures were in place so that if there were any spills of hazardous materials, they would 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, would be reported in post-construction compliance reports.

- A representative was appointed by the Corps to be the point of contact for any Corps 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. This representative was identified to the employees and contractors during an all-employee education program, which was conducted by the Corps relative to the various Federally listed species that may be encountered on the construction sites.

- Measures are in place so that, if requested by the resource agencies, during or upon completion of construction activities, the Corps biologist/environmental manager or contractor would accompany FWS or NMFS Fisheries personnel on an on-site, post-construction inspection tour to review project impact and mitigation success.

- A Corps representative worked closely with the contractor(s) through all construction stages and project activities to ensure that any living riparian vegetation or in-stream woody material within vegetation clearing zones that could be reasonably avoided without compromising basic engineering design and safety was avoided and left undisturbed to the fullest extent feasible.

- All construction activities including clearing, pruning, and trimming of vegetation, was supervised by a qualified Corps biologist to ensure that these activities had a minimal effect on natural resources.

- Willow pole cuttings will be placed along the water's edge where rip rap has been placed. The willows will be planted six feet apart in two, two-foot, off center rows.

- Three and/or four-inch-minus rock was placed on top of the 16-inch-minus or 18-inch-minus rock. The 3 to 4-inch-minus rock was used to fill the interstitial spaces between the larger rock to prevent predators from hiding in the voids and preying on smolts.

- All disturbed areas were reseeded with native grasses.

## SPECIES ACCOUNTS AND STATUS OF SPECIES IN THE ACTION AREAS

### Endangered Fish Species

Five fish species/ESUs and designated critical habitat for four of the five species are addressed below in this initiation of consultation packet.

### Sacramento River Winter-Run Chinook salmon (*Oncorhynchus tshawytscha*)

### Status

Sacramento River winter-run chinook salmon were listed as endangered under the California Endangered Species Act (CESA) on September 22, 1989, and threatened under the ESA on August 4, 1989 (54 FR 32085). NMFS upgraded the Federal listing to endangered status on January 4, 1994 (59 FR 440). NMFS designated critical habitat for the Sacramento River winter-run chinook salmon on June 16, 1993 (58 FR 33213).

Prior to construction of Shasta Dam, winter-run chinook salmon spawned in the upper reaches of the Sacramento River, the McCloud River, and the lower Pit River. Spawning is now restricted to approximately 44 miles of the mainstem Sacramento River, immediately downstream of Keswick Dam (Yoshiyama et al. 1998).

The abundance of winter-run chinook salmon in the Sacramento River prior to construction of Shasta Dam is unknown. Some biologists believe the population was relatively small, possibly consisting of a few thousand fish (Slater 1963). Others, relying on anecdotal accounts, believe the population could have numbered more than 200,000 fish (NMFS 1993).

The population during the mid-1960s, more than 20 years after the construction of Shasta Dam, exceeded 80,000 fish (Bureau of Reclamation 1986). The population declined substantially during the 1970s and 1980s.

In 1989, winter-run chinook salmon escapement; that is, adults returning from the ocean to the river to spawn, was estimated at less than 550 adults. Escapement continued to decline, diminishing to an estimated 450 adults in 1990 and 191 adults in 1991. The sharp decline in escapement during the late 1980s and early 1990s prompted the listing of the winter-run chinook salmon as endangered under the CESA and ESA. Escapement in 1992 was estimated to be 1,180 adults, indicating high survival rates of the 1989 cohort. Data from NMFS indicated that the population has increased during the 1990s through 2001. In 1996 returning spawners numbered approximately 1,000 adults and in 2001 the returning adult population was estimated to be 5,500 (Pacific Fisheries Management Council 2002).

Despite increased efforts to maintain and enhance the population of winter-run chinook salmon by various entities, in NMFS's final listing determination of June 28, 2005 NMFS again found "that the Sacramento River winter-run chinook ESU in-total is in danger of extinction throughout all or a significant portion of its range and conclude that the ESU continues to warrant listing as an endangered species under the ESA (70 FR 37191)".

**Life History**

Sacramento River winter-run chinook salmon spend one to three years in the ocean. Adult winter-run chinook salmon leave the ocean to migrate through the Delta into the Sacramento River from December through July with peak migration occurring in March (Moyle 2002). Adults spawn from mid-April through August (Moyle 2002). Egg incubation continues through October. The primary spawning habitat in the Sacramento River is above Red Bluff Diversion Dam (RBDD) at RM 243, although spawning has been observed downstream of RBDD as far as RM 218 (NMFS 2001). Spawning success below RBDD may be limited primarily by warm water temperatures (Hallock and Fisher 1985; Yoshiyama et al. 1998).

Downstream movement of juvenile winter-run chinook salmon begins in August, soon after the fry emerge. The abundance of juvenile winter-run chinook salmon migrating downstream peaks during September and October (Vogel and Marine 1991). Juvenile winter-run chinook salmon move downstream from spawning areas in response to many factors, which may include inherited behaviors, habitat quality and availability, water flow, water temperatures, and competition for resources such as space and food. The number of juveniles that migrate and the timing of the migration are highly variable. Storm events and the resulting high flow and turbidity appear to trigger downstream migration of substantial numbers of juvenile winter-run chinook salmon.

Winter-run chinook salmon smolts (i.e. juveniles that are physiologically ready to enter seawater) may migrate through the Delta and Bay to the ocean from November through May (Yoshiyama et al. 1998). In general, juvenile abundance in the Delta increases in response to increased flow in the Sacramento River (USFWS 1993). The Sacramento River channel is the main migration route through the Delta. The Yolo Bypass, however, also provides significant out-migration passage during high flow events.

In the winter the Sacramento/San Joaquin system juveniles rear on seasonally inundated floodplains. Juvenile winter-run chinook salmon reared on the Yolo Bypass floodplain have been found to have higher growth and survival rates than those reared in the mainstream Sacramento River (Sommer et al. 2001).

**Factors Affecting Abundance**

One of the main factors in the decline of the Sacramento River winter-run chinook salmon is habitat loss and degradation. Shasta Dam on the Sacramento River blocked access to historical spawning and rearing habitat. Other factors affecting abundance include the effects of reservoir operations on water temperature; harvest; entrainment in diversions; contaminants; predation by non-native, invasive species; and interaction with hatchery stock (USACE 2000).

In the Sacramento River, operation of the Central Valley Project (CVP) and State Water Project (SWP) influences river flow. Low flows can reduce habitat area and adversely affect water quality. The resulting warm water temperatures and low dissolved oxygen levels can cause stress to incubating eggs and rearing juvenile winter-run chinook salmon. Low flow may affect migration of juveniles and adults through increased water temperature or reduced velocity that slows downstream movement of juveniles. Low flow, in combination with diversions, may result in higher entrainment losses at the California State and Federal pumping plants in the south Delta (USACE 2000).

In the Delta, flow drawn through the Delta Cross Channel (DCC) and Georgiana Slough transports a portion of downstream migrant salmon into the central Delta. The number of juveniles entering the DCC and Georgiana Slough is assumed to be proportional to the volume of flow diverted from the Sacramento River (CDFG 1987). Survival of juvenile winter-run chinook salmon drawn into the central Delta is lower than survival of juveniles remaining in the Sacramento River channel.

**Central Valley Spring-Run Chinook Salmon (*Oncorhynchus tshawytscha*)**

**Status**

The Central Valley spring-run chinook salmon ESU was Federally listed as threatened on September 16, 1999 (64 FR 50393). The threatened status of the Central Valley spring-run chinook salmon was reaffirmed in NMFS's final listing determination issued on June 28, 2005 (NOAA 2005). Critical habitat for the Central Valley spring-run chinook salmon was designated by NMFS on September 2, 2005 (70 FR 52488).

Spring-run chinook salmon may have once been the most abundant of the Central Valley chinook salmon (Mills and Fisher 1994). They once occupied the upstream reaches of all major river systems in the Central Valley where there were no natural barriers. Central Valley spring-run chinook salmon are now restricted to the upper Sacramento River downstream of Keswick Dam, the Feather River downstream of Oroville Dam, the Yuba River downstream of Engelbright Dam, several perennial tributaries of the Sacramento River (e.g. Deer, Mill, and Butte Creeks), and the Delta.

The abundance of Central Valley spring-run chinook salmon, as measures by the number of adults returning to spawn, averages about 10,000 adults for natural spawners and another 1,000 to 2,000 adults returning to hatcheries (Mills and Fisher 1994). Spring-run chinook salmon spawn in the early fall and have interbred with Central Valley fall-run chinook salmon in the Sacramento and Feather Rivers. Genetically uncontaminated populations may exist in Deer Creek, Mill Creek, Butte Creek, and other eastside tributaries of the Sacramento River.

**Life History**

Adult Central Valley spring-run chinook salmon enter the mainstem Sacramento River from March through September, with the peak upstream migration occurring in May through June (Yoshiyama et al. 1998). Spring-run chinook salmon are sexually immature during upstream migration, and adults hold in deep, cold pools near spawning habitat until spawning commences in late summer and fall. Spring-run chinook salmon spawn in the upper reaches of the mainstem Sacramento River and tributary streams (USFWS 1995), with the largest tributary run occurring in Butte, Deer, and Mill Creeks (Yoshiyama et al. 1998). Spawning typically begins in late August and may continue through October. Juveniles emerge in November and December in most locations but may emerge later when water temperatures are cooler. Newly emerged fry remain in shallow, low velocity edgewater (CDFG 1998).

Juvenile Central Valley spring-run chinook salmon typically spend up to one year rearing in fresh water before migrating to the sea as yearlings, but some may migrate downstream as young-of-year juveniles. Rearing takes place in their natal streams, the mainstem of the Sacramento River, inundated floodplains (including the Sutter Bypass and the Yolo Bypass), and the Delta. Based on observations in Butte Creek and the Sacramento River, young-of-year juveniles typically migrate from November through May. Yearling spring-run chinook salmon migrate from October to March, with peak migration occurring in November (S.P. Cramer and Associates 1997; Hill and Webber 1999). Downstream migration of yearlings typically coincides with the onset of the winter storm season, and migration may continue through March (CDFG 1998).

**Factors Affecting Abundance**

One of the main factors influencing the decline of the Central Valley spring-run chinook salmon population is habitat loss and degradation. The construction of dams result in blocked access to historical spawning and rearing habitat. Other factors affecting abundance of spring-run chinook salmon include harvesting, entrainment in diversions contaminates in the water, predation by non-native, invasive species, and interbreeding with Central Valley fall-run chinook salmon and hatchery stocks (USACE 2000).

In the Sacramento River and associated major tributaries, operation of the CVP and SWP controls river flow. Low flows limit habitat area and adversely affect water quality, including warm water temperatures and low dissolved oxygen that cause stress to incubating eggs and rearing juveniles. Low flow may affect migration of juveniles and adults through inadequate water depth to support passage or reduced velocity that slows the downstream movement of juveniles. Low flow, in combination with diversions, may result in higher entrainment losses (USACE 2000).

In the Delta, flow drawn through the DCC and Georgiana Slough transports a portion of downstream juvenile migrants into the central Delta. The number of juveniles entering the DCC and Georgiana Slough are assumed to be proportional to the volume of flow diverted from the Sacramento River (CDFG 1987). Survival of juvenile spring-run chinook salmon drawn into the central Delta is lower than survival of juveniles remaining in the Sacramento River channel.

## Central Valley Fall-/Late Fall-Run Chinook Salmon (*Oncorhynchus tshawytscha*)

### Status

Central Valley fall-/late fall-run chinook salmon are not listed under the CESA or ESA. On March 9, 1998 (63 FR 11481), NMFS issued a proposed rule to list fall-run chinook salmon as threatened but on September 16, 1999 determined the species did not warrant listing (64 FR 50393). On April 15, 2004 NMFS classified the Central Valley fall-/late fall-fun chinook salmon as a species of concern (69 Fr 19975).

The Central Valley fall-/late fall-run chinook salmon ESU includes all naturally spawned populations of fall-run chinook salmon in the Sacramento and San Joaquin River basins and their associated tributaries. The most abundant spawning populations of the fall-/late fall-run chinook salmon occur in the Sacramento, Feather, Yuba, and American Rivers (Mills and Fisher 1994). Fall-run chinook salmon in the Sacramento, Feather, and American Rivers have a relatively large hatchery component, averaging more then 25,000 adults. The average number of natural spawners in the Sacramento and San Joaquin systems is approximately 200,000 (Moyle 2002). Central Valley fall-/late fall-run chinook salmon are currently the most abundant and widespread salmon runs in California (Mills et al. 1997), representing approximately 80 percent of the total chinook salmon produced in the Sacramento River drainage (Kjelson et al. 1982).

### Life History

Adult Central Valley fall-/late fall-run chinook salmon migrate into the Sacramento River and its tributaries from June through December in mature condition and spawn soon after arriving at their spawning grounds (Yoshiyama et al. 1998). Spawning occurs September through December with spawning activities peaking in October and November. Emergence occurs from December through March, and juveniles migrate downstream to the ocean soon after emerging, rearing in fresh water for only a few months. Smolt outmigration typically occurs from March through July (Yoshiyama et al. 1998).

Central Valley fall-/late fall-run chinook salmon migrate upstream before they become sexually mature and hold near the spawning grounds for one to three months before spawning. Upstream migration takes place from October through April and spawning occurs from late January through April, peaking in February and March (Yoshiyama et al. 1998). Fry emerge from the reeds beginning in April and continuing through June. Juvenile fall-run chinook salmon rear in their natal stream during the summer, and in some streams they remain throughout the year. Smolt outmigration can occur from November through May (Yoshiyama et al. 1998).

### Factors Affecting Abundance

Factors affecting the abundance of fall-run chinook salmon are similar to those factors affecting the abundance of winter-run and spring-run chinook salmon. Fall-run chinook salmon, however, typically use spawning habitat farther downstream than the spawning habitat utilized by winter-run and spring-run chinook salmon ESUs. However, fall-run chinook salmon also spawn in locations used by the winter-run and spring-run chinook salmon. The effect of dams on spawning habitat for fall-run chinook salmon is not as severe as for other salmon runs, although access to substantial spawning habitat area has been blocked as a result of the construction of dams. Fall-run chinook salmon almost exclusively use mainstream river habitat for spawning and rearing, therefore, the fall-run chinook salmon benefit from higher managed flows in the Sacramento River and its larger tributaries during the summer and fall.

## Central Valley Steelhead (*Oncorhynchus mykiss*)

### Status

The Central Valley steelhead (steelhead) was Federally listed as threatened on March 19, 1998 (63 FR 13347). The threatened status of the Central Valley steelhead was reaffirmed in NMFS's final listing determination on January 5, 2006 (NOAA 2006), at which time NMFS also adopted the term Distinct Population Segment (DPS), in place of ESU, to describe the steelhead and other population segments of this species. NMFS originally designated critical habitat for the steelhead on February 16, 2000 (65 FR 7764). However, following a lawsuit (*National Association of Home Builders et al.* v. *Donald L. Evans, Secretary of Commerce, et al.*), NMFS decided to rescind the listing and re-evaluate how to classify critical habitat for several DPSs of steelhead. Critical habitat for the steelhead was designated by NMFS on September 2, 2005 (70 FR 52488).

Steelhead ranged throughout the tributaries of the Sacramento and San Joaquin Rivers prior to dam construction, water development, and watershed perturbation of the 19th and 20th centuries. Wild stocks are now mostly confined to the upper Sacramento River downstream of Keswick Dam, upper Sacramento River tributaries such as Deer, Mill, and Antelope Creeks, and the Yuba River downstream of Englebright Dam. The abundance of naturally reproducing steelhead, as measured by the number of adults returning to spawn, is largely unknown. Natural escapement in 1995 was estimated to be approximately 1,000 adults each for Mill and Deer Creeks and the Yuba River (S.P. Cramer and Associates 1995). Hatchery returns have averaged around 10,000 adults (Mills and Fisher 1994). The most recent annual estimates of adults spawning upstream of Red Bluff Diversion Dam is less than 2,000 fish (NOAA 2006).

**Life History**

The Central Valley steelhead has one of the most complex life histories of any salmonid species; exhibiting both anadromous and freshwater resident life histories. Freshwater residents are typically referred to as rainbow trout, and those exhibiting an anadromous life history are called steelhead (NMFS 1998). Steelhead exhibit highly variable life history patterns throughout their range but are broadly categorized into winter and summer reproductive ecotypes. Winter steelhead, the most widespread ecotype and the only type currently present in Central Valley streams (McEwan and Jackson 1996), become sexually mature in the ocean, enter spawning streams in the summer, fall, or winter, and spawn a few months later in the winter through late spring (Meehan and Bjornn 1991, Behnke 1992).

In the Sacramento River, adult steelhead migrate upstream during most months of the year. Upstream migration begins in July, peaks in September, and continues through February or March (Hallock 1987). Spawning occurs primarily from January through March, but may begin as early as late December and may extend through April (Hallock 1987). Individual steelhead may spawn more than once, returning to the ocean between each spawning migration or they may remain in fresh water between spawning events.

Juvenile steelhead require a minimum or one year to rear, but usually rear for two or more years in fresh water before migrating to the ocean during smoltification (the process of physiological change that allows ocean survival). Juvenile migration to the ocean generally occurs from December through August, peaking between January and May (McEwan 2001). The importance of main channel and floodplain habitats to steelhead in the lower Sacramento River and the upper Delta is not well understood. Steelhead smolts have been found in the Yolo Bypass during the period of winter and spring inundation (T. Sommer, 2002, pers. comm.), but the importance of this and other floodplain areas in the lower Sacramento River and the upper Delta is not yet clear. Further studies are necessary to understand the ecological significance of floodplains to steelhead.

**Factors Affecting Abundance**

The decline in steelhead populations is attributable to changes in habitat quality and quantity. The availability of steelhead habitat in the Central Valley has been reduced by as much as 95 percent or more as a result of barriers created by the construction of dams (NMFS 1996). Populations of steelhead have been most severely affected by dams blocking access to the headwaters of all major tributaries; consequently, most runs are maintained through artificial production. The decline of naturally produced steelhead has been more precipitous than that of the hatchery stocks. Populations in the southern portion of the range have experienced the most severe declines, particularly in streams from California's Central Valley and south (61 FR 41541). Other factors contributing to the decline of the Central Valley steelhead in the Central Valley are mining, agriculture, urbanization, logging, harvest, hatchery influences, flow management (including reservoir operations), hydropower generation, and water diversion and extraction (NMFS 1996).

## Green Sturgeon (*Acipenser medirostris*)

### Status

The green sturgeon was determined by NMFS to be composed of two populations, a northern and southern DPS (NMFS 2003). The northern DPS includes populations extending from the Eel River northward, and the southern DPS includes populations from the Eel River south to the Sacramento River. The Sacramento River supports the southernmost spawning population of green sturgeon (Moyle 2002). On April 6, 2005, NMFS determined that the northern green sturgeon DPS did not warrant listing under the ESA, but remains on the Species of Concern List (70 FR 17386). The southern green sturgeon DPS was listed as threatened under the Federal ESA on April 7, 2006 (NMFS 2006). Currently, the NMFS is soliciting information that may be relevant to protective regulations and to the designation of critical habitat for the southern green sturgeon DPS. Results would be published in subsequent Federal Register notices.

Green sturgeons were classified as a Class 1 Species of Special Concern by the CDFG in 1995 (Moyle et al. 1995). Class 1 Species of Special Concern are those that conform to the California State definitions of threatened or endangered as stated in the CESA, and could qualify for addition to the official list. On March 20, 2006, emergency green sturgeon regulations were put into effect by the CDFG which require a year round zero (0) bag limit of green sturgeon in all areas of the State (CDFG 2006).

### Life History

The green sturgeon is anadromous, and is the most marine-oriented of the sturgeon species and has been found in near-shore marine waters from Mexico to the Bearing Sea (70 FR 17386). The northern green sturgeon DPS has known spawning populations in the Rogue, Klamath, and Eel Rivers and the southern DPS has a single spawning population in the Sacramento River (NMFS 2005). Adults typically migrate upstream into rivers between late February and late July. Spawning occurs from March to July, with peak spawning occurring from mid-April through mid-June. Green sturgeon are believed to spawn every three to five years, although recent evidence indicates that spawning may be as frequent as every two years (70 FR 17386). Little is known about the specific spawning habitat preferences of the green sturgeon. It is believed that adult green sturgeon broadcast their eggs in deep, fast water over large cobble substrate where the eggs settle into the interstitial spaces (Moyle 2002). Spawning is generally associated with water temperatures from 40 to 57°F. In the Central Valley, spawning occurs in the Sacramento River upstream of Hamilton City, perhaps as far upstream as Keswick Dam (Adams et al. 2002), and possibly in the lower Feather River (Moyle 2002).

Green sturgeon eggs hatch in approximately 8 days at 55°F (Moyle 2002). Larvae begin feeding 10 days after hatching. Metamorphosis to the juvenile stage is complete within 45 days of hatching. Juveniles spend one to four years in fresh water and estuarine water before migrating to salt water at body lengths of 300 to 750 mm (70 FR 17386).

Little is known about movements, habitat use, and feeding habits of his species. Green sturgeons have been salvaged at the State and Federal fish collection facilities in every month, indicating that they are present in the Delta year-round. Juveniles and adults are reported to feed on benthic invertebrates, including shrimp, amphipods, and small fish (70 FR 17386).

### Factors Affecting Abundance

The historical decline of the southern green sturgeon DPS has been attributed largely to the reduction of spawning habitat area. Keswick and Shasta Dams on the Sacramento River and Oroville Dam on the Feather River are impassable barriers that prevent green sturgeon from accessing what were likely historical spawning grounds upstream of these dams. Other potential migration barriers or impediments include the Red Bluff Diversion Dam, the Sacramento Deep Water Ship Channel locks, the Fremont Weir, Sutter Bypass, and the Delta Cross Channel (DCC) in the Sacramento River, and Shanghai Bench and Sunset Pumps on the Feather River. Other factors that have been identified as potential threats to the green sturgeon include reductions in freshwater outflow in the Delta during larval dispersal and rearing, high water temperatures during spawning and incubation, entrainment by water diversions, poaching, contaminants, predation and other impacts by introduced species (70 FR 17386).

## ENVIRONMENTAL BASELINE AND CUMULATIVE EFFECTS

### Environmental Baseline, taken from NMFS (2008) Draft Jeopardy Opinion for OCAP.

The development of the water conveyance system in the Delta has resulted in the construction of armored, rip-rapped levees on 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 affected spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat. As Mount (1995) indicates, there is an "underlying, fundamental conflict inherent in this channelization." Natural rivers strive to achieve dynamic equilibrium to handle a watersheds supply of discharge and sediment (Mount 1995). The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects.

Many of these levees use angular rock (rip rap) to armor the bank from erosive forces. The effects of channelization, and rip rapping, 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 to escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

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

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

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

Dredging of river channels to enhance inland maritime trade and to provide raw material for levee construction has significantly and detrimentally altered the natural hydrology and function of the river systems in the Central Valley. Starting in the mid-1800s, the Corps and other private consortiums began straightening river channels and artificially deepening them to enhance shipping commerce. This has led to declines in the natural meandering of river channels and the formation of pool and riffle segments. The deepening of channels beyond their natural depth also has led to a significant alteration in the transport of bedload in the riverine system as well as the local flow velocity in the channel (Mount 1995).

The Sacramento Flood Control Project at the turn of the nineteenth century ushered in the start of large scale Corps actions in the Delta and along the rivers of California for reclamation and flood control. The creation of levees and the deep shipping channels reduced the natural tendency of the San Joaquin and Sacramento Rivers to create floodplains along their banks with seasonal inundations during the wet winter season and the spring snow melt periods. These annual inundations provided necessary habitat for rearing and foraging of juvenile native fish that evolved with this flooding process. The armored rip rapped levee banks and active maintenance actions of Reclamation Districts precluded the establishment of ecologically important riparian vegetation, introduction of valuable LWD from these riparian corridors, and the productive intertidal mudflats characteristic of the undisturbed Delta habitat.

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

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

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

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

**Cumulative Effects**

The Corps is undertaking the Sacramento River Bank Protection Project (Sac Bank) in the vicinity of many of the project areas. The effects of the Sac Bank are mitigated for under the conditions provided in the Environmental Impact Statement for the project. The cumulated effects of these projects are not expected to negatively affect the listed anadromous fish species in the project area as each project will either have a no effect determination for listed species or is mitigating for consequences to the listed species.

A number of activities may occur in the project area that may indirectly affect listed anadromous fish species in the project area. State agencies may repair roads in the project areas, the RDs may conduct maintenance measures and private citizens may fish in the project areas. The impacts from these potential actions are difficult of measure. PL 84-99 does not authorize the Corps to determine the effects of actions from these elusive sources.

**Special Status Fish Species**

*Short-term construction-related effects*

Short-term effects also consider the potential occurrence of listed species and life stages relative to the location, magnitude, timed, frequency, and duration of project activities. All construction will be conducted within the specified construction windows for each area and so will not likely impact the species. Minimal removal of habitat during the construction process should not affect special-status salmonids. Additionally all willow pole cutting will be placed immediately after construction finishes so will begin to add habitat right away.

Toxic substances used on construction sites, including gasoline, lubricants, and other petroleum-based products could enter the water as a result of spills or leakage from machinery or storage containers. These substances can kill aquatic organisms through exposure to lethal concentrations or exposure to non-lethal levels that cause physiological stress and increase susceptibility to other sources of mortality. With implementation of the conservation measures listed above, exposure of aquatic species to toxic substances did not occur as a result of project activities.

*Long-term effects on habitat*

Long-term species habitat attributes affected by construction activities include increased rearing habitat area and quality and migration habitat conditions. Project effects on habitat for rearing and out migrating salmon and steelhead include increased in stream and overhead cover and improved substrate conditions along the seasonal low- and high- flow shorelines at the project sites.

The Corps will plant willows (*Salix spp.*) along the toe of the waterside levee slope at all the project areas on the Sacramento Main Stem River and the Yolo Bypass for the entire length of the sites. Pole cuttings would be gathered from shrubs near the project area. The willows would be planted six feet apart in two off set rows which are two feet apart for the length of each site. The Corps will not water the willow pole cuttings as they would be planted using the stinger method (Appendix C) along the toe of the levee just prior to the beginning of the rainy season, thus reaching the water table and providing a water source for the cuttings. The Corps is using a very conservative estimate of eventual 30 percent cover for the willow pole cuttings. However, this amount may actually be greater as seen in the demonstration site (Appendix H). The Corps would not replace pole cuttings that die because the loss of the occasional pole cutting is not expected to have a negative effect on the SRA. If one pole cutting were to die the surrounding pole cuttings are expected to grow large enough to fill in the area left by the pole cutting that died and still provide a continuous stretch of SRA. The Corps would implement an inspection of a random sample of the project sites included in this BA to assess vegetation establishment, survivability rates and to determine percent of SRA provided by the plantings. These random surveys would be implemented for the first five years after the levee repairs are completed and the plants are planted. The Corps proposes to plant the willow pole cuttings in mid-December to mid-January to ensure greater survivability of the pole cuttings. However, if it is not possible to work outside of the regular construction window of August 1 to September 30, survival success would be greatly reduced.

Implementation of the project would result in increased SRA habitat. This increase is due to willow pole cuttings being planted on the water side of all sites including many areas where there is no SRA present at this time. Many of these project sites currently only have grasses along the bank and are completely void of any SRA. Willows are being planted where no vegetation is placed along the fast moving Sacramento and San Joaquin river system so some slowing of the current is expected. This will result in some deposition of sediments and in turn will improve surrounding potential habitat areas and encourage riparian vegetation recruitment in the area. While this will not re-establish the once vast flood plains of the historic Sacramento and San Joaquin River Valleys, it will enhance the current conditions found in the mostly barren Lower Sacramento and San Joaquin Rivers.

The changes in habitat values to salmonids resulting from project construction were modeled using the SAM (Appendix E). All sites had no negative impact to salmonids. The results are broken down by RD as follows:

- RD 3. For all salmonids adult migration, juvenile rearing, smolt out migration, and steelhead adult habitat all seasons showed an increase in habitat values. The exceptions being summer smolt migration for salmon and steelhead and fall smolt outmigration for steelhead. This value remained the same and was neither negative nor positive. This is due to the low water levels during that time of year which reduces the amount of instream vegetation (IV). These results illustrate that there is no negative effect to these species and in fact an over all increase of habitat.

- RD 17. For all salmonids adult migration, juvenile rearing and smolt out migration and steelhead adult habitat all seasons showed an increase in habitat values. The exceptions being summer smolt migration for salmon and steelhead and fall smolt outmigration for steelhead. This value remained the same and was neither negative nor positive. This is due to the low water levels during that time of year which reduces the amount of IV. These results illustrate that there is no negative effect to these species and in fact an over all increase of habitat.

- RD 551/755. For all salmonids adult migration, juvenile rearing and smolt out migration, and steelhead adult habitat all seasons showed a significant increase in habitat values. The exceptions being summer smolt outmigration for salmon and steelhead and fall smolt outmigration for steelhead. This value remained the same and was neither negative nor positive. This is due to the low water levels during that time of year which reduces the amount of IV. These results illustrate that there is no negative effect to these species and in fact an over all increase of habitat.

- RD 765. Values for all Salmonids in all seasons show an initial decrease in value and then a slight increase of habitat values, with two exceptions. These being area weighted responses for both salmonid species in all categories except as was seen before in summer smolt outmigration for the salmonids and fall smolt outmigration for steelhead. Additionally spring adult upstream migration for steelhead remained the same.

- RD 785. For all salmonids adult migration, juvenile rearing and smolt out migration and steelhead adult habitat all seasons showed an increase in habitat values. The exceptions being summer smolt migration for salmon and steelhead and fall smolt outmigration for steelhead. This value remained the same and was neither negative nor positive. This is due to the low water levels during that time of year which reduces the amount of IV. These results illustrate that there is no negative effect to these species and in fact an over all increase of habitat.

A total of 23,307 linear feet were disturbed and/or repaired along the water's edge in areas designated as critical habitat for anadromous fish species. Currently grasses dominate most of these sites with some locations supporting large trees and other woody vegetation. Several sites are void of vegetation. All areas disturbed by project activities would be reseeded with native grasses and a total of 7,641 willow pole cuttings would be planted at all the sites to enhance the habitat for both fish and wildlife species. Please see Appendix I for the willow pole cutting break down per RD per site.

**Table 9 – Existing Conditions of Vegetation**

| | |
|---|---|
| Linear footage with NO shaded riverine habitat | 19,200 |
| Linear footage with shaded riverine vegetation that would be trimmed | 273 |
| Linear footage where vegetation removal occurred. Vegetation only provide SRA during high flow events | 0 |
| Linear footage with shaded riverine area but NO vegetation removal would occur | 3834 |

## CONCLUSION

For the combined PL 84-99 sites, the Corps has made a determination of may affect - not likely adversely affect listed species and their designated critical habitat. Planting willow pole cuttings at all of the sites along the Sacramento River and San Joaquin River would result in a net benefit to the species as many of these locations are currently bare of shaded riverine habitat. As seen in Appendix E the SAM analysis supports our determination of may affect not likely to adversely affect as all outputs indicate we will be providing an overall benefit the species habitat in all of our project areas.

## LITERATURE CITED


Adams, P. B., C. B. Grimes, S. T. Lindley, and M. L. Moser. 2002. Status review for North American green sturgeon, *Acipenser medirostris*. NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA.

Bureau of Reclamation. 1986. Central Valley fish and wildlife management study: temperature and flow studies for optimizing Chinook salmon production, Upper Sacramento River, California. Special report. Sacramento, CA.

CDFG. 2006b. Emergency Sturgeon Regulations Will Take Effect on Monday, March 20. News release, March 17. http://www.dfg.ca.gov/news/news06/06030.html

Hallock, R. J. 1987. Sacramento River system salmon and steelhead problems and enhancement opportunities. Report to the California Advisory Committee on Salmon and Steelhead Trout. Sacramento CA. 92 pp.

Hallock, R. J., and F. W. Fisher. 1985. Status of the winter-run Chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento River. (Anadromous Fisheries Branch Office Report.) Sacramento:

McEwan D, Nelson J. 1991. Steelhead restoration plan for the American River. California Department of Fish and Game. 40 pp.

Meehan, W. R., and T. C. Bjornn. 1991. Salmonid distributions and life histories. Pages 47-82 in W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication No. 19, Bethesda, Maryland.

Mills, T. J., and F. Fisher. 1994. *Central Valley anadromous sport fish annual run-size, harvest, and population estimates, 1967 through 1991*. Inland Fisheries Technical Report. California Department of Fish and Game, Sacramento, CA.

Moyle, P. B. 2002. *Inland fishes of California*. 2nd edition. Davis, CA: University of California Press.

NMFS. 1998. *A primer for federal agencies—essential fish habitat: new marine fish habitat conservation mandate for federal agencies*. Habitat Conservation Division, Northeast Regional Office, Gloucester, MA.

NMFS. 2001. Biological opinion for Sacramento River Bank Protection Project, Contract 42E, proposed levee reconstruction at River Mile 149.0, Colusa County, California, and five sites along the mainstem Sacramento River. Sacramento, CA.

NMFS. 2003. 68 FR 4433: Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to List North American Green Sturgeon as a Threatened or Endangered Species. Notice. *Federal Register* 68 pages 4433-4441. January 29, 2003.

NMFS. 2005. Green sturgeon (*Acipenser medirostris*) status review update. NOAA Fisheries, Southwest Fisheries Science Center, Long Beach, CA. 31 pp.

NMFS. 2006. 71 FR 17757: Endangered and Threatened Wildlife and Plants: Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon. Final Rule. *Federal Register* 71 pages 17757-17766. April 7, 2006.

NOAA. 2006. Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead. Federal Register 71: 834-862.

Pacific Fishery Management Council. 2002. Review of 2001 ocean salmon fisheries. Portland, OR.

Slater, D. W. 1963. Winter-run Chinook salmon in the Sacramento River, California, with notes.

USACE. 2000. Biological opinion for the Sacramento River Bank Protection Project, 42E, proposed levee reconstruction at River Mile 149.0, Colusa County, California, and at five other sites along the mainstem Sacramento River. Sacramento, CA.

USFWS (U. S. Fish and Wildlife Service). 1993. Endangered and threatened wildlife and plants; determination of threatened status for the delta smelt. Federal Register 58: 12854-12864.

Vogel, D. A., and K. R. Marine. 1991. Guide to upper Sacramento River Chinook salmon life history. Prepared for the U. S. Bureau of Reclamation, Central Valley Project.

Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the central valley region of California. *North American Journal of Fisheries Management*. 18:487–521.

## CONTACTS, CONTRIBUTERS, AND PREPARERS

For further information regarding the PL 84-99 project and/or this consultation packet, please contact Ms. Elizabeth Holland, Environmental Manager, at (916) 557-6763, or e-mail: elizabeth.g.holland@usace.army.mil or Elif Fehm-Sullivan at (916) 557-7026, or e-mail: elif.e.fehm-sullivan@usace.army.mil. Thank you for your cooperation on this project.

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

JUL 0 2 2008

**In response refer to:**
2007/06163

Francis C. Piccola.
Chief, Planning Division
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814

Dear Mr. Piccola:

This is in response to your letter of August 22, 2007 (received August 29, 2007), requesting initiation of consultation and concurrence from NOAA's National Marine Fisheries Service's (NMFS) for the Public Law (PL) 84-99 Order 3, 4, and 5 Levee Repair project on the Sacramento River, San Joaquin River, and their associated tributaries. You have determined the proposed project may affect, but is not likely to adversely affect Federally listed threatened Central Valley steelhead (*Oncorhynchus mykiss),* endangered Sacramento River winter-run Chinook salmon (*O. tshawytscha* ), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), their designated critical habitat, and the threatened Southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris*). In addition, your office has requested consultation on the impacts of the proposed project to Essential Fish Habitat (EFH) for Pacific salmon pursuant to provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). This letter also serves as consultation under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act of 1934 (FWCA), as amended.

## Consultation History

On October 11, 2007, and March 4, 2008, NMFS sent an insufficiency letter requesting additional information in order to adequately analyze the potential effects of the proposed project. On January 31, 2008, the U.S. Army Corps of Engineers (Crops) responded to our request for additional information. The information was a revised biological assessment with results from the Standard Assessment Method (SAM) model on the effects listed fish species, technical reports, general vegetation, and typical levee design plans.

On March 4, 2008, NMFS sent a letter with a list of comments and request for clarifications on the additional information provided. NMFS and Corps staff met on March 26, 2008, to discuss NMFS concerns. On May 7, 2008, NMFS received a revised biological assessment and a memorandum addressing NMFS' March 4, 2008, letter. NMFS and the Corps corresponded via email between May 12 and June 10, 2008. The discussions in the emails were on the clarification of the project description details (*i.e.*, the reasons behind the changes and discrepancy in the project description, compliance reports from the previous construction activities, planting methodology, design specs, maintenance, and monitoring plans).

On June 5 and 24, 2008, NMFS received sufficient information to continue reviewing the projects and the section 7 formal consultation. The information received was the following:

- Memorandum addressing NMFS' request on the compliance reports for Order 1 and 2 levee repair projects and the commitment to purchase conservation banking credits for the temporal impacts resulting from the construction for Order 1 and 2 levee repairs.

- Reference materials (*i.e.*, brochure, specs, reports, and planting plans, etc.) on the planting technique to be conducted for the willow pole cuttings and report of the success rate. The reference materials demonstrate and verify that the proposed planting techniques would be sufficient with no need to irrigate.

- Commitment to monitor the sites for the next five years to ensure the establishment of willow plants.

- A detailed explanation of the substrate size (D50) along the banks.

Project Description

The Corps proposes to use the PL 84-99 authority to repair levees along Steamboat Slough and Sacramento River at Reclamation District (RD) 3; Natomas Cross Canal and Yankee Slough at RD 1001; Middle Creek at Maintenance Area (MA) 17; the Sacramento River at RD 900; Elder Creek and Deer Creek at Tehema County; the Sacramento River at RD 551; the Yolo Bypass at RD 827 and RD 785; and the Sacramento River at MA1 and the East Levee of the Sacramento River (referred to as Levee District (LD) 3) in Colusa County. The repairs sites are classified as Order 3, 4, and 5 and are described as small slides on the levee slope, wave-washed less than five feet, loss of riprap and erosion into the levee slope and tow, vertical cut banks less than ten feet, and minor damages. The repairs sites at RD 827, RD 900, LD 3, MA 1 and MA 17 are either on the landside of the levee or on the waterside and away from the main stream, which are not considered as part of the consultation.

A total of 29 repair sites at RD 3 along Steamboat Slough (9) and the Sacramento River (20) would be repaired. Steamboat Slough has 3,693 feet of intermittent slope erosion above the existing rock protection. Damages to the Sacramento River levees consist of 5,870 feet of intermittent slope erosion above the existing rock protection. The damages depth varies from 1 to 5 feet and extends between 55 and 855 feet long. The majority of the levee slope repair site is vegetated with horsetails. The only woody vegetation found at most sites is small, shrubby native trees that grow along the toe of the levee approximately two to three feet from the water's edge. Few of the repair sites have mature trees growing along the upper levee slope, some of which would be trimmed and/or removed.

RD 551 and 755 would have a total of 15 repair sites. The Sacramento River at RD 551 has 10 repair sites, totaling 3,567 feet of intermittent erosion and RD 755 would have 5 repair sites with a total of 900 feet of intermittent erosion repair. The damages have been caused primarily by wave-wash, with the depth of erosion varying from 2 to 4 feet and extending between 4.4 and 723-feet. The waterside levee slopes at the majority of the repairs sites at RD 551 and RD 755 are dominated primarily by nonnative grasses and forbs. The lower half of the slope consists of riprap with sparse to no vegetation. Only a couple of sites have woody vegetation existing, which would require trimming and removal of shrubs.

The damages at RD 785 are along the Yolo Bypass and total 3,956 feet of wave-wash erosion. The southern portion of the levee has 2,494 feet of wave-wash erosion along the upper levee slope. The northern portion of the levee has 1,462 feet of toe erosion above the existing natural bench and wave-wash along the upper levee slope. The repairs to the upper levee slope would consist of excavating the damaged surface and backfilling the excavated area with compacted levee fill. The repaired area would be graded to match the existing levee slope of the surrounding levee. The northern reach of the site would be repaired by excavating the damaged levee slope above the existing natural toe bench. The excavated waterside slope would be backfilled with compacted impervious fill and graded to match the surrounding levee slope. Herbaceous and woody vegetation growing along the natural toe bench would be avoided by construction activities and no trees would be removed. The repairs along the lower slope of the levee would occur between the dripline of the trees on the lower slope. Common tule and cattail would be planted along the natural toe of the levee at the northern portion of the site. The planting ratio for common tule and cattail would be 3:1 with plants being planted every 3 feet.

A total of 13 repair sites at RD 1001 along the Natomas Cross Canal (7) and Yankee Slough (5) would be repaired. The Natomas Cross Canal has 2,880 feet of intermittent wave-wash erosion. The damage depth varies from 1 to 8 feet and extends between 50 and 620 feet. The Yankee Slough repair sites are 950 feet at the toe and along the levee slope. The damage depth varies from 5 to 10 and extends from 45 to 280 feet in length. Repair sites in the Natomas Cross Canal and Yankee Slough are dominated by grasses, forbs, and other herbaceous vegetation. Willows, oaks, and cottonwoods are found along the water's edge and on the lower bench of Yankee Slough. Some trees and shrubs growing in the erosion pocket would be removed or trimmed.

The levee on Deer Creek and Elder Creek are part of the Tehema County Flood Control Project. The Deer Creek repair site is 420 feet, and the Elder Creek repair site is 175 feet. Both are damaged by wave-wash. The levee slope rock protection in Deer Creek eroded one to eight feet along the slope. The downstream end of the damaged site has a low berm that extends along the bank of the creek further downstream. A 10-foot long section of the levee slope rock protection eroded and impacted the levee slope transitions into the berm. Both Deer Creek and Elder Creek are dominated by grasses, forbs, and other herbaceous vegetation. No trimming or removal of vegetation established on the rock bar would be conducted in Deer Creek. No large willow trees, alders, or other woody riparian vegetation would be removed or trimmed in Elder Creek. Only small shrubs would be removed.

In summary, the total of length of the repairs for the proposed project is 23,873 linear feet (lf). The repair sites at RD 785 (3,956 lf), RD 1001 along the Natomas Cross Canal (2,880 lf), and Elder Creek (175 lf) would have no woody vegetation removal or trimming. Thus, a total of 16,862 lf in the other repair sites would have the potential of disturbance of woody vegetation (RD 3, RD 551/755, RD 1001 at Yankee Slough, and Deer Creek in Tehama County). Out of the 16,862 lf, the total linear footage with no shaded riverine aquatic (SRA) habitat is 14,504. Approximately 273 linear feet of woody riparian vegetation would be trimmed and 825 lf of woody riparian vegetation located on the upper slope of the levee would be removed. A total of 2,358 lf of SRA would be impacted.

To ensure that listed salmonids would not be affected by the repair, the SAM analysis was conducted and the levee repair designs were modified to minimize the impacts to listed species. The typical levee repair design consists of placing an 18-inch layer of stone material over a 6-inch layer of bedding material. The stone material is 15-inch minus rock filled with 4-inch minus rock. Three rows of willow pole cuttings spaced in two foot centers would be planted along the full linear footage of each repair site. The bottom row would be located at the average summer waterline. A total of 16,862 lf would be disturbed and repaired along the water's edge. All areas disturbed by project activities would be reseeded with native grasses, and a total of 12,284 pole cuttings would be planted.

The construction activities are scheduled from July 1 to October 31, 2008. All repair sites would be constructed from either the waterside or the landside of the levee. Conservation measures and Best Management Practices (BMPs) for erosion control and water quality as listed in the biological assessment would be implemented. To ensure the riparian vegetation becomes fully established and meets the expected success criteria of the SAM without irrigating the repair sites, the Corps plans to follow the U.S. Department of Agriculture – Natural Resource Conservation Service (USDA-NRCS) manual for the planting willow poles and use the stinger mechanical planting system to plant willows through the riprap and into the water table.

Endangered Species Act (ESA) Section 7 Consultation

NMFS has received the information necessary to initiate consultation on Federally listed anadromous fish species within the proposed action area. Based on our review of the material provided with your request and the best scientific and commercial information currently available, NMFS concurs that the proposed PL 84-99 Order 3, 4, and 5 Levee Repairs on the Sacramento River and their associated tributaries is not likely to adversely affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, their designated critical habitat, or North American green sturgeon. NMFS reached this determination for the following reasons:

1. Construction activities would occur from the landside or waterside of the levee, during the time period when listed salmon, steelhead and green sturgeon are least likely to occur within the action area. Adult salmonids and green sturgeon would be expected to have migrated pass the repair sites into the upper reaches of the Sacramento River and its tributaries by the time construction activities are scheduled to begin, and most juveniles would be expected to be rearing in more suitable cold-water reaches upstream of the repair sites during the proposed work window;

2. The levee repair incorporated the use of 4-inch minus rocks between the 18-inch minus rocks to prevent the creation of predator habitat. The 4-inch minus rocks would fill the voids between the 18-inch minus rocks. Based on SAM modeling, the use of rocks greater than 12-inches would provide habitat for predators for listed species. However, as explained in the Corps' April 23, 2008, letter, the 18-inch and 4-inch minus rocks would have a mixture of smaller rocks that average 12-inches and 2-inches, respectively. The composition would be 75 percent 12-inch and 25 percent 2-inch rocks. This averages the D50 value of 10, which was used in the SAM analysis; thus, reflecting no significant impacts to listed species.

3. The levee repair designs incorporate willow pole plantings to improve and enhance the existing SRA habitat, and to act as refugia for juvenile salmonids and green sturgeon during migration. Based on the biological assessment, out of the 23,873 lf that would be repaired, 16,862 lf would have repairs along the water's edge in areas designated as critical habitat. The existing condition of the 16,862 lf is 35 percent SRA and 65 percent devoid of SRA. Approximately 11percent of the existing SRA would be trimmed, and 43 percent of the

existing SRA would be removed. To compensate for the removal and trimming of SRA, the Corps plans to plant a total of 12,284 willow pole cuttings along the summer watерline to cover the full length of each repair sites, thus covering 100 percent of the shoreline.

4. The Corps modified their planting technique for willow pole cuttings to ensure 80-95 percent success rate, since the PL 84-99 Authority does not allow funding for maintenance. The Corps agreed to follow the USDA-NRCS Technical Note: *How to Plant Willows and Cottonwoods for Riparian Restoration.* The willow pole cuttings would be prepared according to the reference and each pole cutting would be driven into the riprap at least five feet and until the pole reaches the water table. The Stinger mechanical planting system would be used to drive the poles. At least two thirds of willow pole length would be buried with soil around the pole. The technique has resulted to 80 percent success after the first year and has been used for bank stabilization projects in the Trinity River and riparian restoration projects along the Merced River in California.

5. Conservation measures to minimize impacts to listed species and BMPs to prevent sedimentation and turbidity during the construction activities would be implemented.

This concludes ESA section 7 consultation for the proposed action. This concurrence does not provide incidental take authorization pursuant to section 7(b)(4) and section 7(o)(2) of the ESA. Reinitiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) 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; (2) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered; or (3) a new species is listed or critical habitat designated that may be affected by the action.

EFH Consultation

With regards to EFH consultation, the proposed project area has been identified as EFH for all races of Central Valley Chinook salmon (*O. tshawytscha*), including the fall-/late-fall-run in Amendment 14 of the Pacific Salmon Fishery Management Plan pursuant to the MSA. Federal action agencies are mandated by the MSA [section 305(b)(2)] to consult with NMFS on all actions that may adversely affect EFH, and NMFS must provide EFH conservation recommendations to those agencies [section 305(b)(4)(A)]. Because the proposed action would implement conservation measures which are expected to avoid adverse impacts to Central Valley fall/late fall-run Chinook, additional EFH Conservation Recommendations are not being provided at this time; however, if there is substantial revision to the action, the lead Federal agency will need to re-initiate EFH consultation.

FWCA

The purpose of the FWCA is to ensure that wildlife conservation receives equal consideration and is coordinated with other aspects of water resources development [16 U.S.C. 661]. The FWCA establishes a consultation requirement for Federal departments and agencies that undertake any action that proposes to modify any stream or other body of water for any purpose, including navigation and drainage [16 U.S.C 662(a)]. Consistent with this consultation requirement, NMFS provides recommendations and comments to Federal action agencies for the purpose of conserving fish and wildlife resources. The FWCA allows the opportunity to offer recommendations for the conservation of species and habitats beyond those currently managed under the ESA and MSA.

Because the proposed project is designed to avoid and minimize environmental impacts to aquatic habitat within the action area and improve the condition of riparian vegetation over the long term, NMFS has no additional FWCA comments to provide.

Please contact Madelyn T. Martinez at (916) 930-3605, or via e-mail at Madelyn.Martinez@noaa.gov, if you have any questions concerning this project, or require additional information.

Sincerely,

Rodney R. McInnis
Regional Administrator

cc: Copy to file – ARN 151422SWR2008SA00108
NMFS-PRD, Long Beach, CA
Tanis Toland and Elif Femme-Sullivan, U.S. Army Corps of Engineers, Sacramento District, Planning Division, 1325 J Street, Sacramento, CA 95814
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UNITED STATES DEPARTMENT OF COMMERCE
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NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

January 20, 2009

In response refer to:
2008/07791

Francis Piccola
Chief, Planning Division
U.S. Army Engineer District, Sacramento
1325 J Street
Sacramento, California 95814-2922

Dear Mr. Piccola:

This letter is intended to inform the U.S. Army Corps of Engineers (Corps) that NOAA's National Marine Fisheries Service's (NMFS) is withdrawing our concurrence with your determination that the proposed levee repairs listed under Order 3, 4, and 5, on Reclamation District (RD) 765, and RD 17 to be conducted under the Public Law (PL) 84-99 authority would be "not likely to adversely affect" 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*), the threatened Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*), and their designated and proposed 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.*). NMFS has determined that your proposed modifications to the project description would be likely to result in adverse affects to these species and habitats.

Consultation History

On July 11, and August 22, 2007, and June 24, 2008, the Corps initiated formal consultation with NMFS for levee repairs under the PL 84-99 authority on RD 17, several sites listed under Order 3, 4, and 5, and on RD 765, respectively.

On October 11, 2007, and March 4, 2008, NMFS sent an insufficiency letter requesting additional information necessary to adequately analyze the potential effects of the proposed project. On January 31, 2008, the U.S. Army Corps of Engineers (Crops) responded to our request for additional information. The information provided was a revised biological assessment with results from the Standard Assessment Method (SAM) model on the effects listed fish species, technical reports, general vegetation, and typical levee design plans.

On March 4, 2008, NMFS sent a letter with a list of comments and a request for clarifications on the additional information provided. NMFS and Corps staff met on March 26, 2008, to discuss

NMFS concerns and the Corps' limits to the PL 84-99 authority. NMFS concern was the persistence of the Corps repairing erosion sites with riprap and without vegetating the repair sites, resulting in the continued degradation of critical habitat in the San Joaquin and Sacramento Rivers, and their tributaries. The Corps stated that under PL 84-99 authority, the Corps is limited to just repairing a site and not allowed to maintain or monitor any riparian plantings. Additionally, the Corps stated their concern over not obtaining a biological opinion or concurrence letter before the end of the inwater work window for this year, which could result in the loss of funding under the PL 84-99. In order to work within the Corps' limits under the PL84-99 authority, and to avoid adverse impacts to Federally listed species under NMFS' purview, both the Corps and NMFS staff agreed to find avenues and techniques to address each others concerns and limitations.

On May 7, 2008, NMFS received a revised biological assessment and a memorandum addressing NMFS' March 4, 2008, letter. NMFS and the Corps corresponded via email between May 12 and June 10, 2008. The discussions in the emails concerned clarification of the project description details (*i.e.*, the reasons behind the changes and discrepancies in the project description, compliance reports from the previous construction activities, planting methodology, design specs, maintenance, and monitoring plans).

On June 5 and 24, 2008, NMFS received sufficient information to continue reviewing the projects and the section 7 formal consultation. The information received was the following:

- Memorandum addressing NMFS' request on the compliance reports for Order 1 and 2 levee repair projects and the commitment to purchase conservation banking credits for the temporal impacts resulting from the construction for Order 1 and 2 levee repairs.

- Reference materials (*i.e.*, brochure, specs, reports, and planting plans, etc.) on the planting technique to be used for the willow pole cuttings and report of the success rate. The reference materials demonstrate and verify that the proposed planting techniques would be sufficient with no need to irrigate.

- Commitment to monitor the sites for the next five years to ensure the establishment of willow plants.

- A detailed explanation of the substrate size (D50) along the banks.

On July 2, and 24, 2008, and August 8, 2008, NMFS issued concurrence letters for these repairs. NMFS found the changes and the final project description addressed NMFS' concern, was within the limits of PL 84-99 authority, and allowed the Corps' Sacramento District to keep the PL 84-99 funding. NMFS review and analysis of these final project descriptions ultimately lead to a determination that the proposed projects "may affect, but are not likely to adversely affect" Federally listed species under NMFS' purview. Thus, the Corps received their concurrence letter on time to keep their PL 84-99 funding and start their construction activities.

Project Description Modification

After the levees were repaired, NMFS received an email from the Corps on October 10, 2008, requesting changes in the project description. The changes requested are listed below:

1. The Corps requests that the willow pole cuttings specifications be changed from 3 rows of willows 3 feet apart for the entire site to 2 rows of willows 6 feet apart for the entire site. In addition, the Corps proposes taking the number of willows from the third row and planting them up or down stream of the repair site (real estate easements must be obtained). The rationale for this is as follows; per the demonstration, three rows of willows planted with the stinger will negate the conservation measure of placing the 3-inch minus over the 16 -18 inch minus rock, as the 3 inch rock will move underneath the larger rock. The stability of the new rock face would be greatly decreased by both the stinger's puncturing action and the fact that 3 inch minus rock will move underneath the larger rocks. Additionally, the third row of willows is not guaranteed to grow as not all polls are able to contact the mud underneath the rock face. Finally over crowding of the willows will result in smaller plants with slower growth as was the case for the Tules over planted in the previous Sac Bank ditches.

2. The Corps requests that mulching be used on RD 17 instead of hydroseeding for the upper slope that has no effect or impact on aquatic species as was agreed to on RD 551/755. We are requesting this due to the fact that the RD has sprayed several agricultural strength pre-emergent herbicides of unknown quantity on both the land side and water side of the levee. Any seed planted at this time will be less likely to germinate. At the same time we need to have some sort of erosion control in place so all of the disturbed areas on the upper slope do not erode into the stream this winter season causing extremely poor water quality.

NMFS Initial Analysis of the Changes

NMFS recognizes that structural integrity and timely completion of the projects are important for public safety. In the last 2 years, NMFS staff has worked hard to coordinate with your staff to accommodate the Corps' limitation under the PL 84-99 authority while still addressing NMFS concerns on Federally listed species to insure that the Corps activities remain in compliance with the ESA. Unfortunately, after conducting our analysis of these last minute changes to the project description and conferring with your staff in an attempt to find avenues and solutions to minimize the impacts to listed species, we find that these changes constitute new information that reveals effects of the action that would adversely affect listed species and/or critical habitat in a manner and to an extent not previously considered in our initial analysis of the proposed project. As stated in our concurrence letters dated July 2, and 24, 2008, and August 8, 2008, under these circumstances the Corps is required to re-initiate consultation for these projects. Until a formal consultation is initiated and a biological opinion is issued, the Corps does not have incidental take authorization pursuant to section 7(b)(4) and section 7(o)(2) of the ESA. In addition, you should be aware that any incidental take of listed species that may occur during the course of construction activities of the proposed project is not exempt from section 9 of the ESA.

We look forward to your letter reinitiating consultation. If you have any questions regarding this correspondence please contact Ms. Madelyn Martinez in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814. Ms. Martinez may be reached by telephone at (916) 930-3605 and by email at Madelyn.Martinez@noaa.gov.

Sincerely,

for Rodney R. McInnis
Regional Administrator

Cc: Copy to file – ARN 151422SWR2006SA00488
NMFS-PRD, Long Beach, CA
Don Tanner, NOAA Fisheries Office of Law Enforcement, Sacramento Field Office
Corps: Elif.E.Fehm-Sullivan@spk01.usace.army.mil and
Tanis.J.Toland@usace.army.mil
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**DEPARTMENT OF THE ARMY**
**U.S ARMY ENGINEER DISTRICT, SACRAMENTO**
**CORPS OF ENGINEERS**
**1325 J STREET**
**SACRAMENTO, CALIFORNIA 95814-2922**

Environmental Resources Branch

MAY 18 2009

Mr. Rodney R. McInnis
Regional Administrator
National Marine Fisheries Service
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802

Dear Mr. McInnis:

This letter is in response to your letter dated January 20, 2009 (2008/07791) withdrawing your concurrence of not likely to adversely affect for all Public Law 84-99 Order 3, 4, and 5 sites included in the large package consultation of January 31, 2008, the Reclamation District (RD) 765 consultation, and the RD 17 consultation. Your decision was based on a change in project description and was in response to our request for initiation of formal consultation of our revised Biological Assessment (enclosure) for these projects.

We are requesting initiation of formal consultation for the Federally listed green sturgeon (*Acipenser medirostris*), Central Valley steelhead (*O. mykiss*), Central Valley winter-run chinook salmon (*O. tshawytscha*), and Central Valley spring-run chinook salmon (*O. tshawytscha*) under Section 7 of the Endangered Species Act (ESA) (16 U.S.C. 1536[c]) and the Magnuson–Stevens Fishery Conservation Act (Public Law 94-541) for proposed levee work on Steamboat Slough and the Sacramento River in RD 3; the San Joaquin River in RD 17; and the Sacramento River in RD 551, RD 755, RD 765; the Yolo Bypass in RD 785; and Yankee Slough in RD 1001.

We have determined, based on the availability of habitat, that the listed green sturgeon, Central Valley steelhead, Central Valley winter-run chinook salmon, and Central Valley spring-run chinook salmon have the potential to occur in the project area. The Corps has conducted field surveys in conjunction with NMFS and has found that there would be no negative effects on the listed species as a result of project activities.

If you have any questions or need additional information, please contact Ms. Elif Fehm-Sullivan, Fisheries Biologist, Environmental Resources Branch, at (916) 557-7026, e-mail: elif.e.fehm-sullivan@usace.army.mil. Thank you for your attention to this matter.

Sincerely,

Frank C. Piccola
Chief, Planning Division

Enclosure

Copy Furnished:
Madelyn Martinez, National Marine Fisheries Service, 6550 Capitol Mall, Suite 8-300, Sacramento, California 95814-4706

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Sacramento Area Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814-4706

JUL 2 9 2009

Francis C. Piccola
Chief, Planning Division
U.S. Army Corps of Engineers
1325 J Street, Suite 1480
Sacramento, California 95814

Dear Mr. Piccola:

This letter acknowledges NOAA's National Marine Fisheries Service's (NMFS), receipt of your May 18, 2009, letter requesting to initiate section 7 formal consultation under the Endangered Species Act for all Order 3, 4, and 5 levee repairs under Public Law (PL) 84-99 authority. The levee repair sites are along Steamboat Slough and the Sacramento River in Reclamation District (RD) 2; the San Joaquin River in RD 17; the Sacramento River in RD 551 and RD 755; the Yolo Bypass in RD 785; and the Natomas Cross Canal and Yankee Slough in RD 1001. The consultation concerns the possible effects of the proposed project on the Federally listed threatened Central Valley steelhead (*Oncorhynchus mykiss*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), endangered Sacramento River winter-run Chinook salmon (*O. tshawytscha*), and their designated critical and essential fish habitat. The consultation also addresses the possible effects of the proposed project on the Federally listed threatened Southern Distinct Population Segment of the North American green sturgeon (*Acipenser medirostris*) and their proposed critical habitat.

Your request for formal consultation was received on May 19, 2009. In general, the levee work would involve excavating the damaged areas and then reconstructing the levees to their pre-flood condition. Approximately 28,000 linear feet of levees would be repaired. The sites would be constructed either from the waterside or from the landside using a barge or heavy equipment. All sites would be planted with willows six feet apart in off center rows along the mean summer water level, during the fall or winter months of 2009. A "stinger" planting apparatus located on a large platform boat on the waterside of the levee would be used to plant the willows.

All information necessary to initiate consultation was either included with your letter and initiation package or can otherwise be obtained during consultation for our consideration and reference. Formal consultation was subsequently initiated by NMFS on May 18, 2009. We have assigned project tracking number 2009/02832 to this consultation. Please refer to that number in future correspondence on this consultation.

The regulations pertaining to formal section 7 consultation are described in 50 CFR § 402.14. Pursuant to these regulations, NMFS has up to 90 calendar days to conclude formal consultation with your agency and an additional 45 calendar days to prepare our biological opinion (unless we mutually agree to an extension). Following this schedule, NMFS would expect to provide you with our biological opinion no later than October 10, 2009. However, you have requested that NMFS issue the biological opinion in less than 135 days so that the preparation of the contracts for the action can begin in June and be awarded before July 2009 so construction can begin during low flows conditions. While it is obviously too late to issue the opinion in June, NMFS recognizes the need to prepare the contracts and construct during low flow conditions and will make every attempt to issue the biological opinion on an expedited timeline.

Please contact Madelyn Martinez at (916) 930-3605, or via e-mail at Madelyn.Martinez@noaa.gov if you have any questions about this project or need additional information.

Sincerely,

Maria Rea
Supervisor, Sacramento Area Office

cc: Copy to file – ARN 151422SWR2009SA00195
NMFS-PRD, Long Beach, California
USACOE: Paige.Caldwell@usace.army.mil, Elizabeth.G.Holland@usace.army.mil, Elif.E.Fehm-Sullivan@usace.army.mil

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

In response refer to:
2009/01912

AUG 18 2009

Francis C. Piccola
Chief, Planning Division
U.S. Army Engineer District, Sacramento
1325 J Street
Sacramento, California 95814-2922

Dear Mr. Piccola:

This document transmits NOAA's National Marine Fisheries Service's (NMFS) biological and conference opinion (Enclosure 1) based on our review of the U.S. Army Corps of Engineers (Corps) proposed Steamboat Slough Public Law (PL) 84-99 Levee Repairs 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 and conference 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*) and their proposed critical habitat.

The proposed levee repairs are being performed 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. The Governor later signed Executive Order S-18-06, directing the California Department of Water Resources to identify and repair eroded levee sites on the State/Federal levee system to prevent catastrophic flooding and loss of life. The 18 sites identified in the Steamboat Slough Levee Repair Project are eligible for PL 84-99 Rehabilitation Assistance and are part of the State of California's highest priority for emergency repairs.

This biological and conference opinion is based on information provided in the April 2009, *Steamboat Slough Levee Repair Project, Sacramento County, California Biological Assessment,* and the April 2009 *Evaluation of the Steamboat Slough PL 84-99 Emergency Repair Sites, using the Standard Assessment Method*. The biological and conference opinion also is based on design drawings, site visits and discussions held with representatives of NMFS, U.S. Fish and Wildlife Service, the California Department of Fish and Game, and the Corps. 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 and conference opinion concludes that these projects are not likely to jeopardize the above species or adversely modify designated or proposed 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 Steamboat Slough Emergency Levee Repair Project 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 and conference 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 Karen McCartney in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814. Karen McCartney may also be reached by telephone at (916) 930-3615 or by Fax at (916) 930-3629.

Sincerely,

for Rodney R. McInnis
Regional Administrator

Enclosures (2)

cc: Copy to file: 151422SWR2009SA00190
NMFS-PRD, Long Beach, CA
General Manager, The Reclamation Board, 1416 9th Street Sacramento, CA 95833
Doug Weinrich, USFWS, 2800 Cottage Way, Sacramento, CA 95825
Gary Hobgood, CDFG, 1701 Nimbus Road, Suite A, Rancho Cordova, CA 95670
Liz Holland, U.S. Army Corps of Engineers, 1325 J Street, Sacramento, CA 95814-2922

**Enclosure 1**

# BIOLOGICAL AND CONFERENCE OPINION

**ACTION AGENCY**: United States Army Corps of Engineers

**ACTIVITY**: Steamboat Slough Levee Repair Project

**CONSULTATION**
**CONDUCTED BY**: NOAA's National Marine Fisheries Service Southwest Region

**TRACKING NUMBER**: 2009/01912

**DATE ISSUED**: AUG 18 2009

## 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. As a result, 33 critical levee repairs were undertaken between July and November 2006.

On August 25, 2006, the U.S. Army Corps of Engineers (Corps) determined that PL 84-99 Order 1 and 2 sites present an imminent threat to public life and property and authorized immediate emergency levee repair actions.

On September 30, 2006, the California Department of Water Resources (CDWR) determined that the Governor's proclamation encompassed PL 84-99 Order 1 and 2 sites and provided State funding to implement their repairs.

On April 15, 2009, NOAA received a Biological Assessment for the Steamboat Slough Levee Repair Project and a request to initiate formal consultation.

A complete administrative record of this consultation is on file at the NMFS Sacramento Area Office.

## II. DESCRIPTION OF THE PROPOSED ACTION

Between December 28, 2005 and January 9, 2006, the State of California experienced a series of severe storms which damaged many levees within the Corps Sacramento District's boundaries. Water levels increased again in April 2006 and high water remained in some parts of the system until June. Many rivers and streams within the Sacramento and San Joaquin River Basins ran above flood stage during these events, and there were significant erosion and seepage problems with some of the levees. CDWR and/or their maintaining agencies conducted flood fight activities while the Corps worked with the State to restore the levee systems to their pre-storm level of protection. These efforts have been conducted under the authority of PL 84-99, Rehabilitation of Damaged Flood Control Works.

High water stages produced heavy damage to the levee embankments. Some of the damages have reduced the stability of the levee below the acceptable limits and may result in potential breaches in the levee and flooding in protected areas. The damages that may contribute to breaches in the levee were considered Order 1 and 2 for repair, since the protected area includes a developed urban area. Other damages that do not reduce the levee stability below the acceptable limits, but may be exacerbated during the next flood season, are repaired later under PL 84-99 authority and are considered Order 3 and 4 for repair.

## A. Construction Activities

### 1. Reclamation District 3

Construction activities are scheduled to begin on August 1, 2009 and would be completed by September 30th, 2009, although construction may occur as late as Oct 31, 2009, depending on contracting and other logistical planning. The site is a total of 420 feet long, consisting of 345 linear feet of out of water work and 75 linear feet of in water work. The area will be grubbed to a maximum depth of 5 feet. Six inches of bedding material will be placed into the cleared area. After the bedding material is placed, 24 inches of riprap with an average size of 9 inches, will be placed where needed by pushing into place from the crest. Four inch minus rock will be broadcast on top of riprap to fill in interstitial voids. Additionally, orange fencing will be placed at the new levee toe to protect all in water vegetation that consists mainly of horsetail (*Equisetum sp.*), and all IWM present will be marked for preservation.

Willow planting would be planted at the toe of the levee while hydroseeding will occur in the disturbed areas on the upper slope of the levee.

### 2. Reclamation District 150

Construction activities are scheduled to begin August 1, 2009 and would be completed by September 30th, 2009. Erosion damage exists at 17 sites along the Sacramento River within Reclamation District 150. Erosion sites consist of wave wash erosion, levee toe scours and loss of rock protection along an intermittent 7,033 linear feet of waterside levee slope. Repairs will excavate the eroded slope at least 6 inches beyond the damaged surface and backfill the area with quarry rock. The quarry rock will be covered by two feet of riprap with an average size of 9 inches placed on a 6 inch thick layer of bedding material. Surface voids in the rock will be filled by casting four inch minus rock on top of the riprap to fill in interstitial voids. To the extent possible all vegetation currently on site greater than 4 inches in diameter will be protected and left in place.

Willow (*Salix spp.*) will be planted along the toe of the waterside levee slope. Pole cuttings will be gathered from shrubs near the project area and planted 6 feet apart in two rows on a 2 foot off center pattern along the levee toe for the length of each repair site using the "Stinger" method. The "Stinger" is designed to be heavy enough to punch a hole down through the spaces between large rock riprap into moist to wet soil underneath. Once the "Stinger" reaches the soil under the rock riprap, it is pushed deep enough to make a hole that allows the placement of the willow cutting into permanently moist soil. No additional soil or irrigation will be provided for by the Corps.

**B. 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 each site include removing invasive vegetation determined to be detrimental to the success of the project, replacing vegetation plantings to maintain a 50% survivability rate of all plantings for a period of three years, 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 Standard Assessment Methodology (SAM). The SAM quantifies habitat values in terms of bank line- or area-weighted species responses that are calculated by combining habitat quality (fish response indices) with quantity (bank length or wetted area) for each season, target year, and relevant species and life stage. The SAM employs six habitat variables to characterize near shore and floodplain habitats of listed fish species.

**C. Monitoring**

The Corps will, within 90 days of the completion of construction, submit a detailed, site-specific monitoring plan for NMFS to review. The Corps proposes to apply this plan to the critical erosion repair sites, and other sites, as necessary for approximately 5 years following construction. The monitoring plan will be incorporated into the O&M manual and implemented at all project sites. One element of the monitoring plan includes photographic documentation of the status and progress of the planted riparian vegetation.

Monitoring is necessary to ensure that the riparian vegetation planted is functioning as projected by the SAM model. The Corps shall submit a yearly report of monitoring results to the resource agencies by December 31 of each year. Monitoring is to be conducted until such time as the projected benefits of mitigation actions to Federally listed fish species can either be substantially confirmed or discounted. If integrated conservation measures fail to meet modeled SAM values, specific remedial measures for each type of conservation measure (i.e., riparian survival and growth) and the level of effort applied to implement such measures will be determined based on the magnitude and the causes of failure. Potential remedial measures may include: (1) planting additional vegetation at the project site, and/or (2) planting additional plants at offsite locations.

**D. Action Area**

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR § 402.02). The action area for the overall Steamboat Slough PL 84-99 extends south-to-north along the Sacramento River from the town of Courtland, at river mile (RM) 34 upstream to Clarksburg at (RM) 42, and includes one site near the confluence of the Sacramento River and Steamboat Slough near Courtland.

## III. STATUS OF THE SPECIES/CRITICAL HABITAT

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

**Sacramento River winter-run Chinook salmon ESU** (*Oncorhynchus tshawytscha*)
Listed as 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** (*O. tshawytscha*)
Listed as 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** (*O. mykiss*)
Listed as threatened (January 5, 2006, 71 FR 834)

**Central Valley steelhead designated critical habitat**
(September 2, 2005, 70 FR 52488)

**Southern DPS of North American green sturgeon** (*Acipenser medirostris*)
Listed as threatened (April 7, 2006, 70 FR 17386)

**Southern DPS of North American green sturgeon proposed critical habitat**
(September 8, 2008, 73 FR 52084)

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

1. <u>Chinook salmon</u>

Chinook salmon are anadromous and the largest member of *Oncorhynchus*, with adults weighing more than 120 pounds having been reported from North American waters (Scott and Crossman 1973, Eschmeyer *et al.* 1983, Page and Burr 1991). 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 the summer, spawn in the 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 the 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 are generally thought to be related to local water temperature and flow regimes. Runs are designated on the basis of adult migration timing. However, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

Information on the migration rates of adult Chinook salmon in freshwater is scant and primarily comes from the Columbia River basin, where information regarding migration behavior is needed to assess the effects of dams on travel times and passage (Matter and Sanford 2003). Keefer *et al.* (2004) found migration rates of Chinook salmon ranging from approximately 10 kilometers (km) per day to greater than 35 km per day and to be primarily correlated with date, and secondarily with discharge, year, and reach, in the Columbia River basin. Matter and Sanford (2003) documented migration rates of adult Chinook salmon ranging from 29 to 32 km per day in the Snake River. Adult Chinook salmon inserted with sonic tags and tracked throughout the Delta and lower Sacramento and San Joaquin rivers were observed exhibiting substantial upstream and downstream movement in a random fashion, several days at a time, while migrating upstream [California Bay-Delta Program (CALFED) 2001]. Adult salmonids migrating upstream are assumed to make greater use of pool and mid-channel habitat than channel margins (Stillwater Sciences 2004), particularly larger salmon such as Chinook salmon, as described by Hughes (2004). Adults are thought to exhibit crepuscular behavior during their upstream migrations, meaning that they are primarily active during twilight hours. Recent hydroacoustic monitoring conducted by LGL Environmental Research Associates showed peak upstream movement of adult Central Valley spring-run Chinook salmon in lower Mill Creek, a tributary to the Sacramento River, occurring in the 4-hour period before sunrise and again after sunset.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools [U.S. Fish and Wildlife Service (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 depict that the daily migration of juveniles passing RBDD is highest in the 4-hour period prior to sunrise (*e.g.*, 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 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 have 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).

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 exhibited larger-sized juveniles captured in the main channel and smaller-sized fry along the margins (USFWS 1997). When the river channel 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 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 diptera larvae, as well as small arachnids and ants, are common prey items (Kjelson *et al.* 1982, MacFarlane and Norton 2001, Sommer *et al.* 2001).

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. Status of Sacramento River Winter-Run Chinook Salmon*

Sacramento River winter-run Chinook salmon were originally listed as threatened in August 1989, under emergency provisions of the ESA, and formally listed as threatened in November 1990 (55 FR 46515). 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 ESU consists of only one population that is confined to the upper Sacramento River in California's Central Valley. The Livingston Stone National Fish Hatchery population has been included in the listed Sacramento River winter-run Chinook salmon ESU (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 1; Yoshiyama *et al.* 1998, Moyle 2002). Spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick Dam and RBDD (Vogel and Marine 1991). The majority of Sacramento River winter-run Chinook salmon spawners are 3 years old.

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). 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 [river mile (RM) 57, USFWS 2001]. The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Winter-run Chinook salmon juveniles remain in the Delta until they reach a fork length of approximately 118 millimeters (mm) and are from 5 to 10 months of age, and then begin emigrating to the ocean as early as November and continuing through May (Fisher 1994, Myers *et al.* 1998).

Historical Sacramento River winter-run Chinook salmon population estimates were as high as near 100,000 fish in the 1960s, but declined to under 200 fish in the 1990s (Good *et al.* 2005). In recent years, the carcass survey population estimates of winter-run Chinook salmon included 8,218 in 2003, 7,869 in 2004, 15,839 in 2005, 17,334 in 2006 (CDFG 2008) which show a recent increase in the population size and a 4-year average of 12,315. The 2006 run was the highest since the listing. However, the population estimate for winter-run Chinook salmon in 2007 was only 2,542, and the preliminary population estimate was only 2,850 in 2008 (CDFG 2008). The ocean life history traits and habitat requirements of winter-run Chinook salmon and fall-run Chinook salmon are similar. Therefore, the unusual and poor ocean conditions that contributed to the drastic decline in returning fall run Chinook salmon populations coast wide in 2007 and 2008 (Varanasi and Bartoo 2008) are suspected to have also caused the observed decrease in the winter-run Chinook salmon spawning population in these years (Oppenheim 2008). 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, Gaines and Poytress (2004) estimated an average of 3,857,036 juveniles exiting in the upper Sacramento River at RBDD between the years of 1996 and 2003. Averaging these 2 estimates yields an estimated population size of 3,782,476 juveniles during that time frame.

Based on 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 Brittnacher (1998) 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 and Mohr (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. They found a biologically significant expected quasi-extinction probability of 28 percent. There is only one population of Sacramento River winter-run Chinook salmon, which depends on cold-water releases from Shasta Dam, and 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 River basin, concluded that the population of winter-run Chinook salmon that spawns below Keswick Dam satisfies low-risk criteria for population size and population decline, but increasing hatchery influence is a concern that puts the population at a moderate risk of extinction. Furthermore, Lindley *et al.* (2007) pointed out that an ESU represented by a single population at moderate risk is at a high risk of extinction over the long term.

*b. Status of Central Valley Spring-Run Chinook Salmon*

NMFS listed the Central Valley spring-run Chinook salmon ESU as threatened on September 16, 1999 (64 FR 50394). In June 2004, NMFS proposed that Central Valley spring-run Chinook salmon remain listed as threatened (69 FR 33102). This proposal was based on the recognition that although Central Valley 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 (70 FR 37160), after reviewing the best available scientific and commercial information, NMFS issued its final rule to retain the status of Central Valley spring-run Chinook salmon as threatened. This decision also included the FRH spring-run Chinook salmon population as part of the Central Valley spring-run Chinook salmon ESU. Critical habitat was designated for Central Valley spring-run Chinook salmon on September 2, 2005 (70 FR 52488).

Adult Central Valley 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 2, Yoshiyama *et al.* 1998, Moyle 2002). Lindley *et al.* (2006a) indicated that adult Central Valley 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).

Table 1. The temporal occurrence of adult and juvenile Sacramento River winter-run Chinook salmon in the Sacramento River.

| **Adult Location** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sacramento River basin[1] | | | | | | | | | | | | |
| Sacramento River[2] | | | | | | | | | | | | |
| **Juvenile Location** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Sacramento River at Red Bluff[3] | | | | | | | | | | | | |
| Sacramento River at Red Bluff[2] | | | | | | | | | | | | |
| Sacramento River at Knights Landing[4] | | | | | | | | | | | | |
| Lower Sacramento River (seine)[5] | | | | | | | | | | | | |
| West Sacramento River (trawl)[5] | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Relative Abundance:** | =High | =Medium | =Low | | | | | | | | | |

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

Table 2. The temporal occurrence of adult and juvenile Central Valley spring-run Chinook salmon in the Sacramento River.

| Adult Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sacramento River basin[1,2] | | | | | | | | | | | | |
| Sacramento River[3] | | | | | | | | | | | | |
| Mill Creek[4] | | | | | | | | | | | | |
| Deer Creek[4] | | | | | | | | | | | | |
| Butte Creek[4] | | | | | | | | | | | | |
| **Juvenile Location** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Sacramento River Tributaries | | | | | | | | | | | | |
| Upper Butte Creek | | | | | | | | | | | | |
| Mill, Deer, Butte Creeks | | | | | | | | | | | | |
| Sacramento River @ RBDD | | | | | | | | | | | | |
| Sacramento River @ Knights Landing | | | | | | | | | | | | |

**Relative Abundance:** =High =Medium =Low

Sources: [1] Yoshiyama *et al.* (1998); [2] Moyle (2002); [3] Meyers *et al.* (1998); [4] Lindley *et al.* (2007); [5] CDFG (1998); [6] McReynolds *et al.* (2005); Ward *et al.* (2002, 2003); [7] Snider and Titus (2000)

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), 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 Central Valley spring-run Chinook salmon migrants to be fry occurring primarily during December through February, and that these movements appeared to be influenced by flow. Small numbers of Central Valley 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 YOY migration and an earlier yearling migration (Lindley *et al.* 2006a).

Once juveniles emerge from the gravel, they 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 of 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 Central Valley 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 FRH. In 2002, 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 and early fall-run Chinook salmon stocks. 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 with fall-run Chinook salmon (Good *et al.* 2005). For the reasons discussed above, the Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance.

The Central Valley 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 annual 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 (Pacific Fishery Management Council 2004; CDFG 2004, 2006; Yoshiyama *et al.* 1998). Finally, for the period of 2006 to 2008 the average abundance for the ESU fell back to 6,917 (CDFG 2009). 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 within the ESU. Generally, these streams have shown a positive escapement trend since 1991. Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 fish since 1995. During this same period, adult returns on Mill Creek have averaged 778 fish, and 1,463 fish on Deer Creek. Although recent trends are positive, annual abundance estimates display a high level of fluctuation, and the overall number of Central Valley spring-run Chinook salmon remains well below estimates of historic abundance. In 2008, adult escapement of spring-run declined in several of the region's watersheds. Butte Creek had an estimated 6,000 adults return to the watershed, while more significant decreases occurred on Mill Creek (362 fish), Deer Creek (140 fish), and Antelope Creek (2 fish). In contrast, Clear Creek had a modest increase in returning spring-run adults with an estimated 199 adults returning in 2008. These fluctuations may be attributable to poor ocean conditions that existed when the returning 2008 adults entered the ocean as smolts (spring of 2006) and led to poor ocean survival in the critical ocean entry phase of their life history. Additional factors that have limited adult spawning populations are in-river water quality conditions. In 2002 and 2003, mean water temperatures in Butte Creek exceeded 21°C for 10 or more days in July (Williams 2006). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of columnaris disease (*Flexibacter columnaris*) and ichthyophthiriasis (*Ichthyophthirius multifiis*) in the adult spring-run over-summering in Butte Creek. In 2002, this contributed to the pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run in Butte Creek.

Lindley *et al.* (2006a) concluded that Butte and Deer Creek spring-run Chinook salmon are at low risk of extinction, satisfying viability criteria for population size, 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 are data deficient and were not assessed for viability. However, because the existing Central Valley 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, and remains at a moderate to high risk of extinction.

*c. Status of Central Valley Steelhead*

Central Valley 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 Central Valley spring-run Chinook salmon remain listed as threatened (69 FR 33102). On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of Central Valley steelhead as threatened (70 FR 37160). This decision also included the Coleman National Fish Hatchery and FRH steelhead populations. These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for Central Valley steelhead on September 2, 2005 (70 FR 52488).

Steelhead can be divided into two life history types, summer-run steelhead and winter-run steelhead, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Only winter steelhead are currently 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 northern California coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

Central Valley steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April, with peaks from January through March, in small streams and tributaries where cool, well oxygenated water is available year-round (table 3, Hallock *et al.* 1961, McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, 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 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Newly-emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

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

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

Some juvenile steelhead 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) have also verified these temporal findings based on analysis of captures at Chipps Island, Suisun Bay.

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

Recent estimates from trawling data in the Delta indicate that approximately 100,000 to 300,000 (mean 200,000) smolts emigrate to the ocean per year, representing approximately 3,600 female Central Valley steelhead spawners in the Central Valley basin (Good *et al.* 2005). This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s.

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

Until recently, Central Valley steelhead were thought to be extirpated from the San Joaquin River system. However, 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).

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 have also 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 Central Valley steelhead catch summaries on the San Joaquin River near Mossdale, representing migrants from the Stanislaus, Tuolumne, and Merced Rivers. Based on trawl recoveries at Mossdale between 1988 and 2002, as well as rotary screw trap efforts in all three tributaries, CDFG (2003) 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." The documented returns on the order of single fish in these tributaries suggest that existing populations of Central Valley steelhead on the Tuolumne, Merced, and lower San Joaquin Rivers are severely depressed

Lindley *et al.* (2006) indicated that prior population census estimates completed in the 1990s found the Central Valley steelhead spawning population above RBDD had a fairly strong negative population growth rate and small population size. Good *et al.* (2005) indicated the decline was continuing, as evidenced by new information (Chipps Island trawl data). Central Valley steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates. The future of Central Valley steelhead is uncertain due to limited data concerning their status. However, Lindley *et al.* (2007) concluded that there is sufficient evidence to suggest that the ESU is at moderate to high risk of extinction.

Table 3. The temporal occurrence of adult and juvenile Central Valley steelhead in the Central Valley.

| Adult Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sacramento River basin[1, 2] | | | | | | | | | | | | |
| Sacramento River at Red Bluff[2, 3] | | | | | | | | | | | | |
| Mill, Deer Creeks[4] | | | | | | | | | | | | |
| Sacramento River at Fremont Weir[6] | | | | | | | | | | | | |
| San Joaquin River[7] | | | | | | | | | | | | |
| **Juvenile Location** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Sacramento River[1, 2] | | | | | | | | | | | | |
| Sacramento River at Knights Landing[2, 8] | | | | | | | | | | | | |
| Sacramento River at Knights Landing[9] | | | | | | | | | | | | |
| Chipps Island (wild)[10] | | | | | | | | | | | | |
| Mossdale[8] | | | | | | | | | | | | |
| Woodbridge Dam[11] | | | | | | | | | | | | |
| Stanislaus River at Caswell[12] | | | | | | | | | | | | |
| Sacramento River at Hood[13] | | | | | | | | | | | | |

**Relative Abundance:** =High =Medium =Low

Sources: [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); [13] Schaffter (1980) *d. Status of Southern DPS of North American Green Sturgeon*

The Southern DPS of North American green sturgeon was listed as threatened on April 7, 2006, (70 FR 17386) and includes the North American green sturgeon population spawning in the Sacramento River and utilizing the Sacramento River, the Delta, and the San Francisco Estuary. North American green sturgeon are widely distributed along the Pacific Coast and have been documented offshore from Ensenada, Mexico, to the Bering Sea, and found in rivers from British Columbia to the Sacramento River (Moyle 2002). As is the case for most sturgeon, North American green sturgeon 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 DPS', Northern and Southern, 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 divided 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) juveniles less than or equal to 3 years of age, (3) larvae and post-larvae less than 10 months of age, and (4) coastal migrant females between 3 and 13 years, and males between 3 and 9 years of age (Nakamoto *et al.* 1995, McLain 2006).

New information regarding the migration and habitat use of the Southern DPS of North American green sturgeon has emerged. Lindley (2006) presented preliminary results of large-scale green sturgeon migration studies, and verified past population structure delineations based on genetic work and found frequent large-scale migrations of green sturgeon along the Pacific Coast. It appears North American green sturgeon are migrating considerable distances up the Pacific Coast into other estuaries, particularly the Columbia Estuary. This information also agrees with the results of green sturgeon tagging studies (CDFG 2002), where CDFG 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. They 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 Kelley *et al.* (2006) surmised they are related to resource availability. 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). They 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 Glen-Colusa Irrigation District (GCID) diversion (RM 205), 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 occurrence, it appears adult green sturgeon could utilize a variety of freshwater and brackish habitats for up to 9 months of the year (Beamesderfer 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). 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 the Southern DPS of North American 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 (table 4, 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). Adults of the Southern DPS of North American green sturgeon begin their upstream spawning migrations into San Francisco Bay in March, reach Knights Landing during April, and spawn between March and July (Heublein 2006). Peak spawning is believed to occur between April and June 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.

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 appear in USFWS sampling efforts at RBDD from May through August at lengths ranging from 20 to 80 mm fork length (USFWS 2006). 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, approximately 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 6 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 behavior beyond the metamorphosis from larvae to juvenile stages. Kynard *et al.*'s (2005) laboratory studies indicated that juvenile fish continued to migrate downstream at night for the first 6 months of life. When ambient water temperatures reached 46°F, downstream migrational behavior diminished and holding behavior increased. This data suggest 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 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 of the Southern DPS of North American green sturgeon likely hold in the mainstem Sacramento River, as suggested by Kynard *et al.* (2005).

Population abundance information concerning the Southern DPS of North American 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 North American green sturgeon includes changes in abundance at the John E. Skinner Fish Facility between 1968 and 2001. The average number of the Southern DPS 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 (April 7, 2006, 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 (April 7, 2006, 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 entrainment of both North American green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s (April 7, 2006, 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 of North American green

Table 4. The temporal occurrence of adult, larval and post-larval, juvenile, and coastal migrant Southern DPS of North American green sturgeon.

| **Adult Location (≥13 yrs for females, ≥9 yrs for males)** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Upper Sac River[1, 2, 3] | | | | | | | | | | | | |
| SF Bay Estuary[4, 8] | | | | | | | | | | | | |
| **Larval / Post-Larval Location (≤10 mos)** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| RBDD, Sac River[5] | | | | | | | | | | | | |
| GCID, Sac River[5] | | | | | | | | | | | | |
| **Juvenile Location (>10 mos and ≤3 yrs)** | | | | | | | | | | | | |
| South Delta*[6] | | | | | | | | | | | | |
| Sac-SJ Delta[6] | | | | | | | | | | | | |
| Sac-SJ Delta[5] | | | | | | | | | | | | |
| Suisun Bay[5] | | | | | | | | | | | | |
| **Coastal Migrant Location (3-13 yrs for females, 3-9 yrs for males)** | | | | | | | | | | | | |
| Pacific Coast[3, 7] | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Relative Abundance:** | =High | | =Medium | | =Low | | | | | | | |

Sources: [1] USFWS (2002); [2] Moyle *et al.* (1992); [3] Adams *et al.* (2002) and NMFS (NMFS 2005a); [4] Kelley *et al.* (2006); [5] CDFG (2002); [6] IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [7] Nakamoto *et al.* (1995); [8] Heublein (2006) *Fish Facility salvage operations sturgeon. Recent spawning population estimates using sibling-based genetics by Israel (2006) indicate 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 2 weeks of age) and GCID (downstream; approximately 3 weeks of age), it appears the majority of the Southern DPS of 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. While green sturgeon populations were not analyzed in the recent salmonid population viability papers (Lindley *et al.* 2006, 2007) and NMFS' status reviews (Adams *et al.* 2002, NMFS 2005a), the information that is available on green sturgeon indicates that, as with Sacramento River winter-run Chinook salmon, the mainstem Sacramento River may be the last viable spawning habitat for the Southern DPS of North American green sturgeon (NMFS 2003). Lindley *et al.* (2007) pointed out that an ESU represented by a single population at moderate risk is at a high risk of extinction over the long term. Although the extinction risk of the Southern DPS of green sturgeon has not been assessed, NMFS believes that the extinction risk has increased because there is only one population, within the mainstem Sacramento River.

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. Both white and green sturgeon likely utilized the San Joaquin River basin for spawning prior to the onset of European influence, based on past use of the region by populations of Central Valley spring-run Chinook salmon and Central Valley steelhead. These two populations of salmonids have either been extirpated or greatly diminished in their use of the San Joaquin River basin over the past two centuries.

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

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

**B. Status of Critical Habitat and Primary Constituent Elements for Listed Salmonids**

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

Critical habitat for Central Valley spring-run Chinook salmon includes stream reaches such as those of the Feather and Yuba Rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear Creeks, and the Sacramento River and Delta. Critical habitat for Central Valley steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope Creeks in the Sacramento River basin; and, the San Joaquin River its tributaries, and the Delta.

Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (September 2, 2005, 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 Central Valley spring-run Chinook salmon and Central Valley steelhead is defined as specific areas that contain the primary constituent elements (PCE) and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for Central Valley spring-run Chinook salmon and Central Valley steelhead, and as physical habitat elements for Sacramento River winter-run Chinook salmon.

1. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for Chinook salmon and steelhead is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for Sacramento River winter-run Chinook salmon is restricted to the Sacramento River primarily between RBDD and Keswick Dam. Central Valley spring-run Chinook salmon also spawn in the mainstem Sacramento River between RBDD and Keswick Dam and in tributaries such as Mill, Deer, and Butte Creeks. Spawning habitat for Central Valley steelhead is similar in nature to the requirements of Chinook salmon, primarily occurring in reaches directly below dams throughout the Central Valley. Most remaining natural spawning habitats (those not downstream from large dams) are currently 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. Regardless of its current condition, spawning habitat in general has a high intrinsic 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 may also 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 River 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 intrinsic value to salmonids, as the juvenile life stages are 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 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 intrinsic value 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 intrinsic value because they function as rearing habitat and as an area of transition to the ocean environment.

## C. Status of Proposed Critical Habitat and PCEs for the Southern DPS of North American Green Sturgeon

Critical habitat was proposed for Southern DPS of green sturgeon on September 8, 2008 (73 FR 52084). Proposed critical habitat for Southern DPS of green sturgeon includes approximately 325 miles of riverine habitat and 1,058 square miles of estuarine habitat in California, Oregon, and Washington, and 11,927 square miles of coastal marine habitat off California, Oregon, and Washington within the geographical area presently occupied by the Southern DPS of green sturgeon. In addition, approximately 136 square miles of habitat within the Yolo and Sutter bypasses, adjacent to the Sacramento River, California, are proposed for designation.

1. Food Resources

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

2. Substrate Type or Size

Suitable critical habitat in the freshwater riverine system should include substrate suitable for egg deposition and development (*e.g.*, bedrock sills and shelves, cobble and gravel, or hard clean sand, with interstices or irregular surfaces to "collect" eggs and provide protection from predators, and free of excessive silt and debris that could smother eggs during incubation), larval development (*e.g.*, substrates with interstices or voids providing refuge from predators and from high flow conditions), and subadults and adult life stages (*e.g.*, substrates for holding and spawning). For example, spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett *et al.*, 1991, Moyle *et al.* 1995). Eggs likely adhere to substrates, or settle into crevices between substrates (Deng 2000, Van Eenennaam *et al.* 2001, and Deng *et al.* 2002). Both embryos and larvae exhibited a strong affinity for benthic structure during laboratory studies (Van Eenennaam *et al.* 2001, Deng *et al.* 2002, Kynard *et al.* 2005), and may seek refuge within crevices, but use flat-surfaced substrates for foraging (Nguyen and Crocker 2007). Recent stream surveys by USFWS and Reclamation biologists have identified approximately 54 suitable holes and pools between Keswick Dam and approximately GCID that would support spawning or holding activities for green sturgeon based on the identified physical criteria. Many of these locations are at the confluence of tributaries with the mainstem Sacramento River or at bend pools. Observations of channel type and substrate compositions during these surveys indicate that appropriate substrate is available in the Sacramento River between GCID and Keswick Dam. Ongoing surveys are anticipated to further identify river reaches with suitable substrate characteristics in the upper river and their utilization by green sturgeon.

3. Water Flow

An adequate flow regime (*i.e.*, magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) is necessary for normal behavior, growth, and survival of all life stages in the upper Sacramento River. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11 - 19°C) (Cech *et al.* 2000, Mayfield and Cech 2004, Van Eenennaam *et al.* 2005, Allen *et al.* 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning success is most certainly associated with water flow and water temperature compared to other variables. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs (average daily water flow during spawning months: 6,900 – 10,800 cfs; Brown 2007). Post-spawning downstream migrations are triggered by increased flows, ranging from 6,150 – 14,725 cfs in the late summer (Vogel 2005) and greater than 3,550 cfs in the winter (Erickson *et al.* 2002; Benson *et al.* 2007). The current suitability of these flow requirements is almost entirely dependent on releases from Shasta Dam. High winter flows associated with the natural hydrograph do not occur within the section of the river utilized by green sturgeon with the frequency and duration that was seen in pre-dam conditions. Rearrangement of the river channel and the formation of new pools and holes are unlikely to occur given the management of the river's discharge to prevent downstream flooding.

4. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages are required for the properly functioning of the freshwater habitat. Suitable water temperatures would include: stable water temperatures within spawning reaches (wide fluctuations could increase egg mortality or deformities in developing embryos); temperatures within 11 - 17°C (optimal range = 14 - 16°C) in spawning reaches for egg incubation (March-August) (Van Eenennaam *et al.* 2005); temperatures below 20°C for larval development (Werner *et al.* 2007); and temperatures below 24°C for juveniles (Mayfield and Cech 2004 and Allen *et al.* 2006). Due to the temperature management of the releases from Keswick Dam for winter-run in the upper Sacramento River, water temperatures in the river reaches utilized currently by green sturgeon appear to be suitable for proper egg development and larval and juvenile rearing. Suitable salinity levels range from fresh water (< 3‰) for larvae and early juveniles (about 100 days post hatch [dph]) to brackish water (10‰) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech 2007). Salinity levels are suitable for green sturgeon in the Sacramento River and freshwater portions of the Delta for early life history stages. Adequate levels of dissolved oxygen are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg $O_2$ $hr^{-1}$ $kg^{-1}$ for juveniles; Allen and Cech 2007). Current mainstem dissolved oxygen levels are suitable to support the growth and migration of green sturgeon in the Sacramento River. Suitable water quality would also include water free of contaminants (i.e., pesticides, organochlorines, elevated levels of heavy metals, *etc.*) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Water free of such contaminants would protect green sturgeon from adverse impacts on growth, reproductive development, and reproductive success (*e.g.*, reduced egg size and abnormal gonadal development, abnormal embryo development during early cleavage stages and organogenesis) likely to result from exposure to contaminants (Fairey *et al.* 1997, Foster *et al.* 2001a, Foster *et al.* 2001b, Kruse and Scarnecchia 2002, Feist *et al.* 2005, and Greenfield *et al.* 2005). Legacy contaminants such as mercury still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River basin.

5. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for passage within riverine habitats and between riverine and estuarine habitats (*e.g.*, an unobstructed river or dammed river that still allows for passage). Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning/rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick

Dam (RM 301) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242). The effects of closure of RBDD on critical habitat is being analyzed in the OCAP consultation. The proposed pumping facilities and operations do not significantly further restrict or impact the migratory corridor of green sturgeon. Closure of the gates at RBDD from May 15 through September 15 currently precludes all access to spawning grounds above the dam during that time period. Adult green sturgeon that cannot migrate upstream past the RBDD either spawn in what is believed to be less suitable habitat downstream of the RBDD (potentially resulting in lower reproductive success) or migrate downstream without spawning, both of which would reduce the overall reproductive success of the species.

Adult green sturgeon that were successful in passing the RBDD prior to its closure have to negotiate the dam on their subsequent downstream migration following spawning during the gates down period. Recent acoustic tag data indicates that some fish are successful in passing the dam when the gates are in the "closed" position (Heublein *et al.* 2008). Typically the gates are raised slightly from the bottom to allow water to flow underneath the radial gates and fish apparently can pass beneath the radial gates during this period. However, recent observed mortalities of green sturgeon during an emergency gate operation (2007) indicate that passage is not without risk if the clearance is too narrow for successful passage.

Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July, during the RBDD gates down period. Juvenile green sturgeon would likely be subjected to the same predation and turbulence stressors caused by RBDD as the juvenile anadromous salmonids, leading to diminished survival through the structure and waters immediately downstream.

6. <u>Depth</u>

Deep pools of ≥ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River above GCID. The significance and purpose of these aggregations are unknown at the present time, although it is likely that they are the result of an intrinsic behavioral characteristic of green sturgeon. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from high water temperatures (Erickson *et al.* 2002, Benson *et al.* 2007). As described above, approximately 54 pools with adequate depth have been identified in the Sacramento River above the GCID location.

7. <u>Sediment Quality</u>

Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants [*e.g.*, elevated levels of heavy metals (*e.g.*, mercury, copper, zinc, cadmium, and chromium), polyaromatic hydrocarbons (PAHs), and organochlorine pesticides] that can result in negative effects on any life stages of green sturgeon. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may negatively affect the growth, reproductive development, and reproductive success of green sturgeon. The Sacramento

River and its tributaries have a long history of contaminant exposure from abandoned mines, separation of gold ore from mine tailings using mercury, and agricultural practices with pesticides and fertilizers which result in deposition of these materials in the sediment horizons in the river channel. Disturbance of these sediment horizons by natural or anthropogenic actions can liberate the sequestered contaminants into the river. This is a continuing concern in the river's watershed.

8. Summary

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

## D. Factors Affecting the Status of Listed Species and Critical Habitat

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

California's robust agricultural economy and rapidly increasing urban growth place high demand for water in the Sacramento and San Joaquin River basins. The demand for water in the Central Valley has significantly altered the natural morphology and hydrology of the Sacramento and San Joaquin Rivers and their major tributaries. Agricultural lands and urban areas have flourished on historic floodplains. An extensive flood management system of dams, levees, and bypass channels restricts the river's natural sinuosity and reduces the lag time of water flowing through the system. A complex network of water delivery systems has transformed much of the Central Valley drainage system into a series of reservoirs, diversion facilities and lined conveyance channels. Flood management and water delivery systems, in addition to agricultural, grazing, and urban land uses, are the main anthropogenic factors affecting watersheds upon which listed salmonids depend.

A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley (*e.g.*, Busby *et al.* 1996, Myers *et al.* 1998, Good *et al.* 2005, CALFED 2000). NMFS has also assessed the factors contributing to Chinook salmon and steelhead decline in supplemental documents (NMFS 1996, 1998) and Federal Register notices (*e.g.*, June 16, 1993, 58 FR 33212; January 4, 1994, 59 FR 440; May 6, 1997, 62 FR 24588; August 18, 1997, 62 FR

43937; March 19, 1998, 63 FR 13347; May 5, 1999, 64 FR 24049; September 16, 1999, 64 FR 50394; February 16, 2000, 65 FR 7764). The foremost reason for the decline in these anadromous salmonid populations is the degradation and/or destruction of habitat (*e.g.*, substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, and migration conditions). Additional factors contributing to the decline of these populations include: over-utilization, disease or predation, the inadequacy of existing regulatory mechanisms, and other natural and manmade factors including global climate change. All of these factors have contributed to the ESA-listing of these fish and deterioration of their critical habitats. 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 and DPSs. Although habitat and ecosystem restoration has contributed to recent improvements in habitat conditions throughout the ESUs/DPSs, 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 there were originally 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 was actually 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 substantial 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 have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and instream woody material. 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 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 instream woody material 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.

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 Central Valley Project Improvement Act (CVPIA), implemented in 1992, requires that fish and wildlife receive equal consideration with other demands for water allocations derived from the Central Valley Project. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish 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 the Interior's ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

Two programs included under CALFED; the Ecosystem Restoration Program (ERP) and the Environmental Water Account, were created to improve conditions for fish, including listed salmonids, in the Central Valley. Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids, and emphasis has been placed in tributary drainages with high potential for Central Valley steelhead and 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 California Department of Water Resources' (CDWR) 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 agreement's inception in 1986. Four Pumps projects that benefit Central Valley spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer Creeks; enhanced law enforcement efforts from San Francisco Estuary upstream to the Sacramento and San Joaquin Rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and screening of diversions in Suisun Marsh and San Joaquin tributaries. Additionally, predator habitat isolation and removal and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead.

c. *Natural Fluctuations in Ocean Conditions and Global Climate Change*

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al.* 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal Oscillation. In addition, large-scale ocean temperature shifts, such as El Niño, appear to change ocean productivity, and can have significant effects on rainfall in the Central Valley

Another key factor affecting many West Coast fish stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. NMFS presumes that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of CWT recoveries from subadults relative to the number of CWTs released from that brood year.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although to what degree is not known. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations—following their protection under the Marine Mammal Protection Act of 1972—has substantially increased salmonid mortality.

Finally, the unusual drought conditions in 2001 warrant additional consideration. Flows in 2001 were among the lowest flow conditions on record. The available water in the Sacramento and San Joaquin River watersheds was 70 percent and 66 percent of normal, according to the Sacramento River Index and the San Joaquin River Index, respectively. The juveniles that passed downriver during the 2001 spring and summer out migration were likely affected, and this, in turn, likely affected adult returns primarily in 2003 and 2004, depending on the stock and species.

d. *Global Climate Change*

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (Intergovernmental Panel on Climate Change 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. This would likely 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, could rise above thermal tolerances for juvenile and adult salmonids (*e.g.*, Sacramento River winter-run Chinook salmon and Central Valley steelhead) that must hold below Keswick Dam over the summer and fall periods.

2. Critical Habitat for Salmonids

According to NMFS' (2005b) Critical Habitat Analytical Review Team (CHART) report, the major categories of habitat-related activities affecting Central Valley salmonids include: (1) irrigation impoundments and withdrawals, (2) channel modifications and levee maintenance, (3) the presence and operation of hydroelectric dams, (4) flood control and streambank stabilization, and (5) 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 CHART report (NMFS 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.

3. Southern DPS of North American Green Sturgeon

The principal factors for the decline in the Southern DPS of North American green sturgeon are reviewed in the listing notice (April 7, 2006, 70 FR 17386) and status reviews (Adams *et al.* 2002, NMFS 2005a), 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 (2005a) concluded that the principle threat to green sturgeon is impassible barriers, primarily Keswick and Shasta Dams on the Sacramento River and Oroville Dam on the Feather River that likely block and prevent access to historic spawning habitat (NMFS 2005a). Spawning habitat may have extended up into the three major branches of the Sacramento River; the Little Sacramento River, the Pit River system, and the McCloud River (NMFS 2005a). In contrast, recent modeling evaluations by Mora (2006) indicate little or no habitat in the Little Sacramento River or the Pit River exists above Shasta Dam; however, a considerable amount of habitat exists above Shasta on the mainstem Sacramento River. Green and white sturgeon adults have been observed periodically in the Feather and Yuba Rivers (USFWS 1995, Beamesderfer *et al.* 2004, McLain 2006), and habitat modeling by Mora (2006) suggests there is suitable habitat above Oroville Dam. There are no records of larval or juvenile white or green sturgeon being captured on the Yuba or Feather Rivers; however, there are reports that green sturgeon may reproduce in the Feather River during high flow years (CDFG 2002), but these are unconfirmed.

No green sturgeon have been documented in the San Joaquin River; however, the presence of white sturgeon has been documented (USFWS 1995, Beamesderfer *et al.* 2004), making green sturgeon presence historically likely, as the two species require similar habitat and their ranges overlap in the Sacramento River. Habitat modeling by Mora (2006) also suggests sufficient conditions are present in the San Joaquin River to Friant Dam, and in the Stanislaus, Tuolumne, and Merced Rivers to their respective 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, based on prior spring-run Chinook salmon distribution and habitat use in the San Joaquin River, it is very possible that green sturgeon were extirpated from the San Joaquin River 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 spawning and rearing habitat that may be available to the Southern DPS of North American green sturgeon will likely significantly decrease.

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

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

## IV. ENVIRONMENTAL BASELINE

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

Historically, as water from the Sacramento River entered the Delta area it would naturally change its course as it meandered towards San Francisco Bay. The course changes were dictated by size of the flows, the land elevations, erosion and a broad range of other naturally occurring dynamics. As the surrounding lands were developed into farms, urban, and suburban areas, it became advantageous to confine the flowing water to a prescribed system of channels; levees were built along the channel banks to assure that flows would stay within those channels. The land surrounding the Sacramento River Delta now has a lower elevation than the water surface of the channels, and failure of the levees would lead to wide-spread flooding and damage to the adjacent land developments. To prevent that, the levees are armored with reinforcing materials whenever they show signs of weakness. This has been an ongoing method of treatment and the repairs have been accomplished by individual land-owners, levee maintenance districts, and government institutions at all levels. Some of the repairs are primitive and some well-designed, but because most of the levees were originally built out of sand dredged from the river bottom, they are inherently weak, and the need to repair them is an ongoing challenge.

Numerous studies, many of which are cited in this opinion, have demonstrated that removal of woody material, shading, and natural riparian vegetation from riverbanks is detrimental to the listed species covered in this opinion. The action area (the Sacramento River Delta) was one of the earliest reaches of the river system to undergo these changes, and the runs of anadromous salmonids continued for many years to be robust in spite of it. However, in recent decades, the cumulative effects of changes to the river system (dams, diversions, channelization, etc.) have caused populations of anadromous salmonids to decline. The action area is primarily a migration corridor for adult returning from the Pacific Ocean to spawn upstream in the Sacramento and its tributaries, and for the juveniles that are migrating seaward.

### A. Status of the Species in the Action Area

The action area functions as a migratory corridor for adult Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley 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 adults, and juvenile rearing and migratory habitat of Southern DPS of North American green sturgeon.

1. Sacramento River Winter-Run Chinook Salmon

Sacramento River winter-run Chinook salmon are currently present in the Sacramento River below Keswick Dam, and are composed of a single breeding population (*Status of the Species and Critical Habitat* section). The entire population of migrating adults and emigrating juveniles must pass through the action area.

A detailed assessment of the migration timing of Sacramento River winter-run Chinook salmon was reviewed in the *Status of the Species and Critical Habitat* section. Adult Sacramento River winter-run Chinook salmon is 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 Steamboat 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 Steamboat 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 salmonids. In the Sacramento River, between Princeton and Sacramento, juveniles are expected between November and mid April with the highest densities observed first during November and December, and second during January through March. The presence of juvenile Sacramento River winter-run Chinook salmon in Steamboat 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 Steamboat Slough. In most cases, past catches of Sacramento River winter-run Chinook salmon juveniles in Steamboat slough have been relatively low.

2. Central Valley Spring-Run Chinook Salmon

Central Valley spring-run Chinook salmon populations currently spawn in the Sacramento River below Keswick Dam, the low-flow channel of the Feather River, and in the Sacramento River tributaries including Mill, Deer, Antelope, and Butte Creeks (CDFG 1998). The entire population of migrating adults and emigrating juveniles must pass through the action area. Adult Central Valley 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 Central Valley spring-run Chinook salmon emigrates during subsequent phases that extend into early June. The age structure of emigrating juveniles is comprised of young of year 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 in the case for

Sacramento River winter-run Chinook salmon, the presence of juvenile Central Valley spring-run Chinook salmon in Steamboat slough is dependant 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 Central Valley spring-run Chinook salmon juveniles in Steamboat slough have been relatively low.

3. Central Valley Steelhead

Central Valley steelhead populations currently spawn in tributaries to the Sacramento and San Joaquin Rivers. The proportion of steelhead in this DPS that migrate through the action area is unknown. However, the vast majority of Central Valley steelhead spawn and rear in the Sacramento River arm of the system, and thus would have to pass through the action area on their way to and from the ocean. 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). The 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.

4. Southern DPS of North American Green Sturgeon

The spawning population of the Southern DPS of North American green sturgeon is currently restricted to the Sacramento River below Keswick Dam, and is composed of a single breeding population (*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 and Steamboat Slough 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 as in the Delta (in the action area downstream of Sacramento) during all months of the year (IEP Database, Borthwick et. al. 1999).

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

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

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).

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 for this project are in the range of a few hundred linear feet 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 function 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 many occur during high flows (USFWS 2000). Juvenile salmonids are likely being impacted by reductions, fragmentation, and general lack of connectivity of remaining nearshore refuge areas.

2. Southern Distinct Population Segment of North American Green Sturgeon

The Sacramento River is utilized by larvae, post-larvae, and to a lesser extent, juvenile North American green sturgeon for rearing and migration purposes. Although it is believed that larvae, post-larvae, and juveniles are primarily benthic (with the exception of the post-larvae nocturnal swim-up behavior which is 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).

Point source and non-point source pollution resulting from agricultural discharge and urban and industrial development occurs in the action area. 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 numbers of diversions in the action area on the Sacramento River and in the Delta are a potential threat to North American green sturgeon due to juvenile entrainment into these diversions.

## C. Factors affecting critical habitat

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

According to NMFS' (2005b) Critical Habitat Analytical Review Team (CHART) report, the major categories of habitat-related activities affecting Central Valley salmonids include: (1) irrigation impoundments and withdrawals, (2) channel modifications and levee maintenance, (3) the presence and operation of hydroelectric dams, (4) flood control and streambank stabilization, and (5) 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 CHART report (NMFS 2005b), the condition of critical habitat varies throughout the range of the species. 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 diversions, 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. 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 urban and agricultural runoff, degraded nearshore and riparian habitat from levee construction and maintenance, and habitat loss and fragmentation.

2. <u>Proposed Critical Habitat for Southern DPS of North American Green Sturgeon</u>

The principal factors for the decline in the Southern DPS of North American green sturgeon are reviewed in the proposed listing notice (April 6, 2005, 70 FR 17386) and status reviews (Adams *et al.* 2002, NMFS 2005a), 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 (2005a) 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 Rivers (USFWS 1995, Beamesderfer *et al.* 2004, McLain 2006), and habitat modeling by 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 green sturgeon presence historically likely, as the two species require similar habitat and their ranges overlap in the Sacramento River. Habitat modeling by Mora (2006) also suggests sufficient conditions are present in the San Joaquin River to Friant Dam, and in the Stanislaus, Tuolumne, and Merced Rivers to their respective 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, based on prior spring-run Chinook salmon distribution and habitat use in the San Joaquin River, it is very possible that green sturgeon were extirpated from the San Joaquin River 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.

## 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 and conference 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 and conference opinion assesses the effects of the proposed action on endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, their designated critical habitat, and threatened Southern DPS of North American green sturgeon and their proposed critical habitat.

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 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 exposure to those effects (the extent of temporal and spatial overlap between individuals of the species and the effects of the action). Once we have identified the exposure of the species to 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, expected short- and long-term habitat modifications and proposed 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 and conference opinion; studies and accounts of the impacts of riprapping and in-river construction activities on anadromous fish habitat and ecosystem function; and documents prepared in support of the proposed action, including the BA; SAM modeling results; project designs; field reviews; and meetings held between NMFS and the Corps.

**B. Assessment**

This 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, Central Valley spring-run Chinook salmon, Central Valley steelhead, the Southern DPS of North American green sturgeon and their designated or proposed critical habitat. 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 effects to green sturgeon, and their proposed critical habitat 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, Central Valley spring-run Chinook salmon, Central Valley 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), could last several hours to several weeks. 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. <u>Short-term Construction Related Impacts</u>

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 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.

The extent of construction-related effects is dependant upon the timing of the activities, the timing of fish presence in the action area (Table 5), and their ability to successfully avoid project-related disturbance (Table 6). 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. Adult Sacramento River winter-run Chinook salmon are expected to be present in the action area from December through May, adult CV spring-run Chinook are expected in the action area from January through July, and adult CV steelhead may be present from September through May.

Table 5. Anadromous fish presence in the Sacramento River during time of Construction

| | | | PL 84-99 Steamboat Slough Levee Repair Construction Work Window | | | |
|---|---|---|---|---|---|---|
| Species | Life Stage | July | August | September | October | November |
| Sacramento River Winter-run Chinook Salmon | Adults | | | | | |
| | Juveniles | | | | | |
| Central Valley Spring-run Chinook Salmon | Adults | | | | | |
| | Juveniles | | | | | |
| Central Valley steelhead | Adults | | | | | |
| | Juveniles | | | | | |
| Southern DPS of North American Sturgeon | Adults | | | | | |
| | Juveniles | | | | | |

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).

Therefore, based on the known presence of anadromous species in the Sacramento River (Table 5) during the time of construction, it is possible that Adult Southern DPS of North American Sturgeon may be present in the action area at the time of construction, but are unlikely to be affected by the near-shore/on-shore activities due to their benthic nature and preference for deep, mid-channel habitats. Central Valley steelhead may also be present in the action area during the construction work window.

*a. 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. 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 *et al.* (1992) found that noise from pile driving activities in the Puget Sound affected the general behavior 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 2004). Behavioural observations of predator and salmon interactions at GCID also indicated 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, the placement of large quantities of rock 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 fry-size listed salmon or steelhead are unlikely to be present in the action area during the construction period, unless flood conditions wash fish downstream. In such a case, the Corps would suspend construction until flows subsided. The only area where fry-sized fish are likely to be present during construction is in region 3. Regardless of river flow, fry-sized winter-run Chinook salmon are consistently trapped by CDFG rotary screw traps (RST) at GCID from August through December. RST captures are low in August and peak from October through November. NMFS expects that the presence of these small fish in region 3, during the placement of rock into the Sacramento River, may crush and kill some winter-run Chinook salmon.

The sound generated by the operation of heavy equipment such as crane mounted barges and other construction activities may temporarily affect the behavior of migrating adult salmonids, possibly causing migration delays. However, construction activities are not likely to injure or kill adult winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead because of their crepuscular migration behavior, and because these fish tend to utilize mid-channel, deep water habitats. Construction will be restricted to the channel edge, and will include implementation of avoidance and minimization measures that will prevent impacts to the migrational behavior of listed species.

**(2 ) Green Sturgeon.** Green sturgeon are likely to be present in the action area during construction. However, NMFS does not expect that green sturgeon will be directly affected by rock placement along the bank of the river because 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 rock placement are not expected.

*b. 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) found that impacts on fish populations exposed to episodes of high suspended sediment may vary depending on the circumstance of the event. They also concluded 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.

Construction activities are expected to result in periodic turbidity levels that exceed 25 to 75 NTUs, and thus 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 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. 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.

**(2) Green Sturgeon.** Green sturgeon are expected to 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 rely heavily on visual cues (Sillman *et al.* 2005). Instead, olfaction appears to be a key feeding mechanism as green sturgeon are frequently found in highly turbid environments. 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 expected.

c.. *Other 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.

d. *Summary of Construction-related Effects*

**(1) *Salmon and Steelhead.*** NMFS expects that relatively low numbers of anadromous salmonids will be present in the action area during construction activities because the construction periods have been scheduled to minimize overlap with primary migration periods.

Those fish that are exposed to these activities 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. Others may be displaced from natural shelter and preyed upon by piscivorous fish. Although construction will occur during peak migration periods, relatively few juvenile fish are expected to be injured or killed by in-river construction activities because most fish are expected to avoid construction activities due to their predominately crepuscular migration behaviors. The implementation of BMPs and other conservation 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 in the area, 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 four to five within each salmon and steelhead population will be affected. Therefore, NMFS expects that actual injury and mortality levels will be low relative to the overall population abundance, and not likely to result in any long-term, negative population trends. Adults should not be injured because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance.

**(2) *Green Sturgeon.*** Adult green sturgeon move upstream through the project sites between March and July. 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. 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.

e. *Construction-related effects to Critical Habitat*

Construction activities will alter the site-scale physical characteristics of the PCEs of salmon and steelhead critical habitat, including elements of freshwater and estuarine rearing and migration habitat. These effects are discussed in detail below in *Section 2, Long Term Impacts.*

## Table 6. Species/Critical Habitat Response to the Action

| Type of Disturbance | Possible effects of Disturbance | Immediate short term effects Construction Phase (*dates, times) | Fish Present/Likely to Effect | Short Term Effects (1 – 3 years) | Fish Present/Likely to Effect | Long Term Effects (4 – 50 years) | Fish Present/Likely to Effect |
|---|---|---|---|---|---|---|---|
| 1. Turbidity | 1. Siltation of spawning gravels<br>2. Avoidance | 1. Possible, but unlikely due to location of action area to available spawning areas.<br>2. Very likely to occur if fish are present | Not Likely<br>- due to elevated summer temperatures in action area | N/A | 1. Juvenile-Green sturgeon<br>2. Adult – Green sturgeon | N/A | N/A |
| 2a. Rock Placement *Spawning Gravel* | 1. Reduction in available spawning gravel recruitment | 1. Unlikely contributor due to low amount of available spawning area downstream of action area. | Not Likely<br>- due to elevated summer temperatures in action area | N/A | N/A | N/A | N/A |
| 2b. Rock Placement *Vegetation Removal* | 1. Impede plant growth through thick rock at waterline, which results in vegetation being further back frnm the shoreline, thus reducing the contribution of allochthonous food resources for aquatic invertebrates | 1. Immediate Loss of some of the vegetation component.<br><br>2. Immediate Loss of allochthonous food resources for aquatic invertebrates | Not Likely<br>- due to elevated summer temperatures in action area | 1. Deficits for 1 – 3 years following the removal of any existing riparian vegetation.<br><br>2. Deficits for 1 -3 years following the removal of existing riparian vegetation and loss of allochthonous food contributions. | Juveniles – Fall-, Winter-, Spring-run, Chinook salmon and steelhead | 1. Positive benefits for 4 – 50 years (life of project) as planted vegetation reaches maturity | Juveniles – Fall, Winter, Spring |
| 2c. Rock Placement *Smooth hydraulically efficient surface.* | 1. Increased water velocities near shoreline<br><br>2. Increased erosional processes downstream of action area. | 1. Immediate increase in near shoreline water velocities resulting in immediate loss of winter/spring high flow events.<br><br>2. Immediate increase in downstream erosional processes during winter/spring high flow events. | Not Likely<br>- due to elevated summer temperatures in action area | 1. For lifetime of project or until deposition and vegetation becomes established.<br><br>2. For lifetime of project or until deposition and vegetation becomes established | Juvenile – Green sturgeon and steelhead | 1. If conditions allow, sedimentation should have occurred allowing for both natural vegetation recruitment which will reduce the near shoreline velocities<br><br>2. and reduced the erosional processes downstream | Juveniles – Fall, Winter, Spring |
| 2d. Rock Placement *Halting Natural erosional processes* | 1. Reduced recruitment of spawning gravel for salmonids<br><br>2. Halts new accretion of point bars and other depositions where new riparian vegetation can colonize.<br><br>3. Arrest meander migration which over time, reduces habitat renewal, diversity and complexity. | 1. Immediate reduction of future recruitment of spawning gravel<br><br>2. Immediate reduction of materials available to form point bars and other depositions where new riparian vegetation can colonize.<br><br>3. Immediate and permanent reduction in ability of river to migrate. | Not Likely<br>- due to elevated summer temperatures in action area | 1. For lifetime of project or until sedimentation deposition and vegetation becomes established.<br><br>2. For lifetime of project or until sedimentation deposition and vegetation becomes established<br><br>3. Permanent for lifetime of project | All stages of life cycle of Chinook salmon, steelhead, and green sturgeon | 1. For lifetime of project or until sedimentation deposition and vegetation becomes established.<br><br>2. For lifetime of project or until sedimentation deposition and vegetation becomes established<br><br>3. Permanent for lifetime of project | Juveniles – Fall, Winter, Spring |
| 2e. Rock Placement *Increased substrate size along shore line* | 1. Change in Predator/Prey relationships | 1. Immediate available habitat for predator species with larger rock sizes along the bank. | Not Likely<br>- due to elevated summer temperatures in action area | 1. For lifetime of project or until sedimentation deposition and vegetation becomes established. | Juveniles – Fall-, Winter-, Spring-run Chinook salmon | 1. For lifetime of project or until sedimentation deposition and vegetation becomes established. | Juveniles – Fall, Winter, Spring |

2. Long-Term effects

*a. About the SAM*

The SAM was used to quantify the responses of listed fish species to with-project conditions over a 30-year project period and compared these responses to the species responses under without-project (existing) conditions. The assessment followed the general steps outlined in the *SAM Final Review Draft and Users Manual* (Stillwater Sciences and Dean Ryan Consultants & Designers 2004, 2006). Computations were performed using the Electronic Calculation Template provided by Stillwater Sciences.

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. 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 in a variety of seasons and life-history stages, over the life of the project. Negative responses (SAM deficits), are indicators of reduced growth and survival conditions relative to baseline conditions, and positive responses, are indications of improved growth and survival conditions.

The model is capable of projecting how without-project conditions would change over time. However, the modeling for these projects compared the with-project conditions to a static existing baseline because it simplifies the interpretation of modeling results and because, based on site evaluations conducted by NMFS, the baseline conditions probably would decline due to the limited amount of remaining high quality habitat. 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.

The SAM quantifies habitat values in terms of bank line- or area-weighted species responses that are calculated by combining habitat quality (fish response indices) with quantity (bank length or wetted area) for each season, target year, and relevant species and life stage. The SAM (Stillwater Sciences, 2004) employs six habitat variables to characterize nearshore and floodplain habitats of listed fish species.

**(1) Bank slope.** _This is the average bank slope along each average seasonal water surface elevation. 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, Schlosser 1991, and Waite and Barnhart 1992). 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.

(2) **Floodplain availability.** This is the ratio of wetted channel and floodplain area during the2-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.

(3) **Floodplain variability.** This was estimated from aerial photographs and engineering cross-sections of the project sites. Based on these analyses, there are no significant changes in the wetted width of the river expected under the with-project conditions.

(4) **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 water surface elevation. 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.

(5) **Instream structure.** This is measured as the percent of shoreline coverage of IWM along each average seasonal water surface elevation. 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 Deitel 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).

(6) **Aquatic and submerged terrestrial vegetation.** This is measured as the percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal water surface elevation. 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.

**(7). Overhanging shade.** This is measured as the percent of the shoreline coverage of shade along each average seasonal water surface elevation. 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. Shade provides overhead cover and allochthonous input 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.

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 a considerable amount of uncertainty regarding the results. To account for some of the uncertainty, the Corps, NMFS, USFWS, and scientists from Stillwater Sciences discussed and agreed upon conservative model input variables that tend to generate worst-case scenarios based on conservative estimates of habitat modification and improvement overtime. The model itself accounts for some of the uncertainty by generating results at four different average water surface elevations. 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 water surface elevation, seasonal variability of average flows is accounted for in the project designs because project features, and conservation measures (*i.e.*, benches, vegetation) are placed at variable elevations. Long-term comprehensive monitoring will measure the success of model results by evaluating habitat evolution and fish habitat use. The design of monitoring studies, including frequency, duration, and location, is currently under development.

Further support for expectations regarding the physical response to habitat conditions over time is supplied 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).

*b. SAM Results for Chinook salmon and steelhead*

The SAM results showed positive results in all life stages for salmon and steelhead. Specifically, the SAM results showed long-term (*i.e.*, 1 to 10 year) gains in the summer, fall, and spring habitat values for juvenile rearing and smolt life stages. By comparing the existing and post construction condition, the migratory corridor would improve. The bank slope and floodplain availability for the repair sites would not change. The willow pole cuttings along the bank shoreline would increase shaded riverine habitat since the migratory corridor in the area is highly degraded. As the willows grow, the overhanging and terrestrial vegetation would improve. A temporal loss of 1-3 years could occur given the survival rate for the willows are 30 percent. The tule plantings along Steamboat Slough would be an increase of aquatic vegetation and increase available rearing habitat for juvenile Chinook salmon and steelhead during their out-migration. The addition of four-inch minus rocks placed on top of the larger riprap will reduce the potential of predator species utilizing the crevices of the rocks as their habitat. Thus, NMFS expects that the project would have no negative affects to juvenile salmon and steelhead. In addition, NMFS expects that his project will have little long-term effect on adult migration. Adult upstream-migrations occur mid-channel, and the changes to near-shore habitats resultiing from this project are not expected to change the hydrology of the mid-channel portion of the river.

*c. SAM results for Southern DPS of North American Green Sturgeon*

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. 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 these conditions should be low.

3. Impacts of Project Monitoring

The monitoring plan will involve photo documentation and point estimates of substrate size, riparian vegetation, and other physical project elements. Direct sampling of juvenile anadromous fish is not proposed. This monitoring is not expected to have any effect on Federally listed fish or designated or proposed critical habitat.

4. 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 implementation of additional SRFCP repair projects to determine if they could be considered interrelated or interdependent actions to the proposed action. NMFS determined that these other levee repair projects are not interrelated because there is no single authority or program that binds them together or interdependent because they would occur regardless of the proposed action.

## C. Summary of Effects

NMFS expects that a relatively small but unknown number of juvenile steelhead and green sturgeon will be present in the action area during construction activities. Only those fish that are holding adjacent to or migrating past a project site are likely to be exposed or affected. Those fish that are exposed to the effects of construction activities 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. Others may be displaced from natural shelter and preyed upon by piscivorous fish. Relatively few juvenile fish are expected to be injured or killed by in-river construction activities because most fish are expected to avoid construction activities due to their predominately crepuscular migration behaviors. The implementation of BMPs and other conservation measures also will minimize impacts to the aquatic environment and reduce project-related effects to fish. Furthermore, only one cohort, or emigrating year class, out of perhaps four to five within each salmon and steelhead population will be affected. Therefore, NMFS expects that actual injury and mortality levels will be low relative to the overall population abundance, and not likely to result in any long-term, negative population trends. Adults should not be injured because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance.

Green sturgeon may be present holding and spawning and their spawning habitat and spawning behavior may be affected if rock is placed into deepwater habitats in the upper regions of the action area. There are eight projects located in these reaches, and none one of them is being constructed within the known spawning habitat of the species, the number of fish likely to be affected is low and limited to the project length.

# 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 and conference 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 riprap and other bank stabilization techniques 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 habitats to simplified habitats that affect salmonids in ways similar to, but more intensely (due to a lack of restoration and conservation measures) than the adverse effects associated with the proposed action. Reasonably certain cumulative effects 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 and juvenile fish.

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

## VII. INTEGRATION AND SYNTHESIS

This section considers the *Effects of the Action*, and the *Integration and Synthesis* section of the programmatic biological opinion, which includes analysis of the *Environmental Baseline, Cumulative Effects*, and the effects of the programmatic action.

### A. Impacts of the Proposed Action on Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, Central Valley Steelhead

The *Environmental Baseline* section of the biological opinion describe how recent evaluations of the viability of Central Valley salmonids found that independent populations of Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon appear to be generally viable because they 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, as the ESU remains vulnerable to extirpation due to their small-scale distribution of independent populations and high likelihood of being affected by a significant catastrophic event. Lindley *et al.* (2007) were not able to determine the viability of existing steelhead populations, but believe that the DPS has a moderate to high risk of 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 continued existence of green sturgeon in the Sacramento River and the observation of sturgeon in the Feather and Yuba Rivers indicate that the population is viable and faces a low to moderate risk of extinction. The largest threats to the viability of the ESUs and DPS' are related to loss of access to historic habitats, and the existence of few independent populations, which places the species at risk of extirpation from catastrophic events.

The *Cumulative Effects* section of the biological opinion described how future State, tribal, local, or private actions that are reasonably certain to occur in the action area include non-Federal riprap projects, continuing or future non-Federal water diversions, the discharge of point and non-point source chemical contaminant discharges, and climate change. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that incrementally reduces the carrying capacity of the rearing and migratory corridors.

NMFS expects that the proposed action will result in adverse short-term, construction-related impacts to the species and their critical habitat that will injure and/or kill Federally listed

Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. Construction-related effects are expected to only affect juveniles. 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, such as noise or crushing of fish from rock placement and barge activity, changes in water quality that temporarily modify their natural behavior and may expose them to increased predation.

Construction impacts to juveniles, occurring for a distance of approximately 7,500 lf of aquatic habitat along the banks of the Sacramento River and Steamboat Slough, are expected to impact juveniles from August 2009 through October 2009. The implementation of BMPs and other on-site measures also will minimize impacts to the aquatic environment and reduce project-related effects to fish. Furthermore, only one cohort, or emigrating year class, out of perhaps four to five within each population will be affected. Therefore, NMFS expects that actual injury and mortality levels will be low relative to the overall population abundance, and not likely to result in any long-term, negative population trends. Adults should not be injured because their size, preference for deep water, and crepuscular migratory behavior enable them to avoid temporary, nearshore disturbance.

SAM-modeled habitat deficits may cause injury and death of individuals at all sites from reduced growth conditions and increased predation, for 1 to 3 years. Long-term effects as modeled by the SAM are expected to result in reduced growth and survival conditions for juvenile and smolt Chinook salmon and steelhead at all seasonal water surface elevations for 1 to 3 years and substantial gains in value from 5 to 10 years. Deficits at summer and fall flow conditions are greater that those at the winter and spring flows. The modeled summer and fall habitat deficits are expected to affect relatively few fish and will not be limiting to Chinook salmon or steelhead populations, since the majority of adult migration and juvenile rearing and emigration within the action area does not occur during average fall flow conditions. 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 water surface elevations, where the habitat deficits are less, and the baseline conditions are reached or exceeded more quickly (*i.e.*, 5 to 10 years versus 10 to 15 years for fall and summer elevations).

### B. Impacts of the Proposed Action on the Southern Distinct Population Segment of North American Green Sturgeon

NMFS also expects the action to adversely affect the Federally listed Southern DPS of North American green sturgeon. Adverse effects to these fish are 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 in water 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 their prey base and feeding success. As is the case for salmonids, the impacts to proposed critical habitat that are expected at certain sites will result in short-term reductions in the value of some features while eventually resulting in substantial long-term gains in conservation value of nearshore and riparian features offering benefits to larvae, post-larvae, juvenile, and adult Southern DPS of North American green sturgeon.

### C. Impacts of the Proposed Action on the Survival and Recovery of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead

The adverse effects associated with the implementation of the proposed project, when analyzed within the context of the current condition of these listed species and the expected future cumulative effects within the action area, are not expected to appreciably reduce the likelihood of survival and recovery of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead. 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 conservation measures. Most 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 is expected to be small because only fish that are present during the time of construction are expected to be affected. Similarly, the number of 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 because the primary loss of habitat condition and function is limited to the low-flow fall water surface elevations, while the majority of juvenile fish are expected to be present during winter and spring months, when seasonal water elevations are higher, and integrated conservation measures such as riparian vegetation and overhanging shade are available to the species. Although Federally listed anadromous fish may be present in the action area during the summer and fall months, abundance is relatively low compared to the number of fish that are present during winter months.

Although some injury or death to individual fish is expected from construction activities and short- and long-term habitat modification, 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, the proposed action is not expected to reduce the likelihood of survival and recovery of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.

### D. Impacts of the Proposed Action on the Survival and Recovery of the Southern Distinct Population Segment of North American Green Sturgeon

The adverse effects to the Southern DPS of North American green sturgeon, when analyzed within the context of the current condition of this threatened species and the expected future cumulative effects within the action area, are not expected to affect the overall survival and recovery of the DPS. 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 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.

## E. Impacts of the Proposed Action on Designated and Proposed Critical Habitat

Impacts to the designated critical habitat of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead include the short- and long-term modification of approximately 7,500 lf of nearshore aquatic and riparian areas that are designated critical habitat. PCEs at the 18 sites include riverine areas for rearing and migration. NMFS CHART (2005b) described existing PCEs within the action area as degraded, with isolated fragments of high quality habitat. In spite of the degraded condition, the CHART report rated the conservation value of the action area as high because it is used as a rearing and migration corridor for all populations of winter-run Chinook salmon and Central Valley spring-run Chinook salmon, and by the largest populations of Central Valley steelhead.

Impacts to PCEs will last for 1 to 5 years, and after 5 years NMFS expects continued improvements leading to substantial gains in habitat quality. 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. The action area serves primarily as a migration corridor. 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 1 to 3 year reduction in the quality and availability of refuge areas in these reaches of the river to be limiting to the anadromous populations in the system. From year 4 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, Central Valley spring-run Chinook salmon, and Central Valley steelhead.

The PCE's of green sturgeon proposed critical habitat are not expected to be significantly impacted by the proposed project. Green sturgeon are not as dependant on near-shore habitat features as juvenile Chinook salmon. Thus, the projected short-term reductions in near-shore habitat features such as SRA and shallow water with flooded vegetation are not expected to result in measurable reductions in the conservation value of green sturgeon proposed critical habitat within the action area.

## VIII. CONCLUSION

After reviewing the best available scientific and commercial information, the current status of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and 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 Steamboat Slough PL 84-99 Levee Repairs, as proposed, are not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, or the Southern DPS of North American green sturgeon, and are not likely to destroy or adversely modify the designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead,.

After reviewing the best available scientific and commercial information, the current status of the Southern DPS of North American green sturgeon proposed critical habitat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' conference opinion that the Steamboat Slough PL 84-99 erosion repairs, as proposed, are not likely to destroy or adversely modify proposed critical habitat for the Southern DPS of North American green sturgeon.

## IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibits 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 contract, grant or permit, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps: (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 contract, 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 must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement [50 CFR 402.14(i)(3)].

### A. Amount and Extent of Take

NMFS anticipates incidental take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon from impacts related to construction of the Steamboat Slough Levee Repair project as a result of reductions in the quality or quantity of their habitat. Take is expected to be limited to rearing juveniles.

NMFS cannot, using the best available information, quantify the anticipated incidental take of individual Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon because of the variability and uncertainty associated with the annual population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use within the project area. However, it is possible to designate ecological surrogates for the extent of take anticipated to be caused by the project, and to monitor those surrogates to determine the level of take that is occurring. The most appropriate ecological surrogates for the extent of take caused by the project are the physical and temporal extent of turbidity caused by construction of the project and the period of time that habitat values will be reduced by construction impacts, as represented by the SAM modeling results.

1. The analysis of the effects of the proposed project anticipates that take in the form of injury and death from predation will result from construction-related turbidity that will extend up to 100 feet from the shoreline, and up to 1,000 feet downstream, along 7,500 linear feet of construction areas along the shore line Steamboat Slough and the Sacramento River.

2. The analysis of the effects of the proposed project anticipates that take in the form of harm, injury, and death of rearing and migrating juvenile Chinook salmon, steelhead, and green sturgeon will result from a reduction in the quality and quantity of nearshore habitat features. These reductions in habitat value are expected to last for no more than 5 years before recovering to, or exceeding, the current level of habitat value.

Anticipated incidental take may be exceeded 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 amount and extent of take described above is not likely to jeopardize Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley 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, Central Valley steelhead, and Central Valley 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 measure (RPM) is necessary and appropriate to minimize the incidental take of listed anadromous salmonids and green sturgeon.

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

## D. Terms and Conditions

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

1. All existing vegetation greater than 4 inches in diameter is to be protected and left in place to the greatest extent possible.

2. The Corps shall monitor all vegetation planted yearly and provide a survivability report to NMFS by December 31 of each year for three years.

3. Reports shall be submitted to:
   Sacramento Area Office
   National Marine Fisheries Service
   650 Capitol Mall, Suite 8-300
   Sacramento California 95814-4706
   Phone: (916) 930-3600
   FAX: (916) 930-3629

# IX. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. These conservation recommendations include discretionary measures that the Corps can implement to further the conservation of listed species and critical habitat, and further the development of information on the conservation of these species.

1. The Corps should ensure that future maintenance actions that repair the bank protection structure fully replace riparian vegetation.

2. The Corps, under the authority of section 7(a)(1) of the ESA, 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.

3. The Corps 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.

4. The Corps should consider developing a programmatic PL84-99 biological assessment for future repairs, which would allow some use of bioengineering techniques in the repair designs.

5. The Corps 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.

6. The Corps 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.

7. As recommended in the NMFS Proposed Recovery Plan for the Sacramento River winter-run Chinook Salmon (NMFS 1997), the Corps 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 compensation when such losses are unavoidable (*i.e.*, 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 (*i.e.*, 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 (*i.e.*, develop and implement alternative levee maintenance practices).

8. 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.

## X. REINITIATION OF CONSULTATION

This concludes formal consultation for the Steamboat Slough Levee Repair project in Sacramento, California. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological and conference opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

## XI. LITERATURE CITED


Adams, P. B., C. B. Grimes, J. E. Hightower, S. T. Lindley, and M. L. Moser. 2002. Status review for North American green sturgeon, Acipenser medirostris. National Marine Fisheries Service. 58 pages.

Allen, P. J. and J. J. Cech Jr. 2007. Age/size effects on juvenile green sturgeon, Acipenser medirostris, oxygen consumption, growth, and osmoregulation in saline environments. Environmental Biology of Fishes 79:211-229.

Allen, P. J., B. Hodge, I. Werner, and J. J. Cech. 2006. Effects of ontogeny, season, and temperature on the swimming performance of juvenile green sturgeon (Acipenser medirostris). Canadian Journal of Fisheries and Aquatic Sciences 63:1360-1369.

Bailey, E. D. 1954. Time pattern of 1953-54 migration of salmon and steelhead into the upper Sacramento River. California Department of Fish and Game, Unpublished report. 4 pages.

Bash, J., C. Berman, and S. Bolton. 2001. Effects of turbidity and suspended solids on salmonids. Center for Streamside Studies, University of Washington.

Beamesderfer, R. 2006. Personal communication. S.P. Cramer & Associates, Inc.

Beamesderfer, R., M. Simpson, G. Kopp, J. Inman, A. Fuller, and D. Demko. 2004. Historical and current information on green sturgeon occurrence in the Sacramento and San Joaquin rivers and tributaries. S.P. Cramer & Associates, Inc. 44 pages.

Benson, R. L., S. Turo, and B. W. McCovey Jr. 2007. Migration and movement patterns of green sturgeon (Acipenser medirostris) in the Klamath and Trinity rivers, California, USA. Environmental Biology of Fishes 79:269-279.

Bisson, P. B. and R. E. Bilby. 1982. Avoidance of suspended sediment by juvenile coho salmon. North American Journal of Fisheries Management 2:371-374.

Bjornn T. C. and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19:83-138.

Botsford, L. W. and J. G. Brittnacher. 1998. Viability of Sacramento River Winter-Run Chinook Salmon. Conservation Biology 12: 65-79.

Brandes, P. L. and J. S. McLain. 2001. Juvenile Chinook salmon abundance, distribution, and survival in the Sacramento-San Joaquin Estuary. In: R.L. Brown, editor. Contributions to the biology of Central Valley salmonids. Volume 2. California Department of Fish and Game Fish Bulletin 179:39-136.

Borthwick, S.M., R.R. Corwin, and C.R. Liston. 1999. Investigations of fish entrainment by archimededs and internal helical pumps at the Red Bluff Research Pumping Plant, Sacramento California: February 1997-June 1998.

Busby, P. J., T. C. Wainwright, G. J. Bryant., L. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon and California. U.S. Department of Commerce, National Oceanic and Atmospheric Administration Technical Memo NMFS-NWFSC-27. 261 pages.

California Bay-Delta Program. 2000. Ecosystem Restoration Program Plan. Vol. I: Ecological Attributes of the San Francisco Bay-Delta Watershed. Final Programmatic EIS/EIR technical appendix, July. Sacramento, California.

California Bay-Delta Program. 2001. Guide to Regulatory Compliance for Implementing CALFED Actions. Volume 1. November.

California Department of Fish and Game. 1998. A status review of the spring run chinook salmon in the Sacramento River drainage. Report to the Fish and Game Commission. Candidate species status report 98-1. June 1998. Sacramento, California.

California Department of Fish and Game. 2002. California Department of Fish and Game comments to NMFS regarding green sturgeon listing. 79 pages plus appendices.

California Department of Fish and Game. 2003. Letter from Dean Marston, CDFG, to Madelyn Martinez, National Marine Fisheries Service, January 9.

California Department of Fish and Game. 2004. Sacramento River spring-run Chinook salmon 2002-2003 biennial report. Prepared for the California Fish and Game Commission. Habitat Conservation Division, Native Anadromous Fish and Watershed Branch. Sacramento, California. 35 pages.

California Department of Fish and Game. 2006. GrandTab spring-run Chinook salmon population estimates.

California Department of Fish and Game. 2008. GrandTab winter-run Chinook salmon population estimates. March 7.

California Department of Water Resources. 2006. Critical Levee Emergency Repair Projects, Draft Biological Assessment. Prepared by URS Corporation. Sacramento, California.

Cannon, T. and T. Kennedy. 2003. Snorkel survey of the lower American River 2003. Draft report prepared for: U.S. Fish and Wildlife Service, Anadromous Fish Restoration Program.

Carlson T.J., G. Ploskey, R.L. Johnson, R.P. Mueller, MaA. Weiland, and P.N. Johnson. 2001. Observations of the behavior and distribution of fish in relation to the Columbia River navigational channel and channel maintenance activities. Prepared for the U.S. Army Corps of Engineers, Portland District, Portland Oregon.

Cech, J. J. J., S. I. Doroshov, G. P. Moberg, B. P. May, R. G. Schaffter, and D. W. Kohlhorst. 2000. Biological assessment of green sturgeon in the Sacramento-San Joaquin watershed (phase 1). Final report to the CALFED Bay-Delta Program. Project #98-C-15, Contract #B-81738. Cited in COSEWIC 2004.

Clark, G. H. 1929. Sacramento-San Joaquin salmon (Oncorhynchus tshawytscha) fishery of California. Fish Bulletin 17:1-73.

Deng, X. 2000. Artificial reproduction and early life stages of the green sturgeon (Acipenser medirostris). Master's Thesis. University of California, Davis, California. 62 pp.

Deng, X., J. P. Van Eenennaam, and S. I. Doroshov. 2002. Comparison of early life stages and growth of green and white sturgeon. Transactions of the American Fisheries Society 28:237-248.

Dunne, T. and L. B. Leopold. 1978. Water in Environmental Planning. W.H. Freeman and Company, New York.

Emmett, R. L., S. A. Hinton, S. L. Stone, and M. E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in West Coast estuaries, Volume II: Species life history summaries. ELMR Report No. 8. NOAA/NOS Strategic Environmental Assessments Division, Rockville, Maryland. 329 pp.

Erickson, D. L., J. A. North, J. E. Hightower, J. Weber, L. Lauck. 2002. Movement and habitat use of green sturgeon Acipenser medirostris in the Rogue River, Oregon, USA. Journal of Applied Ichthyology 18:565-569.

Fairey, R., K. Taberski, S. Lamerdin, E. Johnson, R. P. Clark, J. W. Downing, J. Newman, and M. Petreas. 1997. Organochlorines and other environmental contaminants in muscle tissues of sportfish collected from San Francisco Bay. Marine Pollution Bulletin 34:1058-1071.

Feist, B. E., J. J. Anderson, and R. Miyamoto. 1992. Potential impacts of pile driving on juvenile pink (Oncorhynchus gorbuscha) and chum (O. keta) salmon behavior and distribution. FRI-UW-9603. Fisheries Resources Institute, University of Washington. Seattle, Washington.

Feist, G. W., M. A. H. Webb, D. T. Gundersen, E. P. Foster, C. B. Schreck, A. G. Maule, and M. S. Fitzpatrick. 2005. Evidence of detrimental effects of environmental contaminants on growth and reproductive physiology of white sturgeon in impounded areas of the Columbia River. Environmental Health Perspectives 113:1675-1682.

Fisher, F. W. 1994. Past and present status of Central Valley Chinook salmon. Conservation Biology 8(3):870-873.

Foster, E. P., M. S. Fitzpatrick, G. W. Feist, C. B. Schreck, and J. Yates. 2001a. Gonad organochlorine concentrations and plasma steroid levels in white sturgeon (Acipenser transmontanus) from the Columbia River, USA. Bulletin of Environmental Contamination and Toxicology 67:239-245.

Foster, E. P., M. S. Fitzpatrick, G. W. Feist, C. B. Schreck, J. Yates, J. M. Spitsbergen, and J. R. Heidel. 2001b. Plasma androgen correlation, EROD induction, reduced condition factor, and the occurrence of organochlorine pollutants in reproductively immature white sturgeon (Acipenser transmontanus) from the Columbia River, USA. Archives of Environmental Contamination and Toxicology 41:182-191.

Gaines, P. D. and W. R. Poytress. 2004. Brood-year 2003 winter Chinook juvenile production indices with comparisons to adult escapement. U.S. Fish and Wildlife Service report to California Bay-Delta Authority. San Francisco, California.

Garland, R. D., K. F. Tiffan, D. W. Rondorf, and L. O. Clark. 2002. Comparison of subyearling fall Chinook salmon's use of riprap revetments and unaltered habitats in Lake Wallula of the Columbia River. North American Journal of Fisheries Management 22:1283-1289.

Goetz, F. A., J. J. Dawson, T. Shaw, and J. Dillon. 2001. Evaluation of Low-Frequency Sound Transducers for Guiding Salmon Smolts Away from a Navigation Lock. In C. C. Coutant (ed.), Behavioral Technologies for Fish Guidance, American Fisheries Society Symposium 26. August. 203 pages.

Good, T. P., R. S. Waples, and P. Adams (editors). 2005. Updated status of Federally listed ESU of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Technical Memo. NMFS-NWFSC-66. 598 pages.

Greenfield, B. K., J. A. Davis, R. Fairey, C. Roberts, D. Crane, and G. Ichikawa. 2005. Seasonal, interannual, and long-term variation in sport fish contamination, San Francisco Bay. Science of the Total Environment 336:25-43.

Hallock, R. J. D. H. Fry, and D. A. LaFaunce. 1957. The use of wire fyke traps to estimate the runs of adult salmon and steelhead in the Sacramento River. California Fish and Game. 43(4):271-298.

Hallock, R. J., W. F. Van Woert, and L. Shapovalov. 1961. An evaluation of stocking hatchery-reared steelhead rainbow trout (Salmo gairdnerii gairdnerii) in the Sacramento River system. California Department of Fish and Game. Fish Bulletin No. 14. 74 pages.

Hare, S. R., N. J. Mantua, and R. C. Francis. 1999. Inverse production regimes: Alaska and West Coast Pacific salmon. Fisheries 24 (1): 6-14.

Healey, M. C. 1980. Utilization of the Nanaimo River Estuary by juvenile Chinook salmon, Oncorhynchus tshawytscha. U.S. Fisheries Bulletin 77:653-668.

Healey, M. C. 1991. Life history of Chinook salmon (Oncorhynchus tshawytscha). In C. Groot and L. Margolis, editors, Pacific Salmon Life Histories, pages 396-445. University of British Columbia Press, Vancouver, British Columbia. 564 pages.

Heublein, J. 2006. Personal communication (University of California, Davis) with Tim Hamaker (CH2MHill). February.

Heublein, J. C., J. T. Kelly, C. E. Crocker, A. P. Klimley, and S. T. Lindley. 2008. Migration of green sturgeon, Acipenser medirostris, in the Sacramento River. Environmental Biology of Fishes. Published online November 5, 2008, (DOI: 10.1007/s10641-008-9432-9). http://www.springerlink.com/content/x760521q72k70521/fulltext.html

Huang, B. and Z. Liu. 2000. Temperature Trend of the Last 40 Years in the Upper Pacific Ocean. Journal of Climate 4:3738–3750.

Interagency Ecological Program Steelhead Project Work Team. 1999. Monitoring, assessment, and research on Central Valley steelhead: status of knowledge, review existing programs, and assessment needs. In Comprehensive Monitoring, Assessment, and Research Program Plan, Tech. App. VII.

Intergovernmental Panel on Climate Change. 2001. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T.,Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 881 pages.

Israel, J. 2006. Determining spawning population estimates for green sturgeon with microsatellite DNA. Presentation at Interagency Ecological Program 2006 Annual Workshop, Pacific Grove, California. March 3.

Jones & Stokes Associates, Inc. 2002. Foundation runs report for restoration action gaming trials. Prepared for Friant Water Users Authority and Natural Resource Defense Council.

Keefer, M. L., C. A. Perry, M. A. Jepson, and L. C. Stuehrenberg. 2004. Upstream migration rates of radio-tagged adult Chinook salmon in riverine habitats of the Columbia River basin. Journal of Fish Biology 65:1126-1141.

Kelley, J. T., A. P. Klimley, and C. E. Crocker. 2006. Movements of green sturgeon, Acipenser medirostris, in the San Francisco Bay Estuary, California. Editorial manuscript for Environmental Biology of Fishes.

Klimley, A.P. Biological assessment of green sturgeon in the Sacramento-San Joaquin watershed. A proposal to the California Bay-Delta Authority. 2002.

Kjelson, M. A., P. F. Raquel, and F. W. Fisher. 1982. Life history of fall-run juvenile chinook salmon, Oncorhynchus tshawytscha, in the Sacramento-San Joaquin estuary, California. Pages 393-411 in V.S. Kennedy, editor. Estuarine comparisons. Academic Press, New York, New York.

Kruse, G. O. and D. L. Scarnecchia. 2002. Assessment of bioaccumulated metal and organochlorine compounds in relation to physiological bismarkers in Kootenai River white sturgeon. Journal of Applied Ichthyology 18:430-438.

Kynard, B., E. Parker, and T. Parker. 2005. Behavior of early life intervals of Klamath River green sturgeon, Acipenser medirostris, with note on body color. Environmental Biology of Fishes 72:85-97.

Lassettre, N.S., and R.R. Harris. 2001. The geomorphic and ecological influence of large woody debris in streams and rivers. University of California. Berkeley.

Levy, D. A. and T. G. Northcote. 1981. The distribution and abundance of juvenile salmon in marsh habitats of the Fraser River Estuary. Westwater Research Centre, University of British Columbia, Technical Report no. 25. Vancouver, B.C., Canada.

Lindley, S. T. 2006. Large-scale migrations of green sturgeon. Presentation at Interagency Ecological Program 2006 Annual Workshop, Pacific Grove, California. March 3.

Lindley, S. T. and M. S. Mohr. 2003. Modeling the effect of striped bass (Morone saxatillis) on the population viability of Sacramento River winter-run Chinook salmon (Oncorhynchus tshawytscha). Fisheries Bulletin 101:321-331.

Lindley, S. T., R. Schick, A. Agrawal, M. Goslin, T. Pearson, E. Mora, J.J. Anderson, B. May, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J. G. Williams. 2006. Historical population structure of Central Valley steelhead and its alteration by dams. San Francisco Estuary and Watershed Science. Volume 4, Issue 1, Article 3. http://repositories.cdlib.org/jmie/sfews/vol4/iss1/art3

Lindley, S.T., R. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. R. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2006a. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin basin. San Francisco Estuary and Watershed Science 5(1): 1-26.

Lindley, S. T., R. Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B. P. May, D. McEwan, R.B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin basins. ESUs in California's Central Valley basin. San Francisco Estuary and Watershed Science. Volume 5, Issue 1, Article 4.

MacDonald, L. H., A. W. Smart, and R. C. Wissmar. 1991. Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska. EPA Region 10 and University of Washington Center for Streamside studies, Seattle, Washington.

MacFarlane, B. R., and E. C. Norton. 2001. Physiological ecology of juvenile Chinook salmon (Oncorhynchus tshawytscha) at the southern end of their distribution, the San Francisco Estuary and Gulf of the Farallones, California. Fisheries Bulletin 100:244-257.

Mantua, N. J. and S. R. Hare. 2002. The Pacific decadal oscillation. J. Oceanogr 58:35-44

Martin, C. D., P. D. Gaines and R. R. Johnson. 2001. Estimating the abundance of Sacramento River juvenile winter Chinook salmon with comparisons to adult escapement. Red Bluff Research Pumping Plant Report Series, Volume 5. U.S. Fish and Wildlife Service, Red Bluff, California.

Matter, A. L. and B. P. Sandford. 2003. A comparison of migration rates of radio and PIT-tagged adult Snake River Chinook salmon through the Columbia River hydropower system. North American Journal of Fisheries Management 23:967-973.

Mayfield, R.B. and J.J. Cech, Jr. 2004. Temperature Effects on green sturgeon bioenergetics. Transactions of the American Fisheries Society 133:961-970.

McEwan, D. 2001. Central Valley steelhead. Contributions to the biology of Central Valley salmonids. California Department of Fish and Game Fish Bulletin 179(1):1-44.

McEwan, D. and T. A. Jackson. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game. Sacramento, California. 234 pages.

McLain, J. 2006. Personal communication. Fisheries Biologist. Sacramento Area Office, National Marine Fisheries Service. Sacramento, California.

McReynolds, T. R., C. E. Garman, P. D. Ward, and M. C. Schommer. 2005. Butte and Big Chico Creeks spring-run Chinook salmon, Oncorhynchus tshawytscha life history investigation, 2003-2004. California Department of Fish and Game, Inland Fisheries Administrative Report No. 2005-1.

Meyer, J. H. 1979. A review of the literature on the value of estuarine and shoreline areas to juvenile salmonids in Puget Sound, Washington. U.S. Fish and Wildlife Service. Fisheries Assistance Office, Olympia, Washington.

Mora, E. 2006. Modeling green sturgeon habitat in the Central Valley. Presentation at the 2006 CALFED Science conference, Sacramento, California. October 23.

Mount, J. F. 1995. California rivers and streams: The conflict between fluvial process and land use. University California Press, Berkeley, California.

Moyle, P. B. 2002. Inland fishes of California. University of California Press, Berkeley.

Moyle, P. B., J. E. Williams, and E. D. Wikramanayake. 1989. Fish species of special concern of California. Wildlife and Fisheries Biology Department, University of California, Davis. Prepared for The Resources Agency, California Department of Fish and Game, Rancho Cordova.

Moyle, P. B., Foley P. J., and R. M. Yoshiyama. 1992. Status of green sturgeon, Acipenser medirostris, in California. Final report sent to NMFS, Terminal Island, California by UC Davis Department of Wildlife and Fisheries Biology. 12 pages.

Moyle, P. B., R. M. Yoshiyama, J. E. Williams, and E. D. Wikramanayake. 1995. Fish species of special concern in California, 2nd edition. California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, California. 277 pp.

Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L .J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. Technical Memorandum NMFS-NWFSC-35. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 443 pages.

Nakamoto, R. J., T. T. Kisanuki, and G. H. Goldsmith. 1995. Age and growth of Klamath River green sturgeon (Acipenser medirostris). U.S. Fish and Wildlife Service. Project # 93-FP-13. 20 pages.

National Marine Fisheries Service. 1996. Endangered Species Act - Section 7 consultation, biological opinion, The fishery management plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon, and California of the Pacific Fishery Management Council.

National Marine Fisheries Service. 1998. Factors Contributing to the Decline of Chinook Salmon: An Addendum to the 1996 West Coast Steelhead Factors For Decline Report. Protected Resources Division, National Marine Fisheries Service. Portland, Oregon.

National Marine Fisheries Service. 2003. Draft Report of Updated Status of Listed ESUs of Salmon and Steelhead. NOAA Fisheries, Northwest Fisheries Science Center, Seattle, Washington. (http://www.nwfsc.noaa.gov/cbd/trt/brt/brtrpt.html)

National Marine Fisheries Service. 2005a. Green sturgeon (Acipenser medirostris) status review update. Biological review team, Santa Cruz Laboratory, Southwest Fisheries Science Center, California. February. 31 pages.

National Marine Fisheries Service. 2005b. Final assessment of the National Marine Fisheries Service's critical habitat analytical review teams (CHARTs) for seven salmon and steelhead evolutionarily significant units (ESUs) in California. Prepared by the NOAA Fisheries Protected Resources Division, Long Beach, California.

Newcombe, C. P., and J. O. T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16:693-727

Newton, J. 2002. Personal communication. Red Bluff Fish and Wildlife Office, U.S. Fish and Wildlife Service. Red Bluff, California. August 27.

Nguyen, R. M. and C. E. Crocker. 2007. The effects of substrate composition on foraging behavior and growth rate of larval green sturgeon, Acipenser medirostris. Environmental Biology of Fishes 79:231-241.

Noakes, D. J. 1998. On the coherence of salmon abundance trends and environmental trends. North Pacific Anadromous Fishery Commission Bulletin, pages 454-463.

Nobriga, M. and P. Cadrett. 2003. Differences among hatchery and wild steelhead: evidence from Delta fish monitoring programs. Interagency Ecological Program for the San Francisco Estuary Newsletter 14:3:30-38.

Pacific Fishery Management Council. 2004. Review of 2003 Ocean Salmon Fisheries. Available: www.pcouncil.org

Page, L. M. and B. M. Burr. 1991. A Field Guide to the Freshwater Fishes of North America North of Mexico. The Peterson Field Guide Series, Houghton Mifflin Company, Boston, Massachusetts. 432 pages.

Piegay, H. 2002. Dynamics of wood in large rivers, in Gregory, S.V. (ed.), Ecology and management of wood in world rivers. American Fisheries Society. Bethesda, Maryland.

Power, M.E. 1987. Predator avoidance by grazing fishes in temperate and tropical streams: importance of stream depth and prey size. In: Kerfoot W.C. and Sih A. (eds.) Predation: direct and indirect impacts on aquatic communities. University Press of New England

Radtke, L. D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta with observations on food of sturgeon, in Ecological studies of the Sacramento-San Joaquin Delta, Part II. (J. L. Turner and D. W. Kelley, comp.). California Department of Fish and Game Fish Bulletin 136:115-129.

Reynolds, F. L., T. J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley streams: a plan for action. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California.

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, Colorado.

Ross, Sarah. 2006. December 12, 2006, monitoring report: riparian mitigation on the Lower American River. Powerpoint presentation

Schaffter, R. 1980. Fish occurrence, size, and distribution in the Sacramento River near Hood, California during 1973 and 1974. California Department of Fish and Game.

Schlosser. I.J. 1991. Stream fish ecology: A landscape perspective. BioScience 41:704-711

Schmetterling, D. A., C. G. Clancy, and T. M. Brandt. 2001. Effects of riprap bank reinforcement on stream salmonids in the western United States. Fisheries 26(7): 6-23.

Scott, W. B. and E. J. Crossman. 1973. Freshwater Fishes of Canada. Bulletin 184, Fisheries Research Board of Canada, Ottawa. 966 pages.

Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. Effects of chronic turbidity on density and growth of steelhead and coho salmon. Transactions of the American Fisheries Society 113:142-150.

Sillman, A.J., A.K. Beach, D.A. Dahlin, and E.R. Loew. 2005. Photoreceptors and visual pigments in the retina of the fully anadromous green sturgeon (Acipenser medirostris) and the potamodromous pallid sturgeon (Scaphirhynchus albus). Journal of Comparative Physiology. 191:799-811.

Snider, B., and R. G. Titus. 2000. Timing, composition, and abundance of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing, October 1996-September 1997. California Department of Fish and Game, Habitat Conservation Division, Stream Evaluation Program Technical Report No. 00-04.

Sommer, T. R., M. L. Nobriga, W. C. Harrel, W. Batham, and W. J. Kimmerer. 2001. Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58:325-333.

S.P. Cramer and Associates, Inc. 2000. Stanislaus River data report. Oakdale, California.

Spence, B., G. Lomnicky, R., Hughes, and R. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. Technical Environmental Research Services Corp., Corvallis, Oregon.

Stillwater Sciences. 2004. Appendix H: conceptual models of focus fish species response to selected habitat variables. In: Sacramento River Bank Protection final Standard Assessment Methodology. July.

Stillwater Sciences. 2006. Biological Assessment for five critical erosion sites, river miles: 26.9 left, 34.5 right, 72.2 right, 99.3 right, and 123.5 left. Sacramento River Bank Protection Project. May 12.

Sweeney, B. W., Bott, T. L. Jackson, J. K. Kaplan, L. A. Newbold, J. D. Standley, L. J. Hession, W. C., and R. J. Horwitz. 2004. Riparian deforestation, stream narrowing, and loss of stream ecosystem services. National Academy of Sciences 101:14132-14137.

Tucker, M. 2007. Personal communication. Fisheries biologist. Sacramento Area Office, National Marine Fisheries Service, Sacramento, California. September.

U.S. Army Corps of Engineers Sacramento District. 2004. Standard Assessment Methodology for the Sacramento River Bank Protection Project, Final. Prepared by Stillwater Sciences and Dean Ryan Consultants, Sacramento, California. Contract DACW05-99-D-0006. Task Order 0017. 25 May.

U.S. Fish and Wildlife Service. 1995. Working paper on restoration needs: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Volumes 1-3. Prepared by the Anadromous Fish Restoration Program Core Group for the U.S. Fish and Wildlife Service, Stockton, California.

U.S. Fish and Wildlife Service. 1997. Abundance and survival of juvenile Chinook salmon in the Sacramento-San Joaquin Estuary. 1994 Annual Progress Report. Stockton, California.

U.S. Fish and Wildlife Service. 2000. Impacts of riprapping to ecosystem functioning, lower Sacramento River, California. U.S. Fish and Wildlife Service, Sacramento Field Office, Sacramento, California. Prepared for US Army Corps of Engineers, Sacramento District.

U.S. Fish and Wildlife Service. 2001. Abundance and Survival of Juvenile Chinook Salmon in the Sacramento-San Joaquin Estuary: 1997 and 1998. Annual progress report Sacramento-San Joaquin Estuary.

Van Eenennaam, J. P., M. A. H. Webb, X. Deng, S. I. Doroshov, R. B. Mayfield, J. J. Cech, D. C. Hillemeier, and T. E. Willson. 2001. Artificial spawning and larval rearing of Klamath River green sturgeon. Transactions of the American Fisheries Society 130:159-165.

Van Eenennaam, J. P., J. Linares-Casenave, X. Deng, and S. I. Doroshov. 2005. Effect of incubation temperature on green sturgeon embryos, Acipenser medirostris. Environmental Biology of Fishes 72:145-154.

Varanasi, U. and N. Bartoo. 2008. Memorandum from Usha Varanasi (NMFS-Northwest Fisheries Science Center) and Norm Bartoo (NMFS-Southwest Fisheries Science Center) to D. Robert Lohn (NMFS-Northwest Region) and Rodney McInnis (NMFS-Southwest Region), RE: Evaluating Causes of Low 2007 Coho and Chinook Salmon Returns. Febraury 22. 4 pages.

Vogel, D. A. and K. R. Marine. 1991. Guide to Upper Sacramento River Chinook salmon life history. Prepared for the U.S. Bureau of Reclamation, Central Valley Project.

Vogel, D.A. 2006. Biological Studies at the Glenn Colusa Irrigation District Fish Screen. Final Report to the GCID Technical Oversight Committee.

Waite, I.R., and R.A. Barnhart. 1992. Habitat criteria for rearing steelhead: a comparison of site-specific and standard curves for use in the instream flow incremental methodology. North American Journal of Fisheries Management. 12:40-46.

Ward, P. D., T. R. McReynolds, and C.E. Garman. 2002. Butte and Big Chico Creeks spring-run Chinook salmon, Oncorhynchus tshawytscha life history investigation, 2000-2001. California Department of Fish and Game, Inland Fisheries Administrative Report.

Ward, P. D., T. R. McReynolds, and C. E. Garman. 2003. Butte and Big Chico Creeks spring-run Chinook salmon, Oncorhynchus tshawytscha life history investigation, 2001-2002. California Department of Fish and Game, Inland Fisheries Administrative Report.

Werner, I., J. Linares-Casenave, J.P. Van Eenennaam, and S.I. Doroshov. 2007. The effect of temperature stress on development and heat-shock protein expression in larval green sturgeon (Acipenser medirostris). Environmental Biology of Fishes 79:191-200.

Yoshiyama, R. M., E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. Sierra Nevada Ecosystem Project: final report to Congress. In Assessments, commissioned reports, and background information, volume 3, pages 309-362. University of California, Center for Water and Wildland Resources, Davis, California.

Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the Central Valley Region of California. North American Journal of Fisheries Management 18:487-521.

Yoshiyama, R.M, E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 2001. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. In: Brown, R.L., editor. Contributions to the biology of Central Valley salmonids. Volume 1. California Department of Fish and Game Fish Bulletin 179:71-177.

**Enclosure 2**

**Magnuson-Stevens Fishery Conservation and Management Act**

## ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

## 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 the proposed Steamboat Slough 18 Public Law (PL) 84-99 Levee Repairs, Sacramento County, California. 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. Federal action agencies must consult with NMFS on activities which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies. The geographic extent of freshwater EFH for Pacific salmon in the Sacramento River includes waters currently or historically accessible to salmon within the Sacramento River.

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

The biological and conference opinion for the Steamboat Slough PL 84-99 Levee 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 (*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 1 foot and velocities ranging from 1 to 3.5 feet per second. Preferred spawning substrate is clean loose gravel ranging from 1 to 4 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 implement the Steamboat Slough Levee Repair Project to repair 17 sites in the Sacramento River Delta and one site in Steamboat Slough. A detailed description of the proposed action is provided in the *Description of the Proposed Action* section of the preceding biological and conference 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 and conference opinion (Enclosure 1) for critical habitat of Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon. A summary of the effects of the proposed action on Central Valley fall-/late fall-run Chinook salmon is provided 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 18 project sites. Primary construction related impacts include riprapping approximately 7,500 linear feet of riverbank. Integrated conservation measures to minimize adverse effects of riprapping will be applied to all sites.

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 best management practices (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 operation and maintenance (O&M) actions will be similar to construction impacts. 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.

## IV. CONCLUSION

Upon review of the effects of Steamboat Slough Levee 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 and conference opinion (Enclosure 1), NMFS recommends that Terms and Condition 1a and 1b; as well as all the Conservation Recommendations in the preceding biological and conference opinion prepared for the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead ESUs be adopted as EFH Conservation Recommendations.

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.

## VI. STATUTORY REQUIREMENTS

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

## VII. LITERATURE CITED

Healey, M.C. 1991. Life history of Chinook salmon. *In* C. Groot and L. Margolis: Pacific Salmon Life Histories. University of British Columbia Press. pp. 213-393.

Kjelson, M.A., P.F. Raquel, and F.W. Fisher. 1982. Life history of fall-run juvenile chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin estuary, California, pp. 393-411. *In*: V.S. Kennedy (ed.). Estuarine comparisons. Academic Press, New York, NY.

Lister, D.B., and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon in the Big Qualicum River, British Columbia. J. Fish. Res. Board Can. 27:1215-1224.

Reiser, D.W., and T.C. Bjornn. 1979. Influence of forest and rangeland management on anadromous fish habitat in western North America: Habitat requirements of anadromous salmonids. U.S. Department of Agriculture, Forest Service General Technical Report PNW-96. Pacific Northwest Forest and Range Experimental Station, Portland, Oregon. 54 pp.

Reynolds, F.L., T.J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley Streams: A Plan for Action. California Department of Fish and Game. Inland

Steamboat Slough Levee Repair Project Information Report for PL 84-99 Levee Rehabilitation. 2009

**DEPARTMENT OF THE ARMY**
**U.S ARMY ENGINEER DISTRICT, SACRAMENTO**
**CORPS OF ENGINEERS**
**1325 J STREET**
**SACRAMENTO, CALIFORNIA 95814-2922**

Environmental Resources Branch

OCT 27 2010

Mr. Rodney R. McInnis
Regional Administrator
National Marine Fisheries Service
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802

Dear Mr. McInnis:

The U.S. Army Corps of Engineers (Corps) is writing to initiate informal consultation under Section 7(a) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*), regarding levee repairs from the storm event of 2005/2006 completed under the authority of Public Law (PL) 84-99: Rehabilitation of Damaged Flood Control Works. Consultation on the PL 84-99 sites concluded with Letter of Concurrence (LOC) 2007/06163 dated July 2, 2008 for sites within Reclamation District (RD) 3, 551/755, 785, 1001, and Deer Creek; LOC 2008/03574 dated July 10, 2008 for sites within RD 2098; LOC 2008/03274 dated July 24, 2008 for sites within RD 756; LOC 2008/03939 dated August 8, 2008 for sites within RD 17; and a Biological Opinion (BO) 2009/01912 dated August 18, 2009 for sites within RD 150. All levee repairs have been completed, but the avoidance and minimization measures have not been fully implemented. Due to levee integrity concerns over the willow pole plantings and the implementation of Engineering Technical Letter 1110-2-571 (ETL), the Corps cannot complete these measures.

Construction began on August 4, 2008 at sites within RD 3, 551/755, 785, 1001, and Deer Creek. Repairs were completed by September 30, 2008, except at RD 3. Construction was completed at RD 3 on October 23, 2008 after an extension was granted to continue in-water work past the recommended work window. On January 20, 2009, National Marine Fisheries Service (NMFS) withdrew concurrence of a "not likely to adversely affect" determination for LOC 2007/06163, LOC 2008/03274, and LOC 2008/03939 due to changes in the project description. Consultation for repairs at RD 150 was completed separately from the other sites. Construction at this RD began on November 2, 2009 and was completed by January 20, 2010.

Repairs at each site consisted of the same general design, which included excavating the eroded slope at least six inches beyond the damaged surface and backfilled with quarry rock. The quarry rock was then covered by two feet of 18-inch rock and surface voids were filled with four-inch minus rock. The repaired slope was graded to match the adjacent, undamaged levee slope.

Approximately 40,000 linear feet (lf) of shaded riverine aquatic (SRA) habitat is required to mitigate for construction impacts to endangered species habitat under ESA. In order to reach a "may affect, not likely to adversely affect" determination on Federally listed green sturgeon (*Acipenser medirostris*), Central Valley steelhead (*Oncorhynchus mykiss*), Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*), Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), and their designated critical habitat, the Corps had proposed to plant three rows of willow pole cuttings along the levee toe separated by two feet, with the cuttings spaced three feet apart. A stinger-equipped excavator was selected to use for the plantings because the stinger could easily penetrate the rip-rap allowing the cuttings to be installed into soil. After a demonstration project using the stinger, the Corps determined that the three row planting specification was detrimental to levee integrity and stability and therefore, could not be used. Since then, the Corps has revised the planting specifications to consist of willow pole cuttings in two rows in three foot intervals along the levee toe for the length of each repair site.

With the implementation of the ETL, which prohibits vegetation within 15 feet of the levee toe, planting willow poles along all of the repair sites cannot be completed without a variance. Specifically, the ETL defines the vegetation free zone as the width of the levee plus 15 feet on each side and a minimum of eight feet vertically, measured from any point of the ground. Of the 40,000 lf required for mitigation, approximately 24,000 lf fall within the vegetation free zone, leaving the remaining 16,000 lf outside the vegetation free zone and able to be planted on-site without an approved variance.

As a result of the levee integrity concerns and the ETL guidance, the Corps is no longer able to meet the avoidance and minimization measures defined in the LOCs and the BO. In an effort to keep our commitment and mitigate impacts we propose the follow solution:

- Plant willow pole cuttings in two rows, spaced in three foot intervals along approximately 16,000 lf at sites outside the vegetation free zone. This planting specification allows willows to be planted on-site without compromising the integrity of the levee. Based on a reevaluation of the Standardized Assessment Methodology (SAM) analysis, provided to your office May 19, 2009, the Corps has determined the revised planting method still maintains a "not likely to adversely effect" determination for the Federally listed fish species mentioned above. The 16,000 lf to be planted with this design are sites located within RD 1001, RD 551/755, RD 2098, RD 765, and RD 17. See Enclosures 1 and 2 for site specific details.

- A vegetation variance request was submitted to South Pacific Division Headquarters on September 21, 2010 seeking a variance to plant willow poles within the vegetation free zone. The request is seeking an approval to plant the willow poles along approximately 14,000 lf at sites located in RD 3, RD 150, and RD 551.

- Purchase approximately 10,000 lf of SRA habitat at a species approved mitigation bank for the remaining linear footage for sites that cannot be planted on-site.

Specifically, the Corps would plant 16,342 lf outside the vegetation free zone, obtain a vegetation variance to plant 14,122 lf within the vegetation free zone, and purchase 9,898 lf from an approved mitigation bank.

In an effort to reach an administrative solution, we request your concurrence that the proposed mitigation plan meets our commitments per the LOCs and the BO. Please respond within 30 days from the date of this letter so the Corps can begin implementation of the proposed plan this construction season. If you have any questions or need additional information, please contact Ms. Jamie LeFevre, U.S. Army Corps of Engineers, Environmental Resources Branch, 1325 J Street, Sacramento, California 95814-2922, telephone (916) 557-6693, e-mail: Jamie.M.LeFevre@usace.army.mil.

Sincerely,

Alicia E. Kirchner
Chief, Planning Division

Enclosure

Copy Furnished:
Mr. Michael Hendrick, National Marine Fisheries Service, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814-4706

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

DEC 21 2010

In response refer to:
2010/05786

Alicia E. Kirchner
Chief, Planning Division
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Dear Ms. Kirchner:

This is in response to your October 27, 2010, letter that requests initiation of section 7 consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C 1531 *et seq.*), regarding levee repairs from the storm event of 2005/2006 completed under the authority of Public Law (PL) 84-99: Rehabilitation of Damaged Flood Control Works. As part of the implementation of the PL 84-99 project, the U.S. Army Corps of Engineers (Corps) is proposing to plant willow pole cuttings along approximately 16,000 linear feet (lf) of shaded riverine aquatic (SRA) habitat, and purchase approximately 10,000 lf of SRA habitat at a species approved mitigation bank. Also, the Corps has submitted a vegetation variance request which is seeking to plant willow pole cuttings along approximately 14,000 lf of SRA habitat. The Corps has determined that the PL 84-99 projects may affect but are not likely to adversely affect Federally listed threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), endangered Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*), threatened CV steelhead distinct population segment (DPS) (*O. mykiss*), and threatened Southern DPS of North American green sturgeon (*Acipenser medirostris*), and their respective designated critical habitats. In addition, the Corps has determined that the proposed projects will not adversely affect Essential Fish Habitat (EFH) of Pacific salmon and thus fulfills section 305 (b) (2) of the Magnuson – Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). This letter also serves as consultation under the authority of, and in accordance with, the provisions of the Fish and Wildlife Coordination Act of 1934 (FWCA), as amended.

**<u>Consultation Summary</u>**

The Corps previously consulted with NMFS regarding the PL 84-99 sites. This consultation concluded with:

1. Letter of Concurrence (LOC) 2008/06163 dated July 2, 2008, for levee repair sites within Reclamation District (RD) 3, 551/755, 785, 1001, and Deer Creek;

2. LOC 2008/03574 dated July 10, 2008, for levee repair sites within RD 2098;

3. LOC 2008/03274 dated July 24, 2008, for levee repair sites within RD 756;

4. LOC 2008/03939 dated August 8, 2008, for levee repair sites within RD 17; and a

5. Biological Opinion (BO) 2009/01912 dated August 18, 2009, for levee repair sites within RD 150. RD 150 was dropped from the PL84-99 program for not maintaining their levees. Thus, consultation for repairs at RD 150 was completed separately from the other sites. RD 150 is included in this consultation process as the impacts and subsequent avoidance and minimization measures, and construction periods and methods are similar.

On January 20, 2009, NMFS withdrew its not likely to adversely affect concurrence for LOC 2008/06163, LOC 2008/03274, and LOC 2008/03939 after learning of changes in the project descriptions. As mentioned above, the Corps maintains the determination that the PL 84-99 levee repair projects and associated actions may affect, but are not likely to adversely affect the Federally listed threatened CV spring-run Chinook salmon ESU, endangered Sacramento River winter-run Chinook salmon ESU, threatened CV steelhead DPS, and threatened Southern DPS of North American green sturgeon, and their designated critical habitats.

## Construction Summary

All the PL 84-99 levee repairs have been completed. Construction began on August 4, 2008, at sites within RD 3, 17, 551/755, 756, 785, 1001, 2098, and Deer Creek. Repairs were completed by September 30, 2008, except at RD 3. Construction was completed at RD 3 on October 23, 2008, after an extension was granted to continue in-water work beyond the recommended work window. Construction at RD 150 began on November 2, 2009, and was completed by January 20, 2010. Repairs at each site consisted of the same general design, which included excavating the eroded slope at least six inches beyond the damaged surface and backfilling with quarry rock. The quarry rock was then covered by two feet of 18-inch rock and surface voids were filled with 4-inch (and smaller) rock. The repaired slope was graded to match the adjacent, undamaged levee slope.

## Avoidance and Minimization Measures Summary

As of December 2010, the Corps has yet to fully implement its proposed and prescribed avoidance and minimization measures that were a part of the consultation process. The Corps cites levee integrity concerns over the willow pole planting and the implementation of the Engineering Technical Letter 1110-2-571 (ETL) as the reasons for delinquency regarding the avoidance and minimization measures.

As described in the October 27, 2010, letter and in the original consultation process, approximately 40,000 lf of SRA habitat is proposed by the Corps to mitigate for construction impacts to endangered species habitat under ESA. All Federally listed fish species potentially found in the area of the PL 84-99 levee repair projects, the CV spring-run Chinook salmon ESU, Sacramento River winter-run Chinook salmon ESU, CV steelhead DPS, and Southern DPS of North American green sturgeon, have life histories, biological and habitat requirements that have been impacted. In order to reach a may affect, not likely to adversely affect determination on the Federally listed species and their designated critical habitat, the Corps proposed to plant three rows of willow pole cuttings along the levee toe separated by two feet, with the cuttings spaced three feet apart. A stinger-equipped excavator was selected to use for the plantings because the stinger could penetrate the rip-rap allowing the cutting to be installed into soil. However, after a demonstration project using the stinger, the Corps determined that the three row planting specification was detrimental to levee integrity and stability and therefore, could not be used. Since then, the Corps has revised the planting specifications to consist of willow pole cuttings in two rows in three-foot intervals along the levee toe for the length of each repair site.

With the implementation of the ETL, which prohibits vegetation within 15 feet of the levee toe, planting willow poles along portion of the repair sites cannot be completed without an approved variance. Specifically, the ETL defines the vegetation free zone as the width of the levee plus 15 feet on each side and a minimum of eight feet vertically, measured from any point of the ground. Of the 40,000 lf proposed by the Corps for mitigation, approximately 24,000 lf fall within the vegetation free zone, leaving the remaining 16,000 lf outside the vegetation free zone and able to be planted on-site without an approved variance.

The Corps cites concerns over levee integrity and the ETL guidance as reasons for non-compliance regarding the avoidance and minimization measures defined in the LOCs and the BO. The Corps proposes the following in order to mitigate for PL 84-99 levee repair impacts:

1. Plant willow pole cuttings in two rows, spaced in three-foot intervals along approximately 16,000 lf at sites outside the vegetation free zone. Based on a reevaluation of the Standardized Assessment Methodology (SAM) analysis, provided to NMFS on May 19, 2009, the Corps has determined the revised planting method still maintains a not likely to adversely affect determination for the Federally listed fish species mentioned above. The 16,000 lf to be planted with this design are sites located within RD 1001, RD 551/755, RD 2098, RD 765, and RD 17.

2. A vegetation variance request was submitted to the Corps' South Pacific Division Headquarters on September 21, 2010, seeking a variance to plant willow poles within the vegetation free zone. The request is seeking an approval to plant the willow poles along approximately 14, 000 lf at sites located in RD 3, RD 150, and RD 551

3. Purchase approximately 10,000 lf of SRA habitat at a species approved mitigation bank for the remaining linear footage for sites that cannot be planted on-site.

Specifically, the Corps would plant 16,342 lf outside the vegetation-free zone, obtain a vegetation variance to plant 14,122 lf within the vegetation free zone, and purchase 9,898 lf from an approved mitigation bank.

The Corps has concluded that the proposed conservation measures still maintain a not likely to adversely affect determination because SAM-modeled species responses do not decline below pre-construction conditions.

Note: The SAM model evaluates bank protection by taking into account factors affecting listed fish species. By quantifying responses of listed fish species to changing habitat conditions over time, users can determine the necessary measures to avoid, minimize, or compensate for impacts to fish habitat at various life stages.

**Effects and Endangered Species Act Section 7 Consultation**

NMFS has reviewed the October 27, 2010, letter and its attached information, consultation history, and related administrative record. Despite this information, it is NMFS' position that we do not conduct an after-the-fact consultation. Thus NMFS is not providing a Section 7 consultation for levee repairs resulting from the storm events of 2005/2006 completed under the authority of PL 84-99. However, NMFS is able to consult on the Corps' proposal to plant 16,000 lf of willow pole cuttings, submission of a variance request, and purchase of 10,000 lf of SRA credits for construction related impacts at a NMFS-approved species conservation bank, from this point forward referred to collectively as proposed actions. The potential environmental consequences of the willow plantings associated with the area outside the vegetation-free zone and the variance request will be similar for each listed species. Critical habitat for the species and EFH for Chinook salmon species overlap at the proposed action areas, therefore, the effects analysis for critical habitat and EFH will be discussed collectively.

***16,000 lf of Willow Pole Cuttings***

A Stinger will be used for the 16,000 lf of willow pole cuttings. The Stinger is a hydraulically actuated needle shaped clamshell tool that is mounted to an excavator. Since equipment access from the landside is limited, the Stinger will be mounted on an excavator that will be operated from the deck of a barge. The Excavator will push the needle-shaped tool through rocks, sand, and mud to reach design depths where adequate water is available for willow survival. Once the Stinger is at an appropriate depth (up to nine feet), several willow cuttings will be dropped into the bowl of the clamshell and will be ready to be planted into the planting pit. Pole cuttings shall be placed in a vertical position into the planting pit with the terminal end of the cutting placed so the buds are oriented in the upward direction. Immediately after the pole has been placed, the hole shall be watered. The Stinger then releases the pole cuttings and allows the hole to close back around the planted cutting. The Contractor will attempt to ensure soil contact is made at the bottom of each cutting. This activity is being proposed for spring 2011. The 16,000 lf of willow pole cuttings will be planted within RD 1000, RD 551/755, RD 2098, RD 765, and RD 17. The Contractor will provide all personnel, equipment, material, tools, supervision, quality control, and other items necessary to ensure that the plants are installed at the sites.

***Vegetation Variance Request***

A vegetation variance request was submitted to the Corps' South Pacific Division Headquarters on September 21, 2010, seeking a variance to plant willow poles within the vegetation free zone. The planting of these willow poles will be done in the same fashion as described above for the 16,000 lf. The planting of these willow poles is tentatively scheduled for fall of 2011. The variance request is seeking an approval to plant the willow poles along approximately 14,000 lf at sites located in RD 3, RD 150, and RD 551.

***Purchase 10,000 lf of SRA Habitat***
NMFS and the Corps had a number of discussions related to the proposal of purchasing 10,000 lf of SRA credits. Two mitigation banks were discussed as a possibility for the 10,000 lf of SRA credit. One was a mitigation bank located on the Consumnes River floodplain, the other was a mitigation bank located in the Sacramento-San Joaquin Delta, specifically located on Liberty Island. The Consumnes River location will not provide mitigation for all the listed fish species, while the Liberty Island location will cover all the listed fish species. On October 22, 2010, staff from NMFS, Corps, and Wildlands (owner of the mitigation bank located on Liberty Island) did a site visit at the Liberty Island Mitigation Bank. As a result of the site visit and the meetings with the Corps, NMFS concurs that the purchase of SRA mitigation credits at the Liberty Island Mitigation Bank will provide enhancement to listed fish species.
The proposed actions do not involve any fill material, thus Clean Water Act Section 401 and 404 permitting will not be necessary. Also, since the PL 84-99 construction activities were authorized under emergency repairs, construction activities will be exempted from Clean Water Act Section 401 permitting.

A Streambed Alteration Agreement will not be required as this project will not substantially divert or obstruct the natural flow of any river, change or use any material from the bed, channel, or bank of, any river; or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river.

Based on our review of the material provided with your request and the best scientific and commercial information currently available, NMFS concurs that the proposed actions of planting 16,000 lf of willow pole cuttings, submission of a variance request, and purchasing 10,000 lf of SRA credits for construction related impacts at a NMFS approved species conservation bank are not likely to adversely affect Federally listed CV spring-run Chinook salmon ESU (*O. tshawytscha*), Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*), CV steelhead DPS (*O. mykiss*), and Southern DPS of North American green sturgeon (*Acipenser medirostris*), and their respective designated critical habitats. NMFS reached this determination based on the incorporation of the following measures into the project description:

1. To implement the proposed actions, the Corps will obtain coverage pursuant to Section 10 of the Rivers and Harbors Act of 1899 (Title 33 of the United States Code [USC}, Section 408 [33 USC 408]), referred to as Section 408, for the alteration of the Federal flood control project.

2. Access roads adjacent to the levee will be restored to preexisting conditions.

3. If appropriate, construction barrier fencing will be installed to protect listed species adjacent to the construction zone. Any critical habitat in the construction area will be flagged.

4. The contractor shall submit all appropriate plans, such as, Environmental Protection Plan, Safety Plan, Accident Prevention Plan, etc., to help ensure there are no impacts to critical habitat or listed species.

5. Construction specifications will contain language that prohibits construction-related activities, vehicle operation, material and equipment storage, and other surface-disturbing activities within the fenced environmentally sensitive area.

6. If a listed species is encountered by a biological monitor during construction, construction activities will cease until appropriate corrective measures have been completed or it has been determined that the species will not be harmed.

7. A worker awareness training program shall be conducted for construction crews before the start of construction activities. The program shall include an overview of listed fish and aquatic resources on the project site, measures to minimize impacts on those resources, and conditions of relevant regulatory permits.

8. Stockpiling of construction materials, including portable equipment, vehicles and supplies, including chemicals, shall be restricted to the designated construction staging areas, exclusive of any riparian or wetland areas.

9. Daily, all litter, debris, unused materials, equipment, and supplies shall be deposited at an appropriate disposal or storage site.

Since the Stinger will involve the use of petroleum products (e.g., fuels, lubricants, hydraulic fluids, and coolants), spills of these products could occur in the adjacent water systems. The Corps and its contractor will develop a spill and pollution prevention, control, and counter-measure plan that will prevent discharge of oil and other pollutants into navigable water or adjoining shorelines and minimize the potential of effects from spills of hazardous, toxic, or petroleum substances during construction. If a spill is reportable, the contractor's superintendent will notify the Corps, the Corps will then take action to contact the appropriate safety and cleanup crews. A written description of reportable releases will be submitted to the Regional Water Quality Control Board and documented on a spill report form. This submittal will contain a detailed description of the release, including: type of material, estimate of the amount spilled, the date of the spill, an explanation of why the spill occurred, and a description of the steps taken to prevent and control future releases. Implementation of a spill and pollution prevention plan will substantially minimize the potential for project associated adverse effects on water quality.

The contractor shall provide all plants, labor, equipment and material necessary to provide and plant willow pole cuttings. Implementation of the avoidance and minimization measures will ensure that the effects of the proposed actions are reduced or avoided. The proposed actions are not expected to have cumulative impacts on any listed species and their respective critical habitats.

**Conclusions**

As stated above, NMFS concurs that the Corps' proposal to plant 16,000 lf of willow pole cuttings, submission of a variance request, and purchase of 10,000 lf of SRA credits are not likely to adversely affect the Federally listed threatened CV spring-run Chinook salmon ESU (*O. tshawytscha*), endangered Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*), threatened CV steelhead DPS (*O. mykiss*), and threatened Southern DPS of North American green sturgeon (*Acipenser medirostris*), and their respective designated critical habitats.

Levee repair activities, including those completed under the authority of PL 84-99, that result in perpetuating limited- or non-vegetated riverine habitat, maintains adverse habitat conditions for Federally listed fish species. It is NMFS' position that delayed mitigation at construction sites is likely to result in adverse effects to listed species. Because of the delayed mitigation, NMFS supports the Corps and its desire to proceed with its proposed avoidance and mitigation measures included in the October 27, 2010, letter.

In addition, NMFS requests information regarding the Corps' plans if the vegetation variance request that was submitted on September 21, 2010, is denied. NMFS also requests any information on the timeframe regarding this vegetation variance request.

This concludes ESA section 7 consultation for the proposed project. This concurrence does not provide incidental take authorization pursuant to section 7(b)(4) and section 7(o)(2) of the ESA. Re-initiation of the consultation is required where discretionary Federal agency involvement or control over the proposed project has been retained (or is authorized by law), and if: (1) new information reveals effects of any of the proposed actions that may affect listed species or critical habitat in a manner or to an extent not considered; (2) any of the proposed actions are subsequently modified in a manner that causes adverse effects to listed species or critical habitat; or (3) a new species is listed or critical habitat designated that may be affected by any of the proposed actions.

**Essential Fish Habitat Consultation**

With regards to EFH consultation, the action areas have been identified as EFH for Chinook salmon in Amendment 14 of the Pacific Salmon Fishery Management Plan pursuant to the Magnuson-Stevens Act. Federal action agencies are mandated by the Magnuson-Stevens Act (section 305[b](2)) to consult with NMFS on all actions that may adversely affect EFH, and NMFS must provide EFH conservation recommendations to those agencies (section 305[b][4][A]). Any disturbance due to the implementation of the Proposed Actions will be temporary and localized. Also, the proposed actions will incorporate conservation measures (described above) which are expected to avoid adverse impacts to listed species EFH, additional EFH Conservation Recommendations are not being provided at this time; however, if there is substantial revision to any of the proposed actions that could result in new or additional impacts to EFH, the lead Federal agency will need to re-initiate EFH consultation.

**Fish and Wildlife Coordination Act**

The purpose of the Fish and Wildlife Coordination Act (FWCA) is to ensure that wildlife conservation receives equal consideration, and is coordinated with other aspects of water resources development (16 U.S.C. 661). The FWCA establishes a consultation requirement for Federal departments and agencies that undertake any action that proposes to modify any stream or other body of water for any purpose, including navigation and drainage (16 U.S.C 662(a)). Consistent with this consultation requirement, NMFS provides recommendations and comments to Federal action agencies for the purpose of conserving fish and wildlife resources. The FWCA provides the opportunity to offer recommendations for the conservation of species and habitats beyond those currently managed under the ESA and Magnuson-Stevens Act. Because the proposed action is designed to avoid environmental impacts NMFS has no additional FWCA comments to provide.

Please contact Michael Hendrick, Fisheries Biologist, at (916) 930-3605, or via e-mail at Michael.Hendrick@noaa.gov if you have any questions or require additional information concerning this correspondence.

Sincerely,

Maria Rea
for Rodney R. McInnis
Regional Administrator

cc: Copy to file – ARN 151422SWR2006SA00488
NMFS-PRD, Long Beach, California

# United States Department of the Interior

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


IN REPLY REFER TO:
1-1-07-F-0118

JUL 6 2007

Mr. E. Scott Clark
Chief, Sacramento Valley Office
U.S Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814

Subject: Section 7 Formal Consultation on the Public Law 84-99 Order 1 Levee Repair Sites, Tehama, Sacramento, Yuba, Sutter, and Yolo Counties, California

Dear Mr. Clark:

This is in response to the U.S. Army Corps of Engineers (Corps) February 23, 2007, request for consultation with the U.S. Fish and Wildlife Service (Service) on the proposed Public Law (PL) 84-99 Order 1 Levee Repair Project in Tehama, Sacramento, Yuba, Sutter, and Yolo Counties, California. Your request was received in our office on February 26, 2007. This document represents the Service's biological opinion on the effects of the action to the threatened delta smelt (*Hypomesus transpacificus*) (smelt) and its critical habitat in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

The Service concurs that work occurring on Deer Creek, Dry Creek, and the Sutter Bypass is outside of the range of delta smelt and would, therefore, not directly affect delta smelt or its critical habitat. Additionally, the Corps determined there were no effects to other threatened or endangered species for which the Service has jurisdiction, therefore, only the sites in reclamation district (RD) 3 and 999 will be discussed in this biological opinion.

This biological opinion is based on information provided in the Corps' letter requesting consultation and their biological assessment. A complete administrative record is on file at the Sacramento Fish and Wildlife Office (SFWO).

## 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. As a result, 33 critical levee repairs were undertaken between July and November 2006.

On August 25, 2006, the U.S. Army Corps of Engineers determined that PL 84-99 Order 1 and 2 sites present an imminent threat to public life and property and authorized immediate emergency levee repair actions.

On September 30, 2006, the California Department of Water Resources (DWR) determined that the Governor's proclamation encompassed PL 84-99 Order 1 and 2 sites and provided State funding to implement their repairs.

On February 26, 2007, the Service received the Corps' biological assessment dated February 23, 2007, for PL 84-99 Order 1 Sites.

On March 23, 2007, the Service received a letter from the Corps dated March 21, 2007, which provided supplemental information to the biological assessment.

## BIOLOGICAL OPINION

### Description of Proposed Action

Between December 28, 2005, and January 9, 2006, the State of California experienced a series of severe storms, which damaged the levees within the Sacramento District's boundaries. Water rose a second time in April 2006, and high water remained in some parts of the system until June 2006. Many rivers and streams within the Sacramento and San Joaquin River Basins ran above flood stage during these events, and there were significant erosion and seepage problems with the levees. DWR and/or their maintaining agencies conducted flood fight activities while the Corps has been working with DWR to restore the levee systems to the pre-storm level of protection. These efforts have been conducted under the authority of PL 84-99, Rehabilitation of Damaged Flood Control Works.

The Corps used the PL 84-99 authority to repair levees along the Sacramento River in reclamation district (RD) 999, and Steamboat Slough and Sacramento River in RD 3, in Sacramento and Yolo Counties. All of these sites were viewed as needing immediate repair prior to the next high water event and, therefore, were constructed between October 2006, and February 2007.

### RD 999

The repair sites are located along the Sacramento River, between river mile (RM) 42 and RM 43 near the town of Clarksburg in Yolo County. These sites are part of the Sacramento River Flood

Control Project. Areas surrounding the erosion sites are primarily agricultural, growing a variety of row crops, grapes, and some tree orchards.

The overall project in this RD includes 3 separate sites within a 1 mile stretch of river. The project areas include both the footprint of levee repair as well as adjacent land where staging and operation of equipment occur.

All three sites had native grasses, blackberry, wild grape, willow, and native brush. All free standing trees were retained with approximately 2 to 3 being trimmed with the advice of an onsite arborist. These trees consisted of native oaks, cottonwoods, and black locust. Four trees were removed; however these trees had been up-rooted and were no longer free standing. Trees were removed if soil had eroded from behind the root system or the tree was leaning over. The engineers determined that trees that had the potential to fall over, and take rock revetment with the root system, must be removed. Trees that had compacted soil around the root system were retained. The removed trees along with walnut trees from a local orchard were used as on-site, instream woody material (IWM).

The three sites in RD 999 have similar repairs. Reconstruction of the levee at the three sites was done for 332 linear feet at site two, 142 linear feet at site three, and 213 linear feet at site four. Grout material consisting of slurry cement backfill was placed under the concrete platform between sites two and three. An abandoned sunken bridge abutment was removed and the scour holes and voids filled with riprap at site three. The remaining description applies to all three sites. The riverbank was reconstructed to 2 (horizontal) on 1 (vertical) slope with a 2.3-foot soil V bench using 18-inch quarry rock below the water elevation and soil filled 18-inch quarry rock above water level. The reconstructed slope was covered first with a double layer of erosion protection matting to prevent further erosion and then ½-foot of soil. All disturbed areas were seeded with native grasses to reduce the risk of erosion. Small vegetation along the waterline was removed in order to re-construct the levee. When possible, large trees along the waterline were left in place and willow pole cuttings were planted along the waters edge. Additionally, brush bundles and IWM were placed on the V bench. Construction started in mid-December and was completed by the end of January.

IWM was anchored to the waterside edge of the new berm, the upper slopes were planted with willow cuttings to provide riparian and SRA habitat. All branches, limbs, and twigs would be retained to the extent practicable to maintain the size, volume, and complexity of the IWM. The IWM was placed and anchored so as not to create a hazard for boaters or swimmers at low mean summer water levels. Smaller brush bundles anchored to the lower slopes, below the summer water line, provide fish habitat during summer and fall flows.

**RD 3**

This project includes four sites on Steamboat Slough and four sites on the Sacramento River protecting Grand Island in the California Delta region. Grand Island is approximately 13 miles southwest of Sacramento and 12 miles west of Galt.

General Construction Methods

The contractor began construction by transporting equipment and construction materials to the construction site. Once materials and equipment was on site, the contractor removed grasses and trees that are growing in the erosion site. The damaged area was excavated approximately 0.5 feet beyond the damaged length and depth. The excavated area was constructed into a steep step slope. The slope of the steps was as steep as possible. The excavation site was back filled with compacted impervious material. The waterside slope was restored to a 3:1 slope. Rock protection was placed on top of 6-inch thick bedding material that is placed on the levee slope. All sites are to be constructed to pre-flood conditions and the rock protection will have the same slope and thickness as the adjacent undamaged areas. Rock was placed from a barge onto the levee slopes. Hydroseeding of any disturbed areas occurred. Four of the sites, Sacramento River RM 27.8 and 28.4 and Steamboat Slough 27.8 and 28.4 include the addition of a rockfill platform constructed approximately 2 feet above the water line. The rockfill consisted of at least 15 percent fines.

**Steamboat Slough RM 25.2** –The damaged area is 140 feet long with a 12-foot vertical cut. Vegetation in the project area includes grasses on the levee slope, a cluster of small box elder trees, and several very large oak trees near the top of the levee. The box elder trees in the damaged area were removed to restore the levee to pre-flood conditions. Prior to the flood event the area was protected with rock revetment which was placed to the same slope and grade as the adjacent undamaged areas. The large oak trees on the upper levee slope were not affected by the construction of the project. Willow cuttings were planted along the waterline for the 140-foot repair site and on both sides of the project site to create a total revegetation area twice the length of the original repair site (280 linear feet).

**Steamboat Slough RM 24.2** –The waterside levee slope erosion is 170 feet long with a 10-foot high vertical cut. Existing rock protection was lost during the high flow event. The vegetation in the repair site includes small grasses on the levee slope and two eucalyptus trees and a large oak on the upper levee slope. Based on a site visit on January 8, 2007, it has been determined that the two eucalyptus trees had to be trimmed during construction. Prior to the flood event the area was protected with rock revetment which was replaced to the same slope and grade as the adjacent undamaged areas. Willow cuttings were planted along the waterline for the entire repair site (170 linear feet) and on both sides of the project site to create a total revegetation area twice the length of the original repair site (340 linear feet).

**Sacramento River RM 21.6** – The erosion is 200 feet long and 10 feet high. The erosion is located just above the existing rock protection, on the waterside levee slope. Due to maintenance practices the levee slope is devoid of vegetation. Willow cuttings were planted along the waterline for the entire repair site and on both sides of the project to revegetation a total of 400 feet.

**Sacramento River RM 33.2** – The erosion is 150 feet long and 12 feet high. The erosion is located just above the existing rock protection, on the waterside levee slope. Due to maintenance the levee slope is devoid of vegetation. Willow cuttings were planted along the waterline for the entire site and on both sides of the project site to revegetation a total of 300 linear feet.

**Steamboat Slough RM 24.9** – The waterside levee slope erosion is 205 feet long with a 10-foot high vertical cut. The area is covered by heavy vegetation and several large trees along the waterline, which has caused the erosion near the trees. The ground cover on the upper levee slope is upland grasses and horse tail. Woody vegetation on the levee consists of a large oak near the top of the levee, several large cottonwoods scattered across the site, and several box elders located along the lower levee slope and levee toe. Based on a site visit on January 8, 2007, it has been determined that one box elder tree, located on the western end of the site, needed to be removed. Willow cuttings were planted along the waterline for the repair length and on both sides of the repair to revegetate a total of 410 linear feet.

**Steamboat Slough RM 22.1** – The waterside levee slope erosion is 70 feet long with a 10-foot vertical cut. The existing rock protection was lost during the high flow event. The levee slope is dominated by small grasses, additionally, willows, box elders, tules, and wild rose cover the site. The levee toe has limited vegetation cover due to the rock protection. Willow cuttings were planted along the waterline for the length of the repair as well as on both sides of the site to revegetate a total of 140 linear feet.

**Sacramento River RM 27.8** – The erosion site is 70 feet long and 10 feet high. The erosion is located just above the existing rock protection, on the waterside slope. The levee slope is dominated by small grasses. The levee toe has limited vegetation due to existing rock protection. Willow cuttings were planted along the waterline for the length of the repair as well as on both sides of the site to revegetate a total of 140 linear feet.

**Sacramento River RM 28.4** – The erosion site is 160 feet long and 10 feet high. The erosion is located just above the existing rock protection, on the waterside levee slope. The levee slope is dominated by small grasses. The levee toe has limited vegetation due to the existing rock protection. Willow cuttings were planted along the waterline for the length of the repair as well as on both sides of the site to revegetate a total of 320 linear feet.

Staging and Stockpile Area

Staging areas were used to store construction equipment and materials for several repair sites. Some of the unused equipment was left on the waterside slope at the end of each construction day. The exact location and size of the staging areas were determined by the contractor and approved by the Corps.. Selected staging areas included a clearing near the levee which is regularly mowed to keep herbaceous vegetation short and prevent woody vegetation from establishing and nearby fallow agricultural fields.

*Conservation Measures:*

Stockpiling of construction materials such as portable equipment, vehicles, and supplies, including chemicals, was restricted to the designated construction staging areas and barges, excluding any riparian or wetland areas.

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

A representative shall be appointed by the Corps who shall be the point of contact for any Corps employee, contractor, or contractor employee, who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species during the project construction and operations. This representative shall be identified to the employees and contractors during an all-employee education program conducted by the Corps.

If requested by the resource agencies, during or upon completion of construction activities, the Corps biologist/environmental manager or contractor shall accompany Service or National Marine Fisheries Service personnel on an on-site, post-construction inspection tour to review project impacts and mitigation success.

A Corps representative shall work closely with the contractors through all construction stages to ensure that any living riparian vegetation or IWM within vegetation clearing zones that can reasonably be avoided without compromising basic engineering design and safety is avoided and left undisturbed to the extent feasible.

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

Willow cuttings were planted along the waterline at all repair sites and on both sides of the sites for a total length two times the affected length.

**Status of the Species**

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

*Description:* Delta smelt are slender-bodied fish that typically reach 60-70 mm standard length (measured from tip of the snout to origin of the caudal fin), although a few may reach 120 mm standard length. The mouth is small, with a maxilla that does not extend past the midpoint of the eye. The eyes are relatively large; with the orbit width contained approximately 3.5-4 times in the head length. Small, pointed teeth are present on the upper and lower jaws. The first gill arch has 27-33 gill rakers and there are 7 branchiostegal rays (paired structures on either side and below the jaw that protect the gills). Counts of branchiostegal rays are used by taxonomists to identify fish. The pectoral fins reach less than two-thirds of the way to the bases of the pelvic fins. There are 9-10 dorsal fin rays, 8 pelvic fin rays, 10-12 pectoral fin rays, and 15-17 anal fin rays. The lateral line is incomplete and has 53-60 scales along it. Live fish are nearly translucent and have a steely-blue sheen to their sides. Delta smelt belong to the family Osmeridae, a more ancestral member of the order Salmoniformes which also includes the family Salmonidae (salmon, trout, whitefish, and graylings) (Moyle and Cech 1988).

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

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

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

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

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

Suisun Bay and Suisun Marsh during wetter years (Sweetnam 1999 and Wang 1991). Spawning has also been recorded in Montezuma Slough near Suisun Bay (Wang 1986) and also may occur in Suisun Slough in Suisun Marsh (P. Moyle, UCD, unpublished data).

The spawning season varies from year to year, and may occur from late winter (December) to early summer (July). Pre-spawning adults are found in Suisun Bay and the western Delta as early as September (DWR and Reclamation 1994). Moyle (1976, 2002) collected gravid adults from December to April, although ripe delta smelt were common in February and March. In 1989 and 1990, Wang (1991) estimated that spawning had taken place from mid-February to late June or early July, with peak spawning occurring in late April and early May. A recent study of delta smelt eggs and larvae (Wang and Brown 1993 as cited in DWR and Reclamation 1994) confirmed that spawning may occur from February through June, with a peak in April and May. Spawning has been reported to occur at water temperatures of about 7° to 15° C. Results from a UCD study (Swanson and Cech 1995) indicate that although delta smelt tolerate a wide range of temperatures (<8° C to >25° C), warmer water temperatures restrict their distribution more than colder water temperatures.

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

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

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

Delta smelt feed primarily on (1) planktonic copepods (small crustaceans used by fish for food), (2) cladocerans (small crustaceans used by fish for food), (3) amphipods (small crustaceans used by fish for food) and, to a lesser extent, (4) on insect larvae. Larger fish may also feed on the opossum shrimp (*Neomysis mercedis*). The most important food organism for all sizes seems to be the euryhaline copepod (*Eurytemora affinis*) although in recent years the exotic species, *Pseudodiaptomus forbesi*, has become a major part of the diet (Moyle *et al.* 1992).

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

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

**Habitat Loss and Degradation -** Since the 1850s the amount and extent of suitable habitat for the delta smelt has declined dramatically. The advent, in 1853, of hydraulic mining in the Sacramento and San Joaquin rivers led to an increase in siltation and the alteration of the circulation patterns of the Sacramento/San Joaquin Estuary (Nichols *et al.* 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94% of the Estuary's tidal marshes (Nichols *et al.* 1986, Monroe and Kelly 1992). Much of the delta smelt's historic floodplain and fluvial marsh areas have been excluded from inundation by an elaborate flood control system. Levee systems have eliminated access to relatively large expanses of former fluvial, tule marsh and vegetated floodplains that once served as high-quality spawning and rearing areas for this species. In addition, extensive riprapping, intended to protect the waterside levee slopes of the levees and related flood control system from erosion, scour, wave wash, and tidal fluctuations, has also greatly reduced the amount of shallow, gently-sloping nearshore areas that support vegetation and shallow aquatic habitat of value to delta smelt. Moreover, it is known that riprapping accelerates water velocities along waterside levee slopes (Sedell *et al.* 1990 *in* Service 2000) and has a wide range of other potentially deleterious effects (as discussed and cited *in* Service 2000) to delta smelt and associated native fishes of the Delta and Estuary. Levees (and associated riprap) have also fragmented delta smelt and other native fish habitat by reducing connectivity between the remaining areas of good-quality habitat.

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

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

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

Delta smelt are a minor prey item of juvenile and subadult striped bass (*Morone saxatilis*) in the Sacramento-San Joaquin Delta (Stevens 1966). They also have been reported from the stomach contents of white catfish (*Ameiurus catus*) (Turner 1966 *in* Turner and Kelley (eds) 1966) and black crappie (*Pomoxis nigromaculatus*) (Turner 1966 *in* Turner and Kelley 1966) in the Delta.

*Summary of the Five Year Review:* The threats of the destruction, modification, or curtailment of its habitat or range resulting from extreme outflow conditions, the operations of the State and Federal water projects, and other water diversions as described in the original listing still remain. The only new information concerning the delta smelt's population size and extinction probability indicates that the population is at risk of falling below an effective population size and, therefore, in danger of becoming extinct. Although the Vernalis Adaptive Management Program and Environmental Water Account have helped to ameliorate these threats, it is unclear how effective these will continue to be over time based on available funding and future demands for water. In addition, there are increased water demands outside the CVP and the SWP, which could also impact delta smelt. The increases in water demands are likely to result in less suitable rearing conditions for delta smelt, increased vulnerability to entrainment, and less water available for maintaining the position of X2 near rearing areas. The importance of exposure to toxic chemicals on the population of delta smelt is highly uncertain. In addition, many potential threats have not been sufficiently studied to determine their effects, such as predation, disease, competition, and hybridization. Therefore, a recommendation to delist or a change in classification to endangered the delta smelt was found to be inappropriate or premature.

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

All of the sites in RD 3 and RD 999 are located within habitat for the delta smelt.

<u>Delta Smelt Critical Habitat</u>

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

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

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

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

3. cover or shelter;

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

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

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

*Delta Smelt Critical Habitat*

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

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

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

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

All of the sites in RD 3 and RD 999 are located within designated critical habitat for the delta smelt.

**Effects of the Proposed Action**

Placement of riprap on levees would result in the permanent loss of 1,852 linear feet of river bank within the range of the delta smelt. Slightly less than half of which (892 feet) is natural bank substrate and the remaining 960 feet had previously been rocked. Direct effects due to construction include the loss of existing trees and vegetation due to the rock placement. Construction of the project is scheduled to occur between October 2006 and March 2007, which coincides with when delta smelt move upstream to river channels and back water sloughs to spawn. Therefore, it is expected that delta smelt would be in the project area during construction of the sites in RD 3 and 999. Because construction would be completed mostly outside of the window when delta smelt spawn, February to June, it is unlikely that delta smelt spawning would be directly affected from the placement of rock. However, up to 1,852 linear feet of bank would not be suitable for use by delta smelt for spawning due to the placement of rock and temporal loss of vegetation.

Some of the over-water shade, living trees and shrubs, and erosion potential would be lost due to rock placement. The woody and herbaceous vegetation that would be removed are components of vegetated floodplain and/or shallow water habitat that is used by the delta smelt for foraging and spawning. These areas are also highly productive in terms of prey species for delta smelt. All shallow, open water area existing along the sites would be permanently altered, due to riprap placement. Some of the attributes of existing conditions may be effectively replaced by creating benches at the three sites in RD 999. Vegetation loss would be compensated for at all sites by planting willow pole plantings on site and immediately adjacent to the sites.

The loss of overhead cover due to tree removal or trimming due to construction activities would be partially replaced by planting the sites and areas adjacent to the sites with willow pole plantings. However, there would be a temporal loss of 10 to 15 years while the replanted vegetation gains size and density and some willow species which may be planted, will never gain the height that typical riparian trees would reach. There is also uncertainty as to the long-term survival of vegetation planted in a rock substrate.

Velocities along the refinished bank are likely to be greater, especially at higher flows. Delta smelt spawn in shallow slow-moving water and they may also use these areas for refugia from faster currents, therefore, the loss of this habitat and the increased flows along the bank would adversely affect delta smelt at the 4 natural bank sites. The IWM complexes at the RD 999 sites and willow pole cuttings installed on the all the sites should re-create some of the lost hydraulic diversity, variability, and cover removed.

The primary effect to water quality is the liberation of sediments during placement of riprap and fill. Periods of localized, high suspended sediment concentrations and turbidity owing to channel disturbance can result in a reduction of feeding opportunities for delta smelt, and clogging and abrasion of gill filaments. It is likely that delta smelt would be directly affected from increased turbidity because in-water work would occur when delta smelt are migrating and spawning. In addition, increased sediment loading can degrade food-producing habitat downstream of the project area. It can also interfere with photosynthesis of aquatic flora and displace aquatic fauna. However, adverse effects on water quality are minimized because the Corps will use erosion control measure BMPs to prevent soil or sediment from entering the river. The BMPs were maintained until all areas disturbed during construction were adequately revegetated and stabilized.

The movement of the construction equipment and exposure of bare soil could result in increased turbidity and impaired water quality. Toxic substances including gasoline, lubricants, and other petroleum-based products could enter the water courses as a result of spills or leakage from machinery or storage containers. Toxins could also be released from sediments at the site. These toxins could have an immediate or delayed lethal or sub-lethal effect on various delta smelt life stages and may also affect the reproductive success of the delta smelt. Submerged aquatic vegetation in downstream areas, which is good spawning habitat, may also be negatively affected by the toxic substances. However, adverse effects on water quality are minimized because the Corps will use BMPs that describe the use, containment, and cleanup of contaminants and will keep stockpiled materials away from the water.

The future growth and input of IWM into the river from these sites would be negatively affected. IWM availability and functioning within the Sacramento River is already substantially reduced. The proposed project attempts to minimize this loss of IWM input, by planting willow pole cuttings. However, the willow plantings will only provide limited IWM input after they have had time to get large and old enough. Refugia are habitats or environmental factors that convey spatial and temporal resistance and/or resilience to biotic communities that have been impacted by biophysical disturbances. Riprap will reduce refugia for delta smelt. Riprapping reduces refugia components because it has been found to: (a) cause stream power to increase more rapidly with increasing discharge, due to decreased near-shore roughness; (b) create a smooth, "hydraulically efficient" surface along the riprap blanket, which decreases aquatic habitat complexity and value; (c) arrest meander migration, which over time, reduces habitat renewal, diversity, and complexity; (d) incise the river's thalweg (deepest portion of the channel) adjacent to the armoured area, while narrowing the low-flow width, which decreases both hydrological and biological diversity; and (e) eventually create the need for more riprap at the interfaces between the riprapped and earthen sections (Service 2000). The Corps has proposed to create a bench with IWM at the three RD 999 sites and to plant all sites with willow pole cuttings as well as areas up- and downstream of the site which would slow water down in the shallow water habitat area, increase near-shore roughness and provide aquatic habitat complexity.

**Delta Smelt Critical Habitat**

Delta smelt critical habitat encompasses the Delta, including the mainstem Sacramento River upstream to the limit of tidal influence at approximately RM 59.4. Implementation of the proposed project will impact delta smelt critical habitat via loss of shallow water habitat, reduce input and retention of IWM, temporal and permanent losses of riparian habitat, and further reduction on fluvial function.

The primary constituent elements of delta smelt critical habitat include spawning habitat, larval and juvenile transport hydrology and habitat, larval and juvenile rearing habitat, and adult migration hydrology and habitat. Implementation of the proposed projects will reduce the amount of existing spawning habitat and will also interrupt the fluvial processes by which the river forms and maintains new spawning habitat. Refugia components important for larval and juvenile migration and rearing were reduced. The proposed project may also impact the ability of adult delta smelt to migrate by increasing velocities on a reach-wide scale.

The Recovery Plan requires that, to ensure egg hatching and larval viability, backwater slough and nearshore spawning areas must provide suitable substrates for egg attachment. The final rule for delta smelt critical habitat identifies these suitable substrates as cattails and tules, tree roots, and submerged branches. Implementation of the proposed project will reduce the total amount of submerged vegetation within the critical habitat through direct and indirect losses. The removal on these primary constituent elements reduces the value and function of critical habitat for the delta smelt. The following paragraphs present our analysis of how the primary constituent elements may be impacted and thus may slightly reduce the population, distribution, and numbers of the delta smelt, as expressed in terms of habitat loss. However, the Service feels that although the primary constituent elements may be impacted, they will still retain their function to support critical habitat for delta smelt.

The presence of submerged vegetation within the critical habitat increases the substrates available for the attachment of delta smelt eggs. The presence of vegetation in shallow water areas also enhances those areas' ability to trap and retain sediment which, in turn, serves as a suitable substrate for the establishment of various species of emergent vegetation or woody and herbaceous riparian vegetation.

Larval and juvenile delta smelt are affected by the loss of refugia during transport and rearing. The high quality refugia afforded by submerged vegetation allow the negatively buoyant larvae to evade predation. Shallow water habitat is productive of zooplankton and macroinvertebrates, which are food for juvenile and adult delta smelt. Removal of vegetation and loss of vegetation recruitment due to the rock substrate is an impact to critical habitat because it reduces the ability of the critical habitat to support larval and juvenile delta smelt by reducing the physical amount of refugia and by not retaining food sources. The project design to include plantings would minimize this effect to delta smelt critical habitat.

The Recovery Plan also states that adult delta smelt need unrestricted access to suitable spawning habitat in a period extending from December to July and that spawning areas should be protected from physical disturbance and flow disruption during migratory periods. Though it is possible to schedule construction periods to avoid harassment of delta smelt, the proposed actions will create long-term geomorphic and hydrologic changes to the detriment of the delta smelt. Riprapping of a site would reduce or eliminate its value as delta smelt spawning habitat. Aquatic plants would be eliminated, substrates would be made unsuitable for egg attachment, increased velocities would stress and entrain fish, and predation on delta smelt would likely increase. The project would minimize effects by planting the sites and creating a bench at three of the sites.

Implementation of the proposed action at the 11 sites in delta smelt critical habitat would impact delta smelt critical habitat via a direct, incremental reduction in the availability of shallow water habitat and herbaceous and woody vegetation recruitment along 1,852 linear feet. Existing submerged vegetation at the project sites was covered with rock and the ability of the riprapped sites to grow vegetation would be reduced. Though planting of the riprapped sites would ameliorate this effect.

Riprapping causes stream flows to increase more rapidly with increasing discharge, due to decreased near-shore roughness. The hydraulically smooth surface of riprap, relative to vegetated banks, causes higher, more homogeneous flows, especially along the bank. Delta smelt are relatively weak "stroke and glide" swimmers. The pockets of suitable habitat with submerged vegetation within the delta smelt critical habitat serve as refugia which allow adults to migrate upstream through unsuitable, entirely riprapped reaches. The hydraulic efficiency of riprapped surfaces also increased near-shore velocity, which further impedes upstream migration of delta smelt. In response to the increased downstream velocities, and the scarcity of suitable refugia, either in the form of physical barriers to flow or in eddies and other hydraulically variable discharges, smelt must adopt continuous stroking to move upriver. Continuous stroking unduly stresses delta smelt, resulting in increased predation. Further, the increased velocities may prevent delta smelt from migrating upstream to formerly-occupied areas, which would reduce the distribution of the species. To minimize these effects to delta smelt critical habitat, the project includes providing areas on the riprapped surface that can support native plant species including woody species. As the vegetation matures it will decrease near-shore flows and will likely reestablish potential refugia and restoring primary constituent elements.

The increased velocities associated with riprapped banks move larval and juvenile delta smelt downstream more quickly, but the presence of riprap forces the migration to occur in a system reduced in refugia, resulting in increased predation. The diminished productivity of aquatic systems in the heavily riprapped, lowermost reaches of the lower Sacramento River reduces the food base available to juvenile delta smelt as they migrate downstream. The instream vegetation plantings that are proposed as part of the project would lessen the loss of productivity due to the rock placement.

Implementation of the proposed project would initially increase nearshore velocities at each site. This would preclude the site from serving as refugia during the upstream migration of delta smelt. The occurrence of refugia and productive, vegetated habitats at sites were temporarily reduced, which would respectively increase predation of, and reduce food available for, larval and juvenile delta smelt. The reduced productivity of the aquatic ecosystem would reduce the food available to larval and juvenile delta smelt during their downstream migration. The project design which includes planting vegetation and providing sloped benches which would reduce the impact to delta smelt refugia and food production areas.

Riprapping also causes incision of the river's thalweg and a narrowing of the low-flow width. If the absolute availability of shallow water habitat is a function of the river's depth, then channel incision comes at the cost of shallow water habitat along the margins. The consequence of riprapping is a continued decrease in the proportion of productive, sheltered shallow water habitat relative to less productive deep-water habitat.

The effect to delta smelt critical habitat at these 11 sites is related to the incremental reduction in shallow water habitat and submerged vegetation, a primary constituent element. The rock, rather than earthen, substrate could exclude the existence of emergent plants along the shoreline as well as aquatic plants within the photic zone, to the detriment of delta smelt. This reduction occurs in a river reach already 71 percent riprapped. Basic fluvial processes, the mechanism by which additional shallow water habitat could be created and maintained, will be impeded at the project site within critical habitat.

Implementation of the proposed action at the 11 sites in delta smelt critical habitat would impact delta smelt critical habitat via a direct, incremental reduction in the availability of shallow water habitat and herbaceous and woody vegetation recruitment along 1,852 linear feet. Existing submerged vegetation at the project sites were covered with rock and the ability of the riprapped sites to grow vegetation would be reduced. Planting of the riprapped sites would ameliorate this effect, and, therefore, the Service believes that the project as proposed does not adversely modify or destroy delta smelt habitat. While changing the bank conditions from natural bank to rocked back, reducing vegetation, and constructing steeper banks at some sites, would effect delta smelt critical habitat, the projects designs which include sloped undulating benches, vegetating benches and slopes, and would allow the primary constituent elements of delta smelt critical habitat to remain intact.

**Cumulative Effects**

Cumulative effects include the effects of future State, Tribal, local, or private actins affecting listed species that are reasonably certain to occur in the area considered in this biological opinion. Future Federal actions not related to this proposed action are not considered in determining the cumulative effects, but are subject to separate consultation requirements pursuant to section 7 of the Act.

Prior to completion of the Corps' riprap geographic information system (GIS) for the Sacramento River Bank Protection Project (SRBPP) project area in late 2003, there were estimates–but not precise figures–available of the total amounts of riprap placed along various levees and channels of the project area. It was estimated that the total amount of river bank protected under SRBPP authority in the 194-mile-long project reach along the Sacramento River would increase from 35 percent (in 1987) to 41 percent (i.e., of 194 x 2=388 miles of banks) (USACOE 1987). Furthermore, it was estimated that the completed SRBPP would then encompass riprapping on about 44 percent of bank in the lower 60 miles downstream of Sacramento (i.e., RMs 0-60), 39 percent in mid-river between Sacramento and Colusa (i.e., RMs 60-145), and 30 percent between Colusa and Chico Landing (i.e., RMs 145-194) (USACOE 1987).

However, the SRBPP estimates were incomplete and SRBPP makes up only part of the total bank protection that has been applied within the project reach. Riprapping has also been done by: (a) DWR, and various levee and reclamation districts, and (b) private individuals. With all such non-project riprap combined with the SRBPP riprap, the totals are quite substantial.

Non-permitted riprapping has the same or greater, impacts to ecosystems processes and functions, and, therefore, to the delta smelt, as the ongoing permitted riprapping. Since set-back levees, which allow avoidance of all aquatic and fisheries impacts, are not being implemented by non-permitted interests, temporal and spatial losses of submerged, vegetated areas, including SRA cover and IWM, are both common and significant as is preclusion of setback levee alternatives that could otherwise significantly offset impacts and contribute to the conservation needs of listed species. Non-permitted riprapping poses threats as described above to the delta smelt's adult spawning needs; adult pre-spawning foraging needs and general refugia needs. The net result of continued non-permitted riprapping is a steady, incremental reduction in the environmental baseline for the delta smelt and its critical habitat.

Additional cumulative effects may result from any continuing or future non-Federal diversions of water that may entrain adult or larval fish or that may decrease outflows incrementally, thus shifting the position of the delta smelt's preferred habitat upstream. Water diversions through intakes serving numerous small, private agricultural lands and duck clubs in the Delta, upstream of the Delta, and in Suisun Bay contribute to these cumulative effects. These diversions also include municipal and industrial uses, as well as providing water for power plants. State or local levee maintenance may also destroy or adversely modify critical habitat by disturbing spawning or rearing habitat and release contaminants into the water.

Cumulative effects on the delta smelt and its designated critical habitat include the impacts 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. Implicated as potential sources of mortality for delta smelt, these contaminants may adversely affect delta smelt reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants used as substrates for adhesive egg attachment are lost due to toxic substances.

The introduction of exotic species may occur when levees are breached or when separate creeks or river systems are reconnected during various projects. Several exotic species may adversely affect the smelt and splittail, including the Asian clam (*Potamocorbula amurensis*) and three non-native species of euryhaline copepods. The Asian clam could potentially play an important role in affecting the phytoplankton dynamics. The exotic copepods may displace native species and at least one species of copepods (*Sinocalanus doerri*) is difficult for larval fishes to catch because of its fast swimming and effective escape response. Reduced feeding efficiency and ingestion rates weaken and slow the growth of young and make them more vulnerable to starvation and predation.

Other cumulative effects include: wave action in water channels caused by boats may degrade riparian and wetland habitat and erode banks; the dumping of domestic and industrial waste may present hazards to the fish because they could become trapped in the debris, injure themselves, or ingest the debris; golf courses may reduce habitat and introduce pesticides and herbicides into the environment; oil and gas development and production remove habitat and may introduce pollutants into the delta; residential or agricultural land use can fragment and reduce wildlife habitat and corridors; and unscreened agricultural diversions throughout the delta divert all life stages of the fish (Service 1995).

These cumulative effects further contribute to reducing the respective environmental baselines for the delta smelt.

**Conclusion**

After reviewing the current status of the smelt, the environmental baseline for the species, the effects of the proposed project, and the cumulative effects on this species, it is the Service's biological opinion that the proposed PL 84-99 Order 1 Sites project, as described herein, is not likely to jeopardize the continued existence of the delta smelt. The project will not result in a net destruction or adverse modification of delta smelt critical habitat.

## INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are nondiscretionary for listed species in this opinion and must be implemented by the Corps in order for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity that is covered by this incidental take statement. If the Federal agency (1) fails to adhere to the terms and conditions of the incidental take statement, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

**Amount or Extent of Take**

Construction of the bank protection at sites downstream of Sacramento River RM 80, will result in the incidental take of the delta smelt. The Service anticipates that finding an injured or dead delta smelt will be difficult to detect and quantify for a number of reasons: they have a relatively small body size; they are relatively secretive; their presence in the Sacramento River generally coincides with turbid flow conditions, which makes their detection difficult; and additionally, their presence in flooded vegetation makes them difficult to detect. Therefore, it is not possible to provide precise numbers of smelt that will be harassed, harmed, or killed during and/or after construction. In such instances, where take is otherwise difficult to detect and/or quantify, the Service may quantify take in terms of some aspect of the species' habitat that may be diminished or removed, as a surrogate measure for quantifying individuals.

Accordingly, the Service is quantifying take incidental to the project as the linear feet of shallow water habitat that were affected by the proposed action. Take will be primarily in the form of harm to the species through permanent and temporary loss of its nearshore breeding and feeding habitat. Therefore, the Service estimates that all delta smelt along 1,852 lf of river bank are subject to incidental take as a result of the proposed action.

**Effect of the Take**

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the delta smelt, and will not result in the destruction or adverse modification of designated critical habitat.

**Reasonable and Prudent Measures**

The following reasonable and prudent measures are necessary and appropriate to minimize the effect of the proposed bank protection sites on the delta smelt.

1. The Corps shall implement the project as proposed in the biological assessment and this biological opinion.

2. Effects of harassment of individual delta smelt downstream of Sacramento River RM 80, and of the loss and degradation of the species' habitat shall be minimized.

**Terms and Conditions**

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

1. The following terms and conditions implement reasonable and prudent measure one (1):

   a. The Corps shall minimize the potential for incidental take of the delta smelt resulting from the project related activities by implementation of the project description as described in the biological assessment and the project description of this biological opinion.

   b. If requested, the Corps and DWR or their representative shall allow access to the project site by the Service or the California Department of Fish and Game to assess the effects of the project on the delta smelt.

   c. A Service approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the Service-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 delta smelt, an overview of the life-history of the species, information on take prohibitions, and protections afforded delta smelt under the Act. As needed, training shall be conducted in Spanish for Spanish language speakers and other languages as needed or necessary.

2. The following terms and conditions implement Reasonable and Prudent Measure number two (2):

   a. Since construction was completed by February 2007, willow plantings shall be completed no later than the fall of 2007.

   b. To ensure high survivability of plantings, irrigation will be done frequently and for long durations. The Corps shall develop an irrigation schedule appropriate for establishing vegetation plantings within the three year O&M period, and consistent with riparian survival.

   c. A certified arborist shall trim any trees for construction purposes. The minimal amount of trimming will be completed that also allows the construction contractor to complete their work. Trees and surrounding vegetation will not be trimmed for any other purpose.

   d. Intakes for any water pumps needed for the construction process shall be screened to delta smelt specifications which are similar to salmonids specifications except that approach velocity is 0.2 feet per second.

**Reporting Requirements**

A post-construction compliance report prepared by the monitoring biologists shall be forwarded to the SFWO within 60 calendar days of the completion of construction activity. This report shall detail (i) dates that construction occurred; (ii) pertinent information concerning the success of the Project in meeting compensation and other conservation measures; (iii) an explanation of failure to meet such measures, if any; (iv) known project effects on federally listed species, if any; (v) occurrences of incidental take of federally listed species, if any; and (vi) other pertinent information.

The Service shall be notified immediately by facsimile or telephone and in writing within three (3) working days of any unanticipated take of the delta smelt, and of the take or suspected take of listed wildlife species not authorized in this opinion. Notification must include the date, time, and location of the incident of the incident or of the finding of a dead or injured animal, and any other pertinent information. The Service contact persons are the Chief of the Endangered Species Division, at (916) 414-6600 and the Senior Resident Agent of the Service's Law Enforcement Division at (916) 414-6660.

Any dead or injured delta smelt must be relinquished to the Service. Any killed specimens of fish have been taken should be properly preserved in accordance with Natural History Museum of Los Angeles County policy of accessioning (10% formalin in quart jar or freezing). Information concerning how the fish was taken, length of the interval between death and preservation, the water temperature and outflow/tide conditions, and any other relevant information should be written on 100% rag content paper with permanent ink and included in the container with the specimen. Preserved specimens shall be delivered to the Service's Division of Law Enforcement at 2800 Cottage Way, Room W-2928 Sacramento, California 95825, phone (916) 414-6660.

Proof of environmental training and fulfillment of compensation requirements shall be delivered to the Chief of the Endangered Species Division, Sacramento Fish and Wildlife Office, 2800 Cottage Way, Room W-2605, Sacramento, California, 95825-1846.

## CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

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

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

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

**REINITIATION - CLOSING STATEMENT**

This concludes formal consultation with the Corps on the PL 84-99 Order 1 Sites project. As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the proposed action may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (4) a new species or critical habitat is designated that may be affected by the proposed action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

If you have any questions regarding this biological opinion on the PL 84-99 Order 1 Sites project, please contact Jennifer Hobbs or the Acting Sacramento Valley Branch Chief of the Sacramento Fish and Wildlife Office at (916) 414-6645.

Sincerely,

Peter A. Gross

Ken Sanchez
Acting Field Supervisor

cc:
Madelyn Martinez, National Marine Fisheries Service, Sacramento, CA

**Literature Cited**

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

Arthur, J.F. and M.D. Ball 1979. Factors influencing the entrapment of suspended material in the San Francisco Bay-Delta Estuary. Pages 143-174 *in* T.J. Conomos (ed.) Pacific Division, Amer. Assoc. Advance. Sci., San Francisco, California.

Arthur, J.F. and M.D. Ball 1980. The Significance of the Entrapment Zone Location to the Phytoplankton Standing Crop in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Water and Power Resources Service.

Brett, J.R. 1976. Scope for Metabolism and Growth of Sockeye Salmon, *Oncorhynchus nerka*, and Some Related Energetics. J. Fish. Res. Bd. Can. 33:307-313.

California Department of Fish and Game. 2000. 20mm Survey [database on the internet]. http://www.delta.ca.gov/data/20mm/2000/. Accessed on September 18, 2002.

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

California Natural Diversity Database (CNDDB). 2004. Natural Heritage Division, California Department of Fish and Game. Sacramento, California.

______. 2005. RareFind 3. California Department of Fish and Game. Sacramento, California.

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

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

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

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

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

Ingram, M. G.P. Nabhan, S. Buchmann. 1996. Impending Pollination Crisis Threatens Biodiversity and Agriculture. Tropinet 7:1.

Jones & Stokes, Inc. 1988. Final Report: Field Investigation of Life History Characteristics of the Valley Elderberry Longhorn Beetle along the Cosumnes River, Sacramento County, California. Prepared for the U.S. Fish and Wildlife Service. Sacramento, California. 6 pp. with appendix.

Katibah, E. F. 1984. A Brief History of Riparian Forests in the Central Valley of California. Pages 23-29 *in* Warner, R. E. And K. M. Hendrix (eds.). California riparian systems: ecology, conservation, and productive management. University of California Press, Berkeley, California.

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

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

Kuivila, K. and C. Foe. 1995. Concentrations, transport and biological effects of dormant spray pesticides in the San Francisco estuary. California. Environ. Toxicol. Chem. 14(7):1141-1150.

Lande, R. 1988. Genetics and demography in biological conservation. Science 241:1455-1460.

McCarten, N.F. and C.A. Patterson. 1987. Vegetation Quality and Rare Plant Study of Riparian Plant Communities along the Middle Sacramento River, California. California Department of Fish and Game Non-game Heritage Program. November 1987. Sacramento, California.

McGill, Robert, R., Jr. 1975 Land use Changes in the Sacramento River Riparian Zone, Redding to Colusa. State of California, Resources Agency, Department of Water Resources. April, 1975. Sacramento, California. 23 pp.

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

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

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

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

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

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

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

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

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

Stevens, D. E. 1996. Distribution and food habits of American Shad (*Alosa sapidissima*) in the Sacramento-San Joaquin Delta. Pp. 97-107 *in* J.L. Turner and D.W. Kelley (eds.). Ecological studies of the San Francisco Bay Estuary. California Fish and Game Bulletin No. 136.

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

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

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

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

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

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

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

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

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

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

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

_____. 2000. Impacts of Riprapping to Ecosystem Functioning, Lower Sacramento River, California. Prepared for the U.S. Army Corps of Engineers, Sacramento District, as part of the Fish and Wildlife Coordination Act Report.

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

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

Wang, J.C.S. 1991. Early life stages and early life history of the Delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin Estuary, with comparison of early life stages of the longfin smelt, *Spirinchus thaleichthys*. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Tech. Rept. 28.

Weihs, D. 1974. Energetic advantages of burst swimming of fish. J. Theor. Bio. 48:215-229.

United States Department of the Interior

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

In reply refer to:
1-1-07-F-0355

SEP 27 2007

Mr. Francis Piccola
Planning Division Chief
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814-2922

Subject: Amendment to the Biological Opinion (Service file number 1-1-07-F-0118) for the Public Law 84-99 Order 1 Levee Repair Sites, Tehama, Sacramento, Yuba, Sutter, and Yolo Counties, California

Dear Mr. Piccola:

This letter is in response to the U.S. Army Corps of Engineers (Corps) request for reinitiation of section 7 consultation with the U.S. Fish and Wildlife Service (Service) on the Public Law 84-99 Order 1 Levee Repair Sites (proposed project), in Tehama, Sacramento, Yuba, Sutter, and Yolo Counties, California. Your September 17, 2007, request was received in our office on September 18, 2007. This amended biological opinion addresses the addition of a site in Reclamation District 3 which effects threatened delta smelt (*Hypomesus transpacificus*) and its critical habitat. This amended biological opinion is issued under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*)(Act).

The findings and recommendations in this consultation are based on: (1) the September 17, 2007, letter from the Corps reinitiating section 7 consultation on this project; (2) e-mail correspondence between National Marine Fisheries Service (NMFS) and the Corps, which was forwarded to the Service; and (3) other information available to the Service.

Therefore, the July 5, 2007, biological opinion is now amended as follows:

**Page 3: Change the Project Description from:**
**RD 3**
This project includes four sites on Steamboat Slough and four sites on the Sacramento River protecting Grand Island in the California Delta region. Grand Island is approximately 13 miles southwest of Sacramento and 12 miles west of Galt.

**To:**
**RD 3**
This project includes five sites on Steamboat Slough and four sites on the Sacramento River protecting Grand Island in the California Delta region. Grand Island is approximately 13 miles southwest of Sacramento and 12 miles west of Galt.

**Page 5: Add the Following to the Project Description Just Before Staging and Stockpiling:**
Recent surveys indicated that a site on Steamboat Slough at RM 15.1 could fail during a high water event. This raised the site to an Order 1 status and the Corps proposes to fix the site prior to the flood season in 2007. The repair consists of restoring 772 linear feet of levee slope to pre-flood condition which consisted of rock revetment. The site would be cleared, the scarp backfilled with impervious material, and rock protection would be restored to the waterside slope to the height and thickness of the adjacent undamaged area. Rock protection would be placed on a 6-inch layer of bedding material.

The lower slope of the site is covered with rock revetment and the upper slope is soil with grasses and horsetail. Clusters of emergent vegetation, mostly tules, are present throughout the site. These clusters will be moved to the shoreline immediately adjacent to the proposed fix to minimize any temporal loss of habitat. The upper slope of the proposed project area will be seeded with native grasses to prevent erosion and the waterline will be planted with willow pole cuttings and buttonbush cuttings placed in three rows on two foot centers. Approximately 0.25 acre will be disturbed to repair the site. Work would occur within the delta smelt work window between August 1, 2007, and November 30, 2007.

**Page 14: Replace the First Paragraph under Effects of Proposed Action From:**
Placement of riprap on levees would result in the permanent loss of 1,852 linear feet of river bank within the range of the delta smelt. Slightly less than half of which (892 feet) is natural bank substrate and the remaining 960 feet had previously been rocked. Direct effects due to construction include the loss of existing trees and vegetation due to the rock placement. Construction of the project is scheduled to occur between October 2006 and March 2007, which coincides with when delta smelt move upstream to river channels and back water sloughs to spawn. Therefore, it is expected that delta smelt would be in the project area during construction of the sites in RD 3 and 999. Because construction would be completed mostly outside of the window when delta smelt spawn, February to June, it is unlikely that delta smelt spawning would be directly affected from the placement of rock. However, up to 1,852 linear feet of bank would not be suitable for use by delta smelt for spawning due to the placement of rock and temporal loss of vegetation.

**To:**
Placement of riprap on levees would result in the permanent loss of 2,624 linear feet of river bank within the range of the delta smelt. Slightly less than half of which (892 feet) is natural bank substrate and the remaining 1,732 feet had previously been rocked. Direct effects due to construction include the loss of existing trees and vegetation due to the rock

placement. Construction of 1,825 linear feet of the project is scheduled to occur between October 2006 and March 2007, which coincides with when delta smelt move upstream to river channels and back water sloughs to spawn. Therefore, it is expected that delta smelt would be in the project area during most of the construction of the sites in RD 3 and 999. Because most of the work would be done outside of the timeframe when delta smelt spawn, February to June, it is unlikely that delta smelt spawning would be directly affected from the placement of rock. However, up to 1,852 linear feet of bank would not be suitable for use by delta smelt for spawning due to the placement of rock and temporal loss of vegetation. The remaining 772 linear feet of work would occur during the delta smelt work window of August 1, 2007, to November 30, 2007. Work during this period would avoid affecting spawning delta smelt.

**Page 17: Change the 7th Paragraph Under Delta Smelt Critical Habitat From:**
Implementation of the proposed action at the 11 sites in delta smelt critical habitat would impact delta smelt critical habitat via a direct, incremental reduction in the availability of shallow water habitat and herbaceous and woody vegetation recruitment along 1,852 linear feet. Existing submerged vegetation at the project sites was covered with rock and the ability of the riprapped sites to grow vegetation would be reduced. Though planting of the riprapped sites would ameliorate this effect.

**To:**
Implementation of the proposed action at the 12 sites in delta smelt critical habitat would impact delta smelt critical habitat via a direct, incremental reduction in the availability of shallow water habitat and herbaceous and woody vegetation recruitment along 2,624 linear feet. Existing submerged vegetation at the project sites was covered with rock and the ability of the riprapped sites to grow vegetation would be reduced. Though planting of the riprapped sites would ameliorate this effect.

**Page 18: Change the 12th and 13th Paragraphs under Delta Smelt Critical Habitat From:**
The effect to delta smelt critical habitat at these 11 sites is related to the incremental reduction in shallow water habitat and submerged vegetation, a primary constituent element. The rock, rather than earthen, substrate could exclude the existence of emergent plants along the shoreline as well as aquatic plants within the photic zone, to the detriment of delta smelt. This reduction occurs in a river reach already 71 percent riprapped. Basic fluvial processes, the mechanism by which additional shallow water habitat could be created and maintained, will be impeded at the project site within critical habitat.

Implementation of the proposed action at the 11 sites in delta smelt critical habitat would impact delta smelt critical habitat via a direct, incremental reduction in the availability of shallow water habitat and herbaceous and woody vegetation recruitment along 1,852 linear feet. Existing submerged vegetation at the project sites were covered with rock and the ability of the riprapped sites to grow vegetation would be reduced. Planting of the riprapped sites would ameliorate this effect, and, therefore, the Service believes that the project as proposed does not adversely modify or destroy delta smelt habitat. While changing the bank conditions from natural bank to rocked back, reducing vegetation, and constructing steeper banks at some sites, would effect delta smelt critical habitat, the projects designs which include sloped undulating benches, vegetating benches and slopes, and would allow the primary constituent elements of delta smelt critical habitat to remain intact.

**To:**
The effect to delta smelt critical habitat at these 12 sites is related to the incremental reduction in shallow water habitat and submerged vegetation, a primary constituent element. The rock, rather than earthen, substrate could exclude the existence of emergent plants along the shoreline as well as aquatic plants within the photic zone, to the detriment of delta smelt. This reduction occurs in a river reach already 71 percent riprapped. Basic fluvial processes, the mechanism by which additional shallow water habitat could be created and maintained, will be impeded at the project site within critical habitat.

Implementation of the proposed action at the 12 sites in delta smelt critical habitat would impact delta smelt critical habitat via a direct, incremental reduction in the availability of shallow water habitat and herbaceous and woody vegetation recruitment along 2,624 linear feet. Existing submerged vegetation at the project sites were covered with rock and the ability of the riprapped sites to grow vegetation would be reduced. Planting of the riprapped sites would ameliorate this effect, and, therefore, the Service believes that the project as proposed does not adversely modify or destroy delta smelt habitat. While changing the bank conditions from natural bank to rocked back, reducing vegetation, and constructing steeper banks at some sites, would effect delta smelt critical habitat, the projects designs which include sloped undulating benches, vegetating benches and slopes, and would allow the primary constituent elements of delta smelt critical habitat to remain intact.

**Page 12: Change the 2nd Paragraph Under Amount or Extent of Take From:**
Accordingly, the Service is quantifying take incidental to the project as the linear feet of shallow water habitat that were affected by the proposed action. Take will be primarily in the form of harm to the species through permanent and temporary loss of its nearshore breeding and feeding habitat. Therefore, the Service estimates that all delta smelt along 1,852 lf of river bank are subject to incidental take as a result of the proposed action.

**To:**
Accordingly, the Service is quantifying take incidental to the project as the linear feet of shallow water habitat that were affected by the proposed action. Take will be primarily in the form of harm to the species through permanent and temporary loss of its nearshore breeding and feeding habitat. Therefore, the Service estimates that all delta smelt along 2,624 lf of river bank are subject to incidental take as a result of the proposed action.

The other portions of the project description, species baseline, effects analysis, conclusion, reasonable and prudent measures, and conservation recommendations in the August 10, 2005, biological opinion remain the same.

This concludes formal consultation with the Corps on the amended Public Law 84-99 Order 1 Levee Repair Sites Project. As provided in 50 CFR §402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

Please contact Jennifer Hobbs, or the acting Sacramento Valley Branch Chief, of my staff at (916) 414-6645 if you have questions regarding this amendment to the biological opinion for the Public Law 84-99 Order 1 Levee Repair Sites Project.

Sincerely,

Kenneth Sanchez
Acting Field Supervisor

cc:
Liz Holland, Corps of Engineers, Sacramento, California
Madelyn Martinez, National Marine Fisheries Service, Sacramento, California

# United States Department of the Interior

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


In reply refer to:
81420-2008-I-1031
A27

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477

Mr. Francis C. Piccola
Chief, Planning Division
Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814

Subject: Section 7 Consultation on the Public Law 84-99 Order 3 and 4 Levee Repair Project in RD 551/755, Sacramento County, California

Dear Mr. Piccola:

This letter is in response to your February 19, 2008, letter requesting concurrence with a not likely to adversely affect determination by the Corps of Engineers (Corps) for the threatened delta smelt (*Hypomesus transpacificus*) from proposed levee repair work on the Sacramento River in Sacramento County, California. The proposed Order 3 and 4 levee repairs are in Reclamation District (RD) 551/755 and are being conducted under the authority of Public Law (PL) 84-99, Rehabilitation of Damaged Flood Control Works.

The U.S. Fish and Wildlife Service (Service) received your request on February 20, 2008. This response is in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). In accordance with section 7 of the Act, this document represents the Service's biological opinion of the effects of the proposed action on the federally listed delta smelt. Our analysis of the potential effects of the proposed project is based on the following information: (1) a site visit to the proposed repair sites in December 2006; (2) information in the Corps' February 19, 2008, letter to the Service; and (3) other project related information available to the Service.

Between December 28, 2005, and January 9, 2006, the State of California experienced a series of severe storms, which damaged levees within the Corps' Sacramento District boundaries. Water rose a second time in April 2006, and high remained in the system until June 2006. Many rivers and streams within the Sacramento and San Joaquin River Basins ran above flood stage during these events, and there were significant erosion and seepage problems with the levees. The Department of Water Resources (DWR) and/or their maintaining agencies conducted flood fight activities while the Corps has been working with DWR to restore the levee systems to the pre-storm level of protection. These efforts have been conducted under the authority of PL 84-99, Rehabilitation of Damaged Flood Control Works.

The Corps plans to use the PL 84-99 authority to repair levees along the Sacramento River in RD 551/755 to their pre-flood conditions. All of these sites exhibit damages that do not reduce the levee stability below acceptable limits, but may be exacerbated during subsequent flood seasons and therefore should be repaired.

The 15 repair sites are located along the Sacramento River (River Mile 32.3 to 35.4) near the towns of Paintersville and Courtland on Randall Island. Ten sites are located in RD 551 and five sites are located in RD 755. These sites are part of the Sacramento River Flood Control Project. Areas surrounding the erosion sites are primarily agricultural, growing a variety of row crops, grapes, and some orchards.

The damages consist of intermittent erosion along a 3,567-foot-long reach in RD 551 and a 900-foot-long reach in RD 755. The wave wash damage depth varies from 2-4 feet and individual sites extend from just over 4 feet to 723 feet long. The total length of damaged area is 4,467 feet.

The plans for all repairs are similar. All construction would occur from the levee crown. The damaged levee slopes would be excavated about 0.5 foot beyond the damaged surface, backfilled with compacted impervious soil, and reconstructed to the grade of the adjacent undamaged area. The waterside levee slope would be covered with rock protection placed on a 6-inch thick layer of bedding material. At two sites in RD 755 the repair would extend into the water to re-establish the 2:1 (H:V) waterside levee slope. A drain rock foundation would be constructed along the waterside toe to a height of 2 feet above the water level. The levee would then be reconstructed with compacted impervious soil, a 6-inch layer of bedding material, and an 18-inch layer of stone.

The waterside levee slope on the majority of the sites in RD 551 is dominated by non-native grasses and forbs on the upper half of the slope. The lower half consists of riprap with very sparse to no vegetation. Up to 10 scattered interior live oak trees may need to be trimmed to allow construction to be completed. In RD 755 conditions are similar except one site has woody vegetation which may need to be trimmed for construction to occur.

All disturbed areas without rock protection will be reseeded with native grasses and herbaceous vegetation. Willow pole cuttings will be planted along the water's edge at all project sites. All emergent wetland vegetation will be avoided by construction activities by placing a silt screen on the landside of the levee to create a barrier between the vegetation and construction equipment.

Staging areas will be located on the landside of the levee. The exact location and size of the staging areas will be determined by the contractor and approved by the Corps. Staging areas that are approved by the Corps will not affect endangered species or their critical habitat.

The Corps has proposed the following conservation measures to minimize the effects on delta smelt:

- Stockpiling of construction materials such as portable equipment, vehicles, and supplies, including chemicals, shall be restricted to the designated construction staging areas and barges, excluding any riparian or wetland areas.

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

- A representative shall be appointed by the Corps who shall be the point of contact for any Corps employee, contractor, or contractor employee, who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species during the project construction and operations. This representative shall be identified to the employees and contractors during an all-employee education program conducted by the Corps 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, the Corps biologist/environmental manager or contractor shall accompany Fish and Wildlife Service or National Marine Fisheries Service personnel on an on-site, post-construction inspection tour to review project impacts and mitigation success.

- A Corps representative shall work closely with the contractors through all construction stages to ensure that any living riparian vegetation or IWM (instream woody material) within vegetation clearing zones that can reasonably be avoided without compromising basic engineering design and safety is avoided and left undisturbed to the extent feasible.

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

- Willow cuttings would be placed along the waterline at water's edge where riprap has been placed.

- All disturbed areas would be reseeded with native grasses.

The project would place riprap on levees within the range of the delta smelt that had previously been rocked. No direct effects due to construction are expected since construction is scheduled to occur between August 1 and November 30, 2008. This is outside the spawning period for delta smelt; therefore, it is expected that delta smelt would not be in the project area during construction of the sites in RD 551/755.

No over-water shade from trees and shrubs would be lost due to rock placement. Vegetation loss would be compensated for at all sites by planting willow pole plantings on-site. The willow pole cuttings installed on ~~the~~ all the repair sites should re-create some of the previously lost hydraulic diversity and variability in this reach of the river.

The primary effect to water quality is the liberation of sediments during placement of riprap to re-establish a waterside toe at two locations; however, adverse effects on water quality are minimized because the Corps will use erosion control measure BMPs to prevent soil or sediment from entering the river. In addition, only two sites have in-water work.

The movement of the construction equipment and exposure of bare soil could result in increased turbidity and impaired water quality. Toxic substances including gasoline, lubricants, and other petroleum-based products could enter the water courses as a result of spills or leakage from machinery or storage containers. Toxins could also be released from sediments at the site. These toxins could have an immediate or delayed lethal or sub-lethal effect on various delta smelt life stages and may also affect the reproductive success of the delta smelt. Submerged aquatic vegetation in downstream areas, which is good spawning habitat, may also be negatively affected by the toxic substances. However, adverse effects on water quality are minimized because the Corps will use BMPs that describe the use, containment, and cleanup of contaminants and will keep stockpiled materials away from the water.

Currently there is no input of IWM into the river from these sites because it is riprapped. The IWM availability and functioning within the Sacramento River is already substantially reduced. The proposed planting of willow pole cuttings may provide limited IWM input after they have had time to develop and mature.

Delta smelt critical habitat encompasses the Sacramento-San Joaquin Delta, including the mainstem Sacramento River upstream to the limit of tidal influence at about RM 59.4. Implementation of the proposed action at the 15 sites in delta smelt critical habitat would continue to limit the availability of shallow water habitat and herbaceous and woody vegetation recruitment along 4,467 linear feet. Existing submerged vegetation at the project sites would be preserved. Planting of the repaired riprapped sites would ameliorate this effect, and, therefore, the Service believes that the project as proposed does not adversely modify or destroy delta smelt habitat.

Based on (1) implementation of the above conservation measures, (2) the fact that no delta smelt or critical habitat would be directly impacted with the proposed project, and (3) proposed willow pole cuttings would be placed on each site the Service concurs with your determination that the project may affect, but is not likely to adversely affect the delta smelt provided the following conservation measures are incorporated into the project description:

- Since construction will be completed by ~~September 2008~~ November, 2008, willow pole plantings shall be completed no later than the fall of 2008.

- Any emergent wetland vegetation which cannot be avoided shall be carefully removed prior to construction, held, and replaced (anchored) as construction activities are completed on each site.
- To ensure high survivability of willow pole plantings, irrigation shall be done as needed to ensure the cuttings become established. The Corps shall develop a site inspection schedule to evaluate the condition of the plantings for the first 3 years after they are installed.

This concludes the Service's review of the proposed levee repair work on the Sacramento River in RD 551/755 under the authority of PL 84-99 and no further coordination with the Service under the Act is necessary at this time. Please note that this letter does not authorize take of listed species. As provided in 50 CFR § 402.14, initiation of formal consultation is required where there is discretionary Federal involvement or control over the action (or is authorized by law) and if: (1) new information reveals the effects of the project may affect listed species or critical habitat in a manner or to an extent not considered in this review; (2) the project is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (3) a new species is listed or critical habitat designated that may be affected by this project.

Therefore, unless new information reveals effects of the proposed project may affect listed species in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, no further action pursuant to the Act is necessary.

If you have any questions regarding this response please contact Doug Weinrich at (916) 414-6563.

Sincerely,

Peter A. Cross

Peter A. Cross
Deputy Assistant Field Supervisor

cc:
Elif Fehm-Sullivan, COE, Sacramento, CA
Madelyn Martinez, NOAA Fisheries, Sacramento, CA
Gary Hobgood, CDFG, Rancho Cordova, CA

United States Department of the Interior

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

In reply refer to:
81420-2008-I-1030

JUL 8 2008

Mr. Francis C. Piccola
Chief, Planning Division
Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814

Subject: Section 7 Consultation on the Public Law 84-99 Order 3, 4 and 5 Levee Repair Project in RD 3, Sacramento County, California

Dear Mr. Piccola:

This letter is in response to your February 19, 2008, letter requesting concurrence with a not likely to adversely affect determination by the Corps of Engineers (Corps) for the threatened delta smelt (*Hypomesus transpacificus*) from proposed levee repair work on the Sacramento River in Sacramento County, California. The proposed Order 3, 4 and 5 levee repairs are in Reclamation District (RD) 3 and are being conducted under the authority of Public Law (PL) 84-99, Rehabilitation of Damaged Flood Control Works.

The U.S. Fish and Wildlife Service (Service) received your request on February 20, 2008. This response is in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). This document represents the Service's determination regarding the effects of the proposed action on the federally-listed delta smelt. Our analysis of the potential effects of the proposed project is based on the following information: (1) a site visit to the proposed repair sites in December 2006; (2) information in the Corps' February 19, 2008, letter to the Service; and (3) other project related information available to the Service.

Between December 28, 2005, and January 9, 2006, the State of California experienced a series of severe storms, which damaged levees within the Corps' Sacramento District boundaries. Water rose a second time in April 2006, and remained high in the system until June 2006. Many rivers and streams within the Sacramento and San Joaquin River Basins ran above flood stage during these events, and there were significant erosion and seepage problems with the levees. The Department of Water Resources (DWR) and/or their maintaining agencies conducted flood fight activities while the Corps has been working with DWR to restore the levee systems to the pre-storm level of protection. These efforts have been conducted under the authority of PL 84-99, Rehabilitation of Damaged Flood Control Works.

The Corps plans to use the PL 84-99 authority to repair levees along the Sacramento River in RD 3 to their pre-flood conditions. All of these sites exhibit damages that do not reduce the levee stability below acceptable limits, but may be exacerbated during subsequent flood seasons and, therefore, should be repaired.

The 29 repair sites are located along the Sacramento River (20 sites) and Steamboat Slough (9 sites) which encompass Grand Island. Steamboat Slough has 3,693 feet of intermittent erosion of the existing rock protection and the Sacramento River has 5,870 feet of intermittent slope erosion of the existing rock protection. Damage depth varies from 1 to 5 feet and sites are from 55 to 855 feet long. These sites are part of the Sacramento River Flood Control Project. Areas surrounding the erosion sites are primarily agricultural, growing a variety of row crops, grapes, and some orchards. The town of Ryde is also located on Grand Island.

The plans for all repairs are similar. All construction would occur from the crown of the levee or from waterside of the levee using a barge where sites border Highway 160 and guard rails are present. The damaged levee slopes would be excavated about 0.5 foot beyond the damaged surface, backfilled with compacted impervious soil, and reconstructed to the grade of the adjacent undamaged area. Lost rock protection would be replaced to the height and thickness of adjacent undamaged areas. The rock protection would be placed on a 6-inch thick layer of bedding material.

The waterside levee slope on the majority of the sites in RD 3 is dominated by non-native grasses and forbs. The dominant vegetation on most sites is dense stands of horsetail. The only woody vegetation found at most sites are small native trees that grow along the levee toe about 2-3 feet from the water's edge. At a few sites there are mature trees (oaks or alder) on the upper levee slope, some of which will need pruning or removal (six trees will need to be removed). A qualified biologist or arborist will be present to ensure: (1) only minimal tree trimming is conducted to allow the work to be completed, and (2) remaining woody vegetation is left undisturbed. All emergent wetland vegetation will be avoided by construction by placing a silt screen on the landside of any emergent vegetation to create a barrier between the vegetation and construction equipment. All disturbed areas without rock protection will be reseeded with native grasses and herbaceous vegetation. Willow pole cuttings will be planted along the water's edge at all project sites.

Staging areas will be located on the landside of the levee. The exact location and size of the staging areas will be determined by the contractor and approved by the Corps. Staging areas that are approved by the Corps will not affect endangered species or their critical habitat.

The Corps has proposed the following conservation measures to avoid the effects on delta smelt:

- Stockpiling of construction materials such as portable equipment, vehicles, and supplies, including chemicals, shall be restricted to the designated construction staging areas and barges, excluding any riparian or wetland areas.

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

- A representative shall be appointed by the Corps who shall be the point of contact for any Corps employee, contractor, or contractor employee, who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species during the project construction and operations. This representative shall be identified to the employees and contractors during an all-employee education program conducted by the Corps 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, the Corps biologist/environmental manager or contractor shall accompany Fish and Wildlife Service or National Marine Fisheries Service personnel on an on-site, post-construction inspection tour to review project impacts and mitigation success.

- A Corps representative shall work closely with the contractors through all construction stages to ensure that any living riparian vegetation or instream woody material (IWM) within vegetation clearing zones that can reasonably be avoided without compromising basic engineering design and safety is avoided and left undisturbed to the extent feasible.

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

- Willow cuttings would be placed along the waterline at water's edge where riprap has been placed.

- All disturbed areas would be reseeded with native grasses.

The project would place riprap on levees within the range of the delta smelt that had previously been rocked. No direct effects due to construction are expected since construction is scheduled to occur between August 1 and November 30, 2008. This is outside the spawning period for delta smelt; therefore, it is expected that delta smelt would not be in the project area during construction of the sites in RD 3.

No over-water shade from trees and shrubs would be lost due to rock placement. Vegetation loss would be compensated for at all sites by planting willow pole plantings on-site. The willow pole cuttings installed on all the repair sites should re-create some of the previously lost hydraulic diversity and variability in this reach of the river.

The primary effect to water quality is the liberation of sediments during placement of riprap to re-establish a waterside toe where needed; however, adverse effects on water quality are minimized because the Corps will use erosion control measure best management practices (BMPs) to prevent soil or sediment from entering the river.

The movement of the construction equipment and exposure of bare soil could result in increased turbidity and impaired water quality. Toxic substances including gasoline, lubricants, and other petroleum-based products could enter the water courses as a result of spills or leakage from machinery or storage containers. Toxins could also be released from sediments at the site. These toxins could have an immediate or delayed lethal or sub-lethal effect on various delta smelt life stages and may also affect the reproductive success of the delta smelt. Submerged aquatic vegetation in downstream areas, which is good spawning habitat, may also be negatively affected by the toxic substances. However, adverse effects on water quality are minimized because the Corps will use BMPs that describe the use, containment, and cleanup of contaminants and will keep stockpiled materials away from the water.

Currently there is no input of IWM into the river from these sites because it is riprapped. The IWM availability and functioning within the Sacramento River and Steamboat Slough is already substantially reduced. The proposed planting of willow pole cuttings may provide limited IWM input after they have had time to develop and mature.

Delta smelt critical habitat encompasses the Sacramento-San Joaquin Delta, including the mainstem Sacramento River upstream to the limit of tidal influence at about River Mile 59.4. Implementation of the proposed action at the 29 sites in delta smelt critical habitat would continue to limit the availability of shallow water habitat and herbaceous and woody vegetation recruitment along 9,563 linear feet. Existing submerged vegetation at the project sites would be preserved. Planting of the repaired riprapped sites would ameliorate this effect, and, therefore, the Service believes that the project as proposed does not adversely modify or destroy delta smelt habitat.

Based on (1) implementation of the above conservation measures, (2) the fact that no delta smelt or critical habitat would be directly impacted with the proposed project, and (3) proposed willow pole cuttings would be placed on each site the Service concurs with your determination that the project may affect, but is not likely to adversely affect the delta smelt provided the following conservation measures are incorporated into the project description:

- Since construction will be completed by the end of November 2008, willow pole plantings shall be completed no later than the fall of 2008.

- Any emergent wetland vegetation which cannot be avoided shall be carefully removed prior to construction, held, and replaced (anchored) as construction activities are completed on each site.
- To ensure high survivability of willow pole plantings, irrigation shall be done as needed to ensure the cuttings become established. The Corps shall develop a site inspection

schedule to evaluate the condition of the plantings for the first 3 years after they are installed.

This concludes the Service's review of the proposed levee repair work on the Sacramento River in RD 3 under the authority of PL 84-99 and no further coordination with the Service under the Act is necessary at this time. Please note that this letter does not authorize take of listed species. As provided in 50 CFR § 402.14, initiation of formal consultation is required where there is discretionary Federal involvement or control over the action (or is authorized by law) and if: (1) new information reveals the effects of the project may affect listed species or critical habitat in a manner or to an extent not considered in this review; (2) the project is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (3) a new species is listed or critical habitat designated that may be affected by this project.

Therefore, unless new information reveals effects of the proposed project may affect listed species in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, no further action pursuant to the Act is necessary.

If you have any questions regarding this response please contact Doug Weinrich at (916) 414-6563.

Sincerely,

Peter A. Cross

Peter A. Cross
Deputy Assistant Field Supervisor

cc:
Elif Fehm-Sullivan, COE, Sacramento, CA
Madelyn Martinez, NOAA Fisheries, Sacramento, CA
Gary Hobgood, CDFG, Rancho Cordova, CA

# United States Department of the Interior

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

IN REPLY REFER TO:
81420-2009-I-0707-1

AUG 26 2009

Mr. Francis C. Piccola
Chief, Planning Division
Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814

Subject: Request for concurrence on the Public Law 84-99 Order 3, 4 and 5 Levee Repair Project in Reclamation District 150, Yolo County, California

Dear Mr. Piccola:

This is in response to the U.S. Army Corps of Engineers' (Corps) April 13, 2009, letter requesting consultation with the U.S. Fish and Wildlife Service (Service) on the proposed levee repairs along the Sacramento River in Reclamation District (RD) 150, Yolo County, California (proposed project). Your letter was received in our office on April 15, 2009. The proposed Order 3, 4 and 5 levee repairs are being conducted under the authority of Public Law (PL) 84-99, Rehabilitation of Damaged Flood Control Works. The Corps has requested concurrence with its determination that the proposed project may affect, but is not likely to adversely affect the federally threatened delta smelt (*Hypomesus transpacificus)* and its critical habitat and the federally threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*).

This response is in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). This document represents the Service's determination regarding the effects of the proposed action on the delta smelt and its critical habitat and valley elderberry longhorn beetle. Our analysis of the potential effects of the proposed project is based on the following information: (1) a site visit to the proposed repair sites in June 2007; (2) information in the Corps' April 13, 2009, and June 2, 2009, letters to the Service; and (3) other project related information available to the Service.

Between December 28, 2005, and January 9, 2006, the State of California experienced a series of severe storms, which damaged levees within the Corps' Sacramento District boundaries. Water rose a second time in April 2006, and remained high in the system until June 2006. Many rivers and streams within the Sacramento and San Joaquin River Basins ran above flood stage during these events, and there were significant erosion and seepage problems with the levees. The

Department of Water Resources (DWR) and/or their maintaining agencies conducted flood fight activities. The Corps has been working with DWR to restore the levee systems to the pre-storm level of protection. These efforts have been conducted under the authority of PL 84-99, Rehabilitation of Damaged Flood Control Works.

The Corps plans to use the PL 84-99 authority to repair levees along the Sacramento River in RD 150 to their pre-flood conditions. All of these sites exhibit damages that do not reduce the levee stability below acceptable limits, but may be exacerbated during subsequent flood seasons and, therefore, should be repaired.

**Project Description**

Seventeen sites are proposed for repair of erosion damage. Damage consists of wave wash erosion, levee toe scours, and loss of rock protection along an intermittent 7,033 feet of levee slope along the Sacramento River. Repair sites range from 5 feet to 2,455 feet long. The Corps has developed five repair options for the contractor to use on the damaged sites. More than one option may be used to complete repairs on a site. The repairs consist of a 3-foot or less erosion depth repair; a 3 to 10-foot erosion depth repair; a 3 to 10 foot depth in-water slope repair; a Shaded Riverine Aquatic (SRA) protection repair; and a repair for sections which have soil, vegetation and rock protection eroded away.

Generally repairs will be accomplished by excavating the eroded slopes at least 6 inches beyond the damaged surface and back filling the excavated area with quarry rock. The quarry rock will be covered by 2 feet of riprap placed on a 6-inch-thick layer of bedding material. Surface voids in the rock will be filled by casting 4-inch minus rock onto the riprap. The repaired slope will then be graded to match the adjacent, undamaged levee slope.

All in-water work for the project will be conducted during the August 1 to November 30 work window for delta smelt. Repairs will be completed from the levee crown except at those locations where there is vegetation blocking access. At those sites a barge will be used to complete the repairs. No trees will be removed as a part of this project; shrubs providing SRA cover will also be left in place. Shrubs which do not provide SRA cover will be avoided to the extent possible. All woody vegetation left in place will be protected with burlap when rock is placed around them.

At the completion of construction all of the sites will be planted with willow pole cuttings (two rows, 6 feet off center) at the levee toe for the length of the site.

The Service has reviewed the biological information describing the effects of the proposed project and concurs the proposed repairs may affect, but are not likely to adversely affect the valley elderberry longhorn beetle or the delta smelt and its critical habitat. This concurrence is based on the fact that the Corps proposes to implement the conservation measures outlined below:

**Valley Elderberry Longhorn Beetle**

At total of five elderberry (*Sambucus* sp.) shrubs are within 100 feet of three of the proposed repair sites (sites 014, 016, 017). Stem count data is not available for these shrubs due to the presence in thick vegetation surrounding them. Elderberry shrubs are the sole host plant for the valley elderberry longhorn beetle. The Corps proposes to implement the following protective measures taken from the Service's 1999 *Conservation Guidelines for the Valley Elderberry Longhorn Beetle*:

- A minimum setback of 100 feet from the dripline of all elderberry shrubs would be established, if possible. If the 100 foot minimum buffer zone is not possible a 20 foot or greater buffer zone would be established which would be fenced, flagged and maintained during construction.

- Environmental awareness training would be conducted for all construction representatives and contractor personnel before they begin work. The training would include status, the need to avoid adversely affecting elderberry shrubs, avoidance areas and measures taken by workers during construction, and contact information.

- Dust suppression measures would be used and a biological monitor would provide instruction on establishing the buffer zones for the shrubs. Signs would be posted every 50 feet along the edge of the avoidance area with the following information:

  *"This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment."*

  The signs would be readable from a distance of 20 feet and would be maintained during construction.

Based on (1) implementation of the above conservation measures and (2) no direct impacts to elderberry shrubs would occur with the project, the Service concurs with Corps' determination that the proposed project may affect, but is not likely to adversely affect the valley elderberry longhorn beetle.

**Delta Smelt and Critical Habitat**

The proposed project is along the Sacramento River near the town of Clarksburg. This is the Central Zone of the Delta for delta smelt and is within its designated critical habitat. No shallow water habitat would be lost with the project and delta smelt are unlikely to be in this area of the Sacramento River during the construction period.

The Corps has proposed the following conservation measures to avoid adverse effects on the delta smelt and its critical habitat:

- To the extent possible all work will be conducted from the levee crown.
- Any in-water construction activities will be conducted during the appropriate work window, between August 1 and November 30 of any given year, to avoid adverse effects to delta smelt and its critical habitat.
- To avoid the effects on delta smelt caused by loss of bank side vegetation the Corps will: a) protect in place existing trees, shrubs which provide SRA cover, and other shrubs where feasible using burlap when the rock is placed on the levee slope
- The Corps will plant willow pole cuttings at the levee toe for the length of each repair site at completion of construction activities.
- To avoid loss of spawning and refugial habitat the Corps will avoid areas having emergent vegetation to the maximum extent possible.

**Conclusion**

This concludes the Service's review of the proposed levee repair work on proposed levee repairs in RD 150 under the authority of PL 84-99 and no further coordination with the Service under the Act is necessary at this time. Please note that this letter does not authorize take of federally-listed species. If new information reveals the effects of the project may affect listed species or critical habitat in a manner or to an extent not considered in this review, the project is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion, a new species is listed or critical habitat designated that may be affected by this project, the Service should be contacted to determine if additional consultation is necessary.

If you have any questions regarding this opinion, please contact Doug Weinrich at (916) 414-6563.

Sincerely,

Daniel Russell

FOR Peter C. Cross
Deputy Assistant Field Supervisor

cc:
Elif Fehn-Sullivan, COE, Sacramento, CA
Madelyn Martinez, NOAA Fisheries, Sacramento, CA
Gary Hobgood, CDFG, Rancho Cordova, CA

CESPK-PD-RA March 30, 2010

MEMORANDUM FOR RECORD

SUBJECT: PL84-99 ESA compliance meeting - March 30, 2010

1. Purpose: A meeting was held on March 30, 2010 at the U.S. Army Corps of Engineers' (Corps) Sacramento District. The purpose of the meeting was to present and discuss options to comply with mitigation requirements for Endangered Species Act (ESA) due to a change in project description. In attendance were representatives from the Corps (P. Caldwell, C.M. Turner, L. Holland, J. LeFevre, P. Risher), National Marine Fisheries (NMFS) (H. Brown), and U.S. Fish and Wildlife Service (USFWS) (D. Weinrich).

2. Background: Between December 28, 2005 and January 9, 2006, the State of California experienced a series of severe storms, which damaged the levees within the Sacramento District's boundaries. High flows during this period saturated waterside levee slopes along the Sacramento River, San Joaquin River, and their tributaries causing a variety of damages including erosion of the levee toe, wave wash erosion, loss of existing rock protection, and scour holes.

The District initiated consultation with NMFS and USFWS in 2007 which included a mitigation plan to plant willow pole cuttings in three rows, spaced in two foot centers along the water line at each of the repaired sites. Following initial implementation of willow pole plantings at a test sites using the stinger method, the Corps determined the three row planting specification was detrimental to levee integrity and could not be used. Following this determination, the District informally coordinated with both NMFS and the USFWS to inform them of a change in project description. As a result, NMFS withdrew their original letter of concurrence dated July 2, 2008 on January 20, 2009. The District formally reinitiated consultation which included a revised Biological Assessment and impact analysis with NMFS May 18, 2009, and USFWS March 16, 2009, with a revised planting specification two rows of plantings spaced in two foot centers. Following the reinitiation, USFWS responded with a concurrence letter stating the change in project description would not affect their original determination, a Biological Opinion dated July 7, 2007. NMFS failed to formally respond to the District's reiniaition request dated May 18, 2009.

The Corps completed final levee repairs in January 2010. The remaining work is limited to mitigation planting per the above mentioned agreement. However, most proposed plantings are not in accordance with the ETL 1110-2-571 and will therefore require a variance.

3. Description: Approximately 40,400 linear feet (lf) of constructed levee repaired area requires mitigation, of which 10,400 lf does not require a variance because it does not lie within the fifteen feet vegetation free zone. Approximately 21,500 lf is within the vegetation free zone, and will require a variance in order to plant along the waterline. The remaining 8,500 lf of rehabilitation repairs would require planting on the waterside slope, and therefore, obtaining a variance would be more challenging as it would be difficult to meet the justification requirement for planting on the levee slope. Thus, the goal is to mitigate at another location that protects the same primary migratory pathways, or at an approved mitigation bank. Possible alternative sites have been identified within the same reclamation districts as the repairs and in many cases are adjacent to the site. Alternate sites are currently being screened based on location of the planting to the levee prism. The District will provide photos and GPS points to resource agencies so they can determine if the sites are suitable.

4. Discussion Items: NMFS and USFWS stated onsite mitigation is best for species. Both agencies recommended that the remaining 8,500 lf should be planted at a location that is a rip rapped or un-vegetated location along primary migratory corridors to reestablish connectivity in habitat. A suggested alternative to planting at offsite locations would be to purchase credits at an approved mitigation bank.

The question was asked what would happen if the willow pole survival success rate is not met within the required timeline. NMFS firmly reiterated the Corps is required to ensure an 80-95 percent success rate based on the SAM model and if the Corps does not complete mitigation they would be in violation with Section 7 and Section 9 of ESA. However, as we do not have any formal consultation document from NMFS, we are unsure of the consequences if this stated requirement is not met. NMFS has consulted with legal counsel and has indicated that at this time, they do not intend to provide any formal response to the District's reinitiation request dated May 18, 2009. USFWS discussed the highest survival rate can be obtained through irrigation over a period of three years when the vegetation becomes established. Irrigation is not proposed for the sites because the authorization for PL 84-99 rehabilitation projects is intended to support an emergency rehabilitation effort, and because funds were appropriated through the war supplemental which must be spent on emergency rehabilitation projects or returned to SPD/HQ as soon as possible for other Corps use. Congressional representatives are currently requesting that the funds be spent or returned immediately, therefore, a three year irrigation effort is not appropriate. Unfortunately, it is unlikely that the survival rate will be met by the proposed mitigation.

Temporal losses have occurred but we currently have no formal requirement to mitigate for these losses. At this time, neither NMFS nor USFWS are requiring that we mitigate for temporal losses.

NMFS announced their plan to send a letter to Colonel Chapman explaining their position regarding the ETL and its impacts and is crafting comments in response to the Federal Register posting of the Policy Guidance Letter regarding the vegetation variance request procedure.

All members agreed that the appropriate approach is to plant were a variance is easily justified, and find either an alternate location for the 8,500 lf or consider using a mitigation bank. The Sacramento District will identify possible opportunities for mitigation banking. If a bank is identified, it may be used in place of finding alternate mitigation sites. NMFS requested a notification letter from the Corps regarding the results of our bank analysis and final mitigation plan.

Following planting, the District will provide written notification of the location, quantity, and type of mitigation planted.

4. Point of Contact for this Memorandum is Ms. Liz Holland, at our Sacramento District Planning and Operations Division, 1325 J Street, 10th floor, Sacramento, California 95814, e-mail *Elizabeth.G.Holland@usace.army.mil*, or telephone 916-557-6763.

Liz Holland

Liz Holland CESPK-PD-RA
USACE, Environment Analysis

CESPK-PD-RA February 25, 2011

MEMORANDUM FOR RECORD (Supplemental)

SUBJECT: Update on consultation with the National Marine Fisheries Service (NMFS) on the mitigation for the PL 84-99, 2005-2006 storm event

1. Purpose: This MFR supplements CESPK-PD-RA MFR dated March 30, 2010 signed by Ms. Liz Holland by providing documentation of NMFS consultation activities conducted between April 1, 2010 and December 30, 2010.

2. Background: The Sacramento District initiated consultation with NMFS in 2007 which included a plan to plant willow pole cuttings in three rows, spaced two feet off-center along the waterline at each repair site. Following initial implementation of planting willow poles at a test site using the stinger method, the Sacramento District determined the three row planting specification was detrimental to levee integrity and could not be safely used. Following this determination, the Sacramento District informally coordinated with NMFS and requested a revised plan to plant willow poles in two rows, spaced three foot off-center. On January 20, 2009 NMFS withdrew their concurrence as a result of the change in project description. The Sacramento District reinitiated formal consultation May 18, 2009, which included a revised biological assessment, an impact analysis, and the revised planting plan. NMFS failed to formally respond to the Sacramento District's reinitiating request dated May 18, 2009.

On March 30, 2010, the Sacramento District, NMFS, and U.S. Fish and Wildlife Service conducted a meeting to discuss ESA compliance through proposed mitigation plantings. Ms. Liz Holland documented that in an MFR dated March 30, 2010.

3. Description: On October 27, 2010, the Sacramento District initiated informal consultation with NMFS for changes to avoidance and minimization measures. This letter described the revised plan to plant willow poles in two rows along the waterline and purchase approximately 10,000 linear feet of SRA habitat at a mitigation bank. The letter specifically requested NMFS concurrence that the proposed mitigation plan met our commitments.

NMFS responded on December 21, 2010. In their letter, NMFS stated that while they do not conduct after the fact consultation for the repairs, they were able to consult on the Sacramento District's proposal to plant willow pole cuttings. NMFS concurred with our proposed actions.

In accordance with the agreement, the Sacramento District purchased 10,000 lf of SRA habitat credits at a mitigation bank located on Liberty Island in the Sacramento-San Joaquin Delta. Bill of Sale was completed February 4, 2011.

4. Point of Contact for this Memorandum is Ms. Jamie LeFevre, Environmental Analysis Section. She may be reached at Jamie.M.LeFevre@usace.army.mil or 916-557-6693.

Jamie LeFevre

Jamie M. LeFevre CESPK-PD-RA
USACE, Environment Analysis

# The Stinger

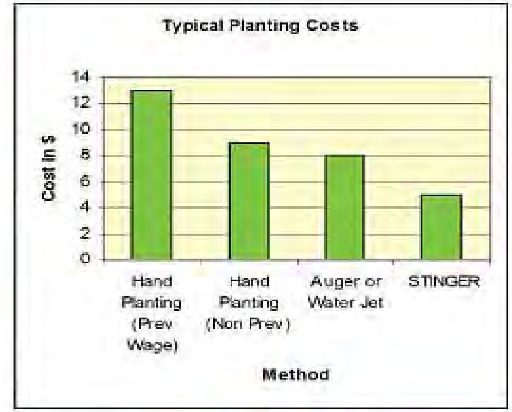
## How it Works

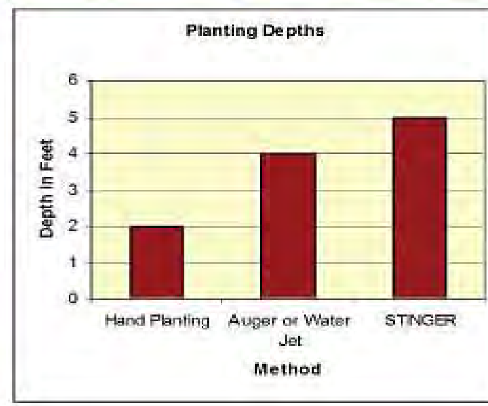
The Stinger is a hydraulically actuated needle shaped clamshell tool. The Stinger tool is mounted on a modified PC 220 excavator. The excavator's hydraulic system powers the clamshell rams.

In the field, the excavator can push the needle shaped tool through rocks, sand and mud to reach design depths where adequate water is available for plant survival. Once the stinger is at depth, a ground laborer drops several cuttings into the bowl of the clamshell. The hydraulic ram is then actuated, opening the bottom of the clamshell. The plant cuttings drop out the bottom of the Stinger and stay in place as the Stinger is raised out of the hole.

Placement rates of over 700 plants per shift are readily attainable. Keys to high productivity are a well marked planting area, adequate stocks of healthy cuttings and one or two ground personnel to keep up with the rapid placement rate of the Stinger.

The Stinger was designed for environmental restoration projects in Montana. Currently the Stinger patent is owned by the Salish & Kootenai Tribe and today there are a number of machines working throughout the west. Erick Ammon, Inc. has the only Stinger available for use in California. This machine is kept in Northern California between projects in an effort to reduce mobilization costs to California jobs.
The tracked excavator that carries the Stinger can work in steep rocky slopes (like levee faces) and in wet areas where low ground pressure is critical.



CESPK-ED-GS (1110-2-1150a) 23 January 2009

MEMORANDUM FOR RECORD

SUBJECT: PL84-99 Structural Impacts of Willow Pole planting using the Stinger.

1. **Introduction.** The undersigned reviewed the still photos and video of the 7 October ~~2009~~ 2008 demonstration of willow pole planting at RD 3 using the Stinger method.

2. **Discussion.** Based on the review and subsequent briefing from the Emergency Management Section (Caldwell and Bergmooser) it is apparent that stinger method impacts the integrity of the PL84-99 repair. This method impacts the repair by dislodging riprap which decreases the strength of the slope. A reduction in strength can result in slope instability and increase in slope erosion, which may compromise the integrity of the levee. Furthermore, slope movement due to slope instability can potentially damage willow pole plantings.

3. **Conclusions.** To limit impacts to the repaired slope the undersigned concurs with the recommendations presented in the attached document.

Kevin J. Hazleton, P.E, G.E.
Geotechnical Engineer
Soil Design Section

Encl: PL84-99: Structural Impacts of Willow Pole planting using the Stinger.

Cc: Emergency Management (Caldwell, Bergmooser)
Soil Design Section (Ketchum, file)

**PL84-99: Structural Impacts of Willow Pole planting using the Stinger**

## DISCUSSION AND ANALYSIS

**BACKGROUND:** In consultation with our regulatory agencies (FWS, NMFS and CDFG) we agreed to a prescriptive planting of willow pole cuttings in 3 rows on 3 feet centers using a tool called a Stinger. The Stinger is attached to a hydraulic excavator in the bed of a Landing Ship, Tank (LST) that embeds the cutting up to 5 feet below the surface of the levee face. The Stinger had been primarily used by its manufacturer on level benches *within* channels and in limited application for channel and roadway restoration measures.

In October 2008 SPK conducted a test of this tool and planting methodology on a site within RD3 using 3 planting patterns to test productivity, effectiveness and impact on the constructed levee repair. By observation the willows reached the soil when planted at the waters edge and in some circumstances the second row; there was no evidence that willows planted in the third row reached the soil below the rock revetment.

**REFERENCE:** Video and still photos of demonstration project dated 7Oct08.

**DISCUSSION:** ED-G (Hazelton) was asked to review the still photos and video of the demonstration project on 7Oct08 followed by a briefing on the typical cross sections for erosion failures, typical cross sections and material specifications from the CY2006 repairs. From the video it is apparent that the planting process using the Stinger impacts the structural integrity of the rock repair. Planting three rows at 3ft spacing in effect dislodges every rock within the cross section; increasing the distance between cuttings and reducing the number of rows then reduces the impact to the cross section.
The primary issue and concern for this method is the impact on the leading edge/toe of the repair.
The integrity of this section is critical to the long term stability of the repair section and to the extent that a significant amount of that section is dislodged the repair is increasingly subject to erosion along the toe of the slope; when that supporting structure is lost, the rock above and along the slope will dislodge and the repair fail.
Given that the general slope of the levee within the Delta along the Sacramento River is between 1:1 to 1.5:1, rock repairs sections generally greater than 3 feet in thickness at the base, the depth of penetration of the Stinger and the planting pattern, it is doubtful that the third row of cuttings would reach the water elevation during normal summer flow. This was borne out in the demonstration project.

**RECOMMENDATION:** Limiting the minimum impact to the repaired slope, in particular the keyed section or toe of the repair; hence using this method to plant one row along the waters edge would be preferable.
An acceptable alternative may be to increase the distance between cuttings and installation of a second row off-set to the first. While this alternative will impact the structural integrity of the toe more than the single row, the level of impact to the repair indicated in the demonstration would appear to be acceptable.

Plant Guide

# COYOTE WILLOW

## *Salix exigua* Nutt.

Plant Symbol = SAEX

*Contributed by: USDA NRCS National Plant Data Center, New Mexico Plant Materials Center, & Idaho Plant Materials Center*

Alfred Brousseau


**Alternate Names**

Sandbar willow, gray willow, narrow-leaved willow, dusky willow, pussywillow

**Uses**

*Ethnobotanic*: The value of willow as the raw material necessary for the manufacture of a family's household goods cannot be over-estimated. Among the Paiute, every woman carried bundles of long, slender willow which had been scraped white, and coils of willow sapwood that she had gathered and prepared during the winter months when the leaves were gone (Wheat 1967). Willow branches are used as the warp for twined baskets and the foundation in coiled baskets. Willows are used to weave water jugs, cradles for newborn infants, hats, cooking vessels, serving bowls, trays, seed beaters, and storage baskets. Some tribes use willow roots as a sewing strand. Virtually all California tribes use willow in their baskets.

Tribes which use willow, such as *Salix exigua*, include the Chemehuevi, Paiute, Mono, Panamint, Pviotso (Northern Paiute), Shoshoni, Bannock, Ute, Washo, Chiricahua, Jicarilla Apache, Mescalero Apache, Navajo, San Carlos Apache, Western Apache, White Mountain Apache, Havasupai, Maricopa, Yavapai, Hopi, San Juan Pueblo (Tewa), Zuni, Papago, and Pima Indians extending through the American Southwest and Mexico. In Ancestral Puebloan times, willow, along with threeleaf sumac, was the material of choice for manufacturing Native American baskets.

Willow is gathered from the time the leaves fall in autumn until the buds begin to swell in spring. The year-old wands without branches are chosen, and sorted by size and length. The bark can easily be stripped off in the spring when the sap rises. Willow wands with the smallest leaf scars are split and peeled to obtain the tough, flexible sapwood used for the weft in basket weaving. Color variation is achieved by alternating peeled and unpeeled willow sticks in the warp. Ute Indians used to concoct a green dye for coloring buckskin by soaking willow leaves in hot water and then boiling the mixture to concentrate the pigment. Willow roots also have been used by others to manufacture a rose-tan dye.

The Paiute built willow-frame houses covered with mats of cattails or tules. Slender willow withes were woven into tight circular fences as protection from the wind that blew sand into eyes and food. For shade, shed roofs thatched with willows, called "willow shadows", were constructed. In the Pueblo province, coyote willow branches are employed with leaves attached for thatching roofs. Other light construction uses included the tops of storage bins or racks for aerating corn while it dried, such as one recently unearthed at prehistoric Arroyo Hondo Pueblo.

A bed or sleeping bench of willow poles raised high off the ground indicated a wealthy man in the Miwok culture in California's Sierra Nevada. Willow brush was placed radically over the roof timbers of an earth lodge. Boats had eight willow ribs and a gunwale of willow pole along each side. Sweat lodges are made with willow. A women's shinney game was played on a field similar to a football field with five-foot long, sharp willow poles. A ring of rope or string was thrown into an indent in the field and the women had to move it up the field and throw it against a goal post without touching or carrying it on the poles. Counting games are played with willow counting sticks.

Ancestral Puebloans used willow wood for textile loom anchors, rods to control the weaving rhythm, and finishing needles. Bows, arrow points, pot rests, scrapers and cradle parts all were crafted from willow. In later times, Navajo made weaving sticks and arrow shafts from willow along with other straight-grained woods, and Ute Indians made snowshoe frames from dried willow branches. Matting was another early product made from willows.

Other implements made from willow include fire sticks twirled as a spindle to generate enough heat to ignite a flame and what appear to be prayer sticks recovered from various archaeological sites. Willow is still used for making prayer sticks by the Zunis and doubtless by some of the Rio Grande pueblo. Inner bark was used in spring for rope in California (Murphey 1959).

Aspirin is the pharmaceutical equivalent of willow bark tea, which is an effective remedy for headache, fever or sore throat. More than 2,400 years ago, the Greeks learned to use extracts of several native willow species to treat pain, gout, and other illnesses. In more recent times, in 1839, salicylic acid was isolated from wild plants and manufactured synthetically. Early salicylic acid-based products had unpleasant side effects. Sixty years later, the Bayer Company developed a derivative of salicylic acid, called it aspirin, and the rest is history.

Tea made from willow leaves will cure laryngitis. Willow reduces inflammation of joints and membranes. When used as an analgesic, willow treats urethra and bladder irritation, infected wounds, and eczema. Willow is used as an over-all treatment of many diseases, including hay fever, diarrhea, prostatitis, satyriasis, and relief of ovarian pain. A poultice is made for treating gangrene and skin ulcers. For one remedy used by the Paiute, burned willow charcoal was added to water and taken as a tea to stop diarrhea. A San Juan tribal elder said he used willow leaves to make his mouth water and relieve thirst.

Young willow shoots can be stripped of their bark and eaten. The inner bark can be eaten raw, prepared like spaghetti, or made into a flour. The young leaves may be eaten in case of emergency

*Other Uses*: Ecological diversity, bank and sediment stabilization, maintenance of channel morphology, water quality improvement, ground-water recharge, flood abatement, fish and wildlife habitat, ribs of boats, and games.

*Riparian Ecosystem Services and Functions*: The riparian zone essentially encompasses those alluvial sediment deposits where river and alluvial ground water supplement that available from local precipitation. High-to-low elevations, north-south and east-west gradients, and steep-to-shallow terrain all influence the relationship between geomorphic and fluvial processes and vegetation community structure. Riparian ecosystem functions include the following:

- Ecological diversity.
- Riparian vegetation traps sediments and nutrients from surface runoff and prevents them from entering the aquatic system.
- Dense matrix of roots in the riparian zone can serve as an effective filter of shallow groundwater.
- Water quality is improved through filtration and trapping of sediment, nutrients (particularly nitrogen dissolved in groundwater), and pollutants.
- Riparian vegetation tends to prevent the river from down-cutting or cutting a straight path (channeling), thus promoting a sinuous course, ground-water recharge, and maintenance of an elevated water table.
- Riparian areas act as a sponge by absorbing floodwaters which is then slowly released over a period of time, which minimizes flood damage and sustains higher base flows during late summer.
- Structurally complex riparian vegetation communities provide many different habitats and support a diverse array of animal species. Different groups of animals occupy or use the different layers of vegetation, and this multi-story arrangement is often present nowhere else in the arid landscapes.
- Canopies of plants growing on streambanks provide shade, cooling stream water, while roots stabilize and create overhanging banks, providing habitat for fish and other aquatic organisms.

*Wildlife*: Rabbits and many ungulates, including deer, moose, and elk, browse on willow twigs, foliage and bark (Martin 1951). Beavers consume willow branches, while several species of birds eat willow buds and young twigs.

California's riparian forests support a high diversity of breeding birds (Miller 1951). In one study conducted on the Sacramento River, 147 bird species were recorded as nesters or winter visitants' (Laymon 1985). The percentage of breeding individuals that are migratory is very high in the cottonwood-willow habitat. Moister conditions in the cottonwood-willow forest may promote lusher plant growth, higher invertebrate populations and, therefore, more available food for flycatchers, warblers and other migratory, insectivorous birds. Riparian areas support up to 10.6 times the density of migrant birds per hectare as adjacent non-riparian areas (Stevens et al. 1977). Most of these migratory birds belong to the foliage insect (47%) or air insect (34%) foraging guilds.

Coyote willow is browsed avidly by deer and to some extent by sheep, goats, and cattle, in summer and early fall. Cattle will leave the willow patches when the foliage matures and dries, whereas deer devour the current leafless stem throughout the winter. The browse rating for willow is good to fair for sheep and goats; good to poor for cattle; fair for deer; and fair to useless for horses (Sampson et al. 1981).

*Livestock*: Riparian ecosystems offer water, shade, and food for domestic livestock. Cattle and sheep congregate in riparian areas, particularly during hot or dry periods. Overgrazing of domestic livestock in riparian areas destroys riparian ground cover, disrupts the reproductive cycle of cottonwood trees, destabilizes streambanks, and thus increases sediment loads to streams.

**Status**
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

**Description**
*General*: Willow Family (Salicaceae). *Salix exigua*, with its long, thin leaves, is the most distinctive of the willow species. The leaves have a very short petiole, and mature blades are 50 - 124 mm long, linear, with an acuminate leaf tip and either a serrate or entire leaf edge. Coyote willow is a shrub < 7 m tall, and spreads clonally by root-sprouting. The catkin inflorescence appears with or after the leaves in the spring, and are 22-70 mm long on leafy shoots 5-110 mm long. The flower bracts are a tawny yellow color.

**Distribution**
For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site. *Salix exigua* is distributed in wetlands, along alluvial bottomlands and streamsides at elevations lower than 2700 m. Coyote willow is distributed throughout California north to Alaska, east across North America, and south to Arizona and Mexico (Hickman (1993). Mason (1957) says *Salix exigua* is often found at sites of former Indian habitation, and notes this was one of the common basket willows of the Indians

**Establishment**
*Adaptation*: Coyote willow dominates the riparian forests of lower terrace deposits and stabilized gravel bars. Willows are found near water; they require a bare gravel or sand substrate with adequate moisture for germination and development. Willows grow very rapidly when their roots are in contact with the permanent water table.

Typically, in California, cottonwoods and willows predominate on the immediate stream banks, whereas valley oaks are spread irregularly over the natural levees farther away from stream banks. In other parts of the American west, temporal gradients occur within a location in the riparian zone. Early pioneer communities such as cottonwood/willow give way to late successional communities such as mesquite or sagebrush, often a consequence of sediment accumulation (Patten 1998). Many similarities among western riparian ecosystems exist because several dominant genera (e.g. *Populus* and *Salix* spp.) are common throughout the West, and many geomorphic and hydrologic processes that influence riparian establishment are similar.

Western riparian ecosystems have been greatly altered by human activity. Riparian forests have been reduced to fragmented, discontinuous patches because of human intervention. For example, estimates are that 70 - 90 percent of the natural riparian ecosystems in the U.S. have been lost to human activities (Warner 1979). Regional losses in these ecosystems have been estimated to exceed 98% in the Sacramento Valley in California (Smith 1977) and 95% in Arizona (Warner 1979). Many factors have contributed to these resource losses, including the following: natural resource use; urbanization; alteration of stream flows through dam construction and ground-water withdrawal; modification of biotic conditions through grazing, agriculture, and introduction of non-native species; and alteration within watersheds (Patten 1998).

Coyote willow roots freely from cuttings, and is an easy species to propagate. Coyote willow is a shrub 3 to 15 feet in height with multiple branches and deciduous leaves. Its architecture is resilient to disturbance such as high velocity floodwaters, sediment deposition, medium to high flooding (anoxic conditions), high winds, heavy precipitation, or pruning from beaver, deer or wildlife. Beaver browsed more than 5,000 willow cuttings to ground level in New Mexico, and all the willow resprouted (Los Lunas Plant Materials Center 1998). These cutting also survived over two months of continuous inundation.

The NRCS Plant Materials Center at Los Lunas in cooperation with the U.S. Fish and Wildlife Service developed a pole planting technique for establishing willow and cottonwood (USDA, NRCS). We reprint this procedure below.

- "Trial planting on well adapted sites indicate more that 80% survival of cottonwood and willow poles when dormant poles are cut and planted between November and February.
- It is essential to monitor the water tables at proposed planting sites for at least one year before planting. Poles planted where the water table fluctuates widely will have lower survival rates than those planted where water table is relatively stable. If groundwater monitoring shows the water level will drop more than 3 feet during the growing season (May-October), another site should be selected. Monitoring of observation wells for at least one calendar year before planting will allow better planting depth to ensure establishment.
- Salt cedar (*Tamarix chinensis*), Russian olive (*Eleagnus angustifolia*), and giant reed (*Arundo donax*) will need to be controlled before poles are planted. However, young cottonwoods and willows can grow successfully in quite small openings in stands of salt cedar. Study of natural stands suggest they will eventually shade out the salt cedar."

*Steps for Successful Pole Plantings*:

- Select sites as close to the area as possible to conserve genetic diversity. Try to match donor site and revegetation site in terms of soils, elevation, hydro-dynamics, permanent groundwater table, and soil salinity (which should be low).
- Select willow cuttings from a local, native stand in healthy condition. Prune no more than 2/3 of plants in an area. Willow cuttings for pole plantings should generally be at least 1/2 inch in diameter or larger. Select the longest, straightest poles available. Use only two to four-year old wood. The total length of the poles needed depends upon the water table depth (see #7 below).
- Measure water table fluctuations for at least 1 year, preferably longer, to determine the lowest water table depth. Take a reading at least once a month, preferably more often during the driest months of the year.
- Cut poles while dormant during January and February. Remove all side branches except the top two or three.
- Prepare cuttings by trimming off the top to remove the terminal bud, allowing a majority of the energy in the stem to be sent to the lateral buds for root and shot development.
- Soak poles in water for at least 5 to 7 days before planting.
- Dig holes to the depth of the lowest anticipated water table. Sites where the water table will be within one foot of the ground surface during the growing season are better suited for willows than cottonwoods.
- The cuttings should extend several inches into the permanent water table to ensure adequate moisture for sprouting. At least 1/2 to 2/3 of the cutting should be below ground to prevent the cutting from being ripped out during high water flows. Usually, at least 2 to 3 feet should be below ground. It should also be long enough to emerge above adjacent vegetation such that it will not be shaded out.
- Place cuttings in the hole the same day they are removed from the soak treatment. Set the butt as close to the lowest annual water table elevation as possible.
- Electric hammer drills (Dewalt model DW530) fitted with one-inch diameter, 3-foot bits were used to plant thousands of coyote willows in New Mexico. With one drill, two people installed 500 willow per day to a 3-foot depth. A power auger or a punch bar can also be used.
- Coyote willow pole cuttings were generally planted on 10 to 20 foot centers in New Mexico. Areas with a shallow water table (4-6 feet) were generally planted with a higher number of pole cuttings to enhance overall survival of the project; in this case, coyote willow was planted on 1-foot centers or even closer. Often understory species were planted under the canopy of pre-existing overstory (cottonwoods, tree willows) since they are often observed occupying this niche.
- It is critical to ensure the soil is packed around the cutting to prevent air pockets. "Mudding" (filling the hole with water and then adding soil to make a mud slurry) can remove air pockets.
- When necessary, install tree guards around the poles to protect from beavers, other rodents, or rabbits. Coyote willows tend to be fairly resistant to pruning from beavers, so tree guards may not be necessary.
- As buds begin to swell (usually in April or May), wipe them off the lower two-thirds of the pole. This will reduce evapotranspiration water loss and stimulate root growth.
- Exclude the planting area from livestock grazing for at least two to three growing seasons.

There are other techniques for stabilization of banks and erosion control, called bioengineering, which utilize coyote willows. These include brush layers, brush mattresses, brush or tree revetments, brush trenches, vertical bundles, and willow wattles. Often fiberschine, erosion control fabric and hay bales are utilized to stabilize an eroding site. For further information on these techniques, refer to *The Practical Streambank Bioengineering Guide* by USDA, Natural Resources Conservation Service (Bentrup and Hoag 1998).

Establishment From Seed: Willow seeds must be collected as soon as the capsules mature (when they turn from green to yellow) and planted immediately since they retain their viability for only a few days at room temperature. Even under the most favorable conditions, maximum storage is four to six weeks. No dormancy occurs, so germination takes place 12 to 14 hours after planting if the seeds are kept constantly moist willows are difficult to propagate in quantity by seed.

Willows root so readily by either stem or root cuttings that there is little need to use other methods. Hardwood cuttings planted in early spring root promptly.

For natural seed revegetation, coyote willow requires moist soil from spring over-bank flows or capillary wetting of the soil surface for establishment. A number of studies have related components of the reproductive cycle of *Salix* species to floodplain site conditions produced by streamflow and associated fluvial processes. In particular, components of the annual pattern of streamflow, or annual hydrograph, are associated with specific stages of *Salix* seedling emergence and growth. These include the following: 1) flood flows that precede *Salix* seed dispersal produce suitable germination sites; 2) flow recessions following a peak expose germination sites and promote seedling root elongation; and 3) base flows supply soil moisture to meet summer and winter seedling water demand (Shafroth et al. 1998; Mahoney et al. 1998). The combination of root growth and capillary fringe defines the successful recruitment band for seedling establishment, which is usually from about 0.6 to 2 m in elevation above the late summer stream stage (Mahoney et al. 1998). The rate of stream stage decline is also critical for seedling survival and should not exceed 2.5 cm per day.

**Management**

*Traditional Resource Management*: Willow is nature’s healer. Poles of willow readily sprout, and help to stabilize stream banks and provide habitat. Sweat lodges constructed of willow have been known to sprout and grow, even though the willows were subjected to very high heat.

Willows were traditionally tended by pruning, to produce long straight stems. Willow is gathered only at certain times of the year, beginning in the autumn after the leaves fall. For many weavers, gathering will continue until the following spring when the sap begins to rise again. Some gatherers, once they find a good stand, will cut as much as they can. The willows in many areas have not been tended in a long time, and the stems are old, woody, and twisted. Often basket weavers will prune many willows, sometimes replanting the stems, so there will be nice straight basketry materials the following year.

The Chemehuevi gather shoots, which they have burned several times, until only the living stumps of the willow, remain (Collings 1979). Straight young shoots grow from these stumps in profusion. Each twig is carefully selected. Those finally selected are at least fifteen inches long and between 1/8 and 3/16 of an inch in diameter with as little taper from end to end as possible.

Before gathering, the weavers I have interviewed make offerings of thanks and pray for permission to gather (Stevens, unpublished field notes, 1998). Often tobacco or other offerings are given before beginning to gather.

Basket weavers process materials with their hands and mouths. Herbicides sprayed on willows and along streams have a much higher health risk for humans when they are used for traditional materials. A Washoe basket weaver says, “Sometimes when you take the willows' skins off, they have spots from pesticides.” Another weaver says the plants then grow deformed; the shoots don't grow straight and the willows are bumpy and wormy inside (Fulkerson 1995).

Howe and Knopf (1991) conclude that to ensure the survival of willows and cottonwoods in riparian communities, resource managers need to implement strategies to control the spread of exotic species.

Livestock grazing has widely been identified as a leading factor causing or contributing to degradation of riparian habitats in the western United States (U.S. General Accounting Office 1988; Chaney et al. 1990, Fleischner 1994, Ohmart 1996). Livestock grazing can alter vegetative structure and composition of riparian habitat. Overgrazing, especially by livestock and big game, frequently changes plant species composition and growth form, density of stands, vigor, seed production of plants, and insect production. Livestock grazing can cause the replacement of bird and mammal species requiring the vertical vegetation structure of riparian habitat to species, which are ubiquitous in their habitat preferences.

Slovlin (1984) recommended a 5-year rest from cattle grazing to re-establish healthy stands of riparian vegetation, such as cottonwood and willows. Siekert et al. (1985) reported that spring grazing showed no significant changes in channel morphology, whereas summer and fall grazing did. However, even with limited seasonal grazing, all tree seedlings would be eliminated. Marlow and Pogacnik (1985) recommended fencing riparian habitat, rest-rotation, light grazing (<20% forage removal), and grazing after streambanks have dried to 10% moisture.

**Cultivars, Improved and Selected Materials (and area of origin)**

Containerized coyote willow saplings are available from most nurseries in the areas where adapted. We recommend using plants from the same region, elevation, climate, soil type, moisture or hydrologic regime as you are replanting.

Coyote willow poles, suitable for transplanting, are available from the NRCS Plant Materials Center at Los Lunas, New Mexico and Tucson, Arizona. The Plant Materials Centers vegetatively propagate these poles from parent stock. Each center maintains parent stock of several ecotypes collected from the center's NRCS service area. These ecotype collections vary in the amount of genetic diversity within ecotypes. These centers can supply poles to NRCS Field and State Offices, and other public agencies.

Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

**References**

Auble, G.T. & M.L. Scott 1998. *Fluvial disturbance patches and cottonwood recruitment along the upper Missouri River, Montana*. Wetland 18(4): 546-556.

Baird, K. 1989. *High quality restoration of riparian ecosystems*. Restoration and Management Notes 7(2):60-64.

Beier, P. & R.H. Barret 1987. *Beaver habitat use and impact in the Truckee River basin, California USA*. J. Wildlife Management 51: 794-799.

Bentrup, G. & J.C. Hoag 1998. *The practical streambank bioengineering guide. User's guide for natural streambank stabilization techniques in the arid and semi-arid Great Basin and Intermountain West.* USDA, NRCS, Plant Materials Center, Aberdeen, Idaho.

Brode, J. & R.B. Bury 1984. *The importance of riparian systems to amphibians and reptiles.* Pages 30 - 35 IN: R.E. Warner and K. Hendrix, eds. California riparian systems; ecology, conservation, and productive management. University of California Press, Berkeley, California.

Brotherson, J.D., S.R. Rushford, W.E. Evenson, & C. Morden 1983. *Population dynamics and age relationships of eight trees in Navajo National Monument, Arizona*. J. Range Management 36: 250-256.

Brunsfeld, S.J. & F.D. Johnson 1985. *Field guide to the willows of east-central Idaho*. Forest, Wildlife and Range Experiment Station. University of Idaho Bull. #39.

Bull, E.L. & J.N. Slovlen 1982. *Relationships between avifauna and streamside vegetation.* Trans. North. Am. Wildl. Nat. Resour. Conf. 47: 496-506.

Cemments, C. 1991. *Beavers and riparian systems*. Rangelands 13:277-279.

Chaney, E., W. Elmore, & W.S. Platts 1990. *Livestock grazing on western riparian areas.* U.S. Environmental Protection Agency, Region 8, Denver, Colorado.

Collings, J.L. 1979. *Profile of a Chemehuevi basket weaver*. American Indian Art Magazine (Autumn). pp 3-11.

Conard, S.G., R.L. MacDonald & R.F. Holland 1977. *Riparian vegetation and flora of the Sacramento Valley*. Pages 47-56, IN: Anne Sand (ed.), Riparian Forests in California. Their Ecology and Conservation.

Crouch, G.L. 1979. *Long-term changes in cottonwoods on a grazed and ungrazed Plains bottomland in Northeastern Colorado*. USDA, Forest Service Research Note RM 370: 1-4.

Ditterberner, P.L. & M.R. Olson 1983. *The plant information network (PIN) data base Colorado, Montana, North Dakota, Utah, and Wyoming*. U.S. Fish and Wildlife Service FWS/OBS-83/36.

Dunmire, W.W. & G.D. Tierney 1997. *Wild plants and native peoples of the Four Corners.* Museum of New Mexico Press, Santa Fe, New Mexico. 312 pp.

Dunmire, W.W. & G.D. Tierney 1995. *Wild plants of the Pueblo province. Exploring ancient and enduring use*. Museum of New Mexico Press, Santa Fe, New Mexico. 290 pp.

Ellis, L.M. 1994. *Bird use of salt cedar and cottonwoods on a grazed and ungrazed plains bottomland in Northeastern Colorado*. USDA, Forest Service Research Note RM-370:1-4.

Farley, G.H., L.M. Ellis, J.N. Stuart, & N.J. Scott, Jr. 1994. *Avian species richness in different-aged stands of riparian forest along the middle Rio Grande, New Mexico*. Conservation Biology 8:1098-1108.

Fenner, P.W., W.W. Brady, & D.R. Patton 1984. *Observations on seed and seedlings of Fremont's cottonwood*. Desert Plants 6:55-58.

Fleishner, T.L. 1994. *Ecological costs of livestock grazing in western North America*. Conservation Biology 8:629-644.

Fowler, C.S. 1992. *In the shadow of Fox Peak. An ethnography of the cattail-eater Northern Paiute people of Stillwater Marsh*. Cultural Resource Series Number 5. U.S. Department of the Interior. Fish and Wildlife Service, Region 1. Stillwater National Wildlife Refuge. 264 pp.

Fulkerson, M.L. 1995. *Weavers of tradition and beauty. Basketmakers of the Great Basin.* University of Nevada Press. 138 pp.

Gaines, D. 1977. *The valley riparian forests of California: Their importance to bird populations.* Pages 57-86, IN: Anne Sand (ed.), Riparian Forests in California. Their Ecology and Conservation.

Glinski, R.L. 1977. *Regeneration and distribution of sycamore and cottonwood trees along Sonoita Creek, Santa Cruz County, Arizona*. USDA, Forest Service Gen. Tech. Rep. RM-43:116-123.

Grenfell, W.E., Jr. 1988. *Valley foothill riparian*. Pages 86-87, IN: Kenneth A. Mayer and William F. Laudenslayer, Jr. A guide to wildlife habitats of California. USDA - Pacific SW Forest and Range Experiment Station, California Dept. of Fish and Game, PG and E, and USDA Forest Service Region 5.

Grime, J.P. 1978. *Interpretation of small-scale patterns in the distribution of plant species in space and time.* Pages 101-104, IN: A.J.H. Freysen and J.W. Woldendorp (eds.) Structure and Functioning of Plant Populations. Elsevier. North-Holland, Amsterdam, New York.

Grime, J.P. and R. Hunt 1975. *Relative growth rate: its range and adaptive significance in a local flora*. J. Ecology 63: 393-422.

Hartmann, H.T., D.E. Kesler, & F.T. Davies, Jr. 1990. *Plant propagation principles and practices*. Prentice Hall, Englewood Cliffs, New Jersey. 647 pp.

Hickman, J.C. (ed.) 1993. *The Jepson manual. Higher plants of Cali*fornia. University of California Press. 1400 pp.

Hoag, J.C. 1992. *Use of willow and cottonwood cuttings for vegetation shorelines and riparian areas.* USDA, NRCS, Riparian/Wetland Project Information Series #3, Plant Materials Center, Aberdeen, Idaho.

Hoag, J.C. 1993a. *Selection and acquisition of woody plant species and materials for riparian corridors and shorelines*. Riparian/Wetland Project Information Series #2. USDA, NRCS, Plant Materials Center, Aberdeen, Idaho.

Hoag, J.C. 1993b. *How to plant willows and cottonwood for riparian rehabilitation*. Idaho Plant Materials Technical Note #23. USDA NRCS, Boise, Idaho.

Howe, W.H. & R.L. Knopf 1991. *On the imminent decline of Rio Grande cottonwoods in central New Mexico*. The Southwestern Naturalist 36:28-224.

Johnson, R.R. & C.W. Lowe 1985. *On the development of riparian ecology*. Pages 112-116 IN: R.R. Johnson, C.D. Ziebell, D.R. Patten, P.F. Ffolliot, and R.H. Hamre (tech. coord.) Riparian ecosystems and their management: Reconciling conflicting uses. General Technical Report RM-120. USDA, Forest Service, Fort Collins, Colorado.

Kindscher, K. 1992. *Medicinal wild plants of the prairie. An ethnobotanical guide*. University Press of Kansas. 340 pp.

Knopf, F.I. and F.B. Samson 1994. *Scale perspectives on avian diversity in western riparian ecosystems*. Conservation Biology 8(3):669-676.

Laymon, S.A. 1984. *Riparian bird community structure and dynamics: Dog Island, Red Bluff, California.* Pages 587-597 IN: R.E. Warner and K. Hendrix, eds. California riparian systems; ecology, conservation, and productive management. Univ. of California Press, Berkeley, California.

Mahoney, J.M. & S.B. Rood 1998. *Streamflow requirements for cottonwood seedling recruitment - an integrative model.* Wetlands 18(4): 634-645.

Marlow, C.B. & T.M. Pogacnik 1985. *Time of grazing and cattle-induced damage to streambanks.* Pages 279-284 IN: Johnson, R.R., C.D. Ziebell, D.R. Patton, P.F. Ffolliott, and R.H. Hamre (Tech. Coords). Riparian Ecosystems and Their Management: Reconciling Conflicting Uses. Proc. First North Am. Riparian Conf. USDA, For. Serv. Gen. Tech. Rep. RM-120. 523 pp.

Martin, A.C., H.S. Zim, & A.L. Nelson 1951. *American wildlife and plants: A guide to wildlife food habits*. Dover Publications, Inc., New York, New York. 500 pp.

McGinley, M.A. & T.G. Whitham 1985. *Central place foraging by beavers (Castor canadensis): A test of foraging predictions and the impact of selective feeding on the growth form of cottonwoods (Populus fremontii).* Oecologia 66: 558-562.

Michny, F.J., D. Boos & F. Wernette 1974. *Riparian habitats and avian densities along the Sacramento River, California*. State of California Dept. of Fish and Game. 23 pages.

Moore, M. 1979. *Medicinal plants of the Mountain West*. Museum of New Mexico Press. 200 pp.

Ohmart, R.D. 1996. *Historical and present impacts of livestock grazing on fish and wildlife resources in western riparian habitats*. Pages 245-279 IN: P.R. Karausman (ed.) Rangeland Wildlife. Society for Range Management, Denver, Colorado, USA.

Ohmart, R.D. & B.W. Anderson 1986. *Riparian habitat. In inventory and monitoring of wildlife habitat*. Bureau of Land Management. pp 169-199.

Patten, D.T. 1998. *Riparian ecosystems of semi-arid North America: diversity and human impacts.* Wetland 18(4): 498-512.

Platts, W. et al. 1987. *Methods for evaluating riparian habitat with applications to management.* USDA, Forest Service, Intermountain Research Station, General Technical Report INT-221.

Pope, D.P., J.H. Brock, & R.A. Backhaus 1990. *Vegetative propagation of key Southwestern woody riparian species.* Desert Plants 10: 91-95.

Reichenbacher, F.W. 1984. *Ecology and evolution of Southwestern riparian plant communities*. Desert Plants 6:15-22.

Roberts, W.G, J.G. Howe & J. Major 1977. *A survey of riparian forest flora and fauna in California*. Pages 3-20 IN: Anne Sand (ed.). Riparian Forests in California. Their Ecology and Conservation.

Robichaux, R. 1977. *Geologic history of the riparian forests of California*. Pages 21-34 IN: Anne Sand (ed.). Riparian Forests in California. Their Ecology and Conservation.

Rucks, M.G. 1984. *Composition and trend of riparian vegetation on five perennial streams in southeastern Arizona*. pp 97-107 IN: R.E. Warner and K.M. Hendrix (eds.). California Riparian Systems: Ecology, Conservation, and Productive Management. University of California Press, Berkeley, California.

St. John, T.V. 1987. *Mineral acquisition in native plants*. Pages 529-536 IN: Elias, Thomas S. (ed.) Conservation and Management of Rare and Endangered Plants. California Native Plant Society, Sacramento, California.

St. John, T.V. 1988. *Soil disturbance and the mineral nutrient of native plants*. Pages 34-39 IN: Rieger J.P. and B.K. Williams (eds.) Proceedings of the Second Native Plant Revegetation Symposium. San Diego, California.

Sampson, A.W. & B.S. Jespersen 1981. *California range brushlands and browse plants.* Division of Agricultural Sciences. University of California.

Schulz, T.T. & W.C. Leininger 1991. *Nongame wildlife communities in grazed and ungrazed montane riparian sites*. Great Basin Naturalist 51(3):286-292.

Schulz, T.T. & W.C. Leininger 1990. *Differences in riparian vegetation structure between grazed areas and exclosures*. Journal of Range Management 43(4):295-299.

Shafroth, P.B., G.T. Auble, J.C. Stromberg, & D.T. Patten 1998. *Establishment of woody riparian vegetation in relation to annual patterns of streamflow, Bill Williams River, Arizona.* Wetlands (18)4:577-590.

Shanefield, A.N. 1984. *Alder, cottonwood, and sycamore distribution and regeneration along the Nacimiento River, California*. pp 196-201 IN: R.E. Warner and K.M. Hendrix (eds.). California Riparian Systems: Ecology, Conservation, and Productive Management. University of California Press, Berkeley, California.

Siekert, R.E., Q.D. Skinner, M.A. Smith, J.L. Dodd, & J.D. Rodgers 1985. *Channel response of an ephemeral stream in Wyoming to selected grazing treatments*. Pages 276-278 IN: Johnson, R.R., C.D. Ziebell, D.R. Patton, P.F. Ffolliott, and R.H. Hamre (Tech. coords). Riparian Ecosystems and Their Management: Reconciling Conflicting Uses. Proc. First North Am. Riparian Conf. USDA, For. Serv. Gen. Tech. Rep. RM-120. 523 pp.

Slovlin, J.M. 1984. *Impact of grazing on wetlands and riparian habitat: a review of our knowledge.* Pages 1001-1104 IN: *Developing strategies for rangeland management*. Nat. Res. Counc. Natl. Acad. Sci. Westview Press, Boulder, Colorado.

Smith, F. 1977. *A short review of the status of riparian forests in California*. Pages 1-2 IN: Anne Sand (ed.). *Riparian Forests in California*. Their Ecology and Conservation.

Stevens, L.E., B.T. Brown, J.M. Simpson, & R.R. Johnson 1977. *The importance of riparian habitat to migrating birds*. Pages 156-164 IN: Johnson, R.R. and D.A. Jones (tech. coords.). *Importance, preservation and management of riparian habitat: a symposium*. USDA, Forest Service Gen. Tech. Report RM-43. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 217 pp.

Strike, S.S. 1994. *Ethnobotany of the California Indians*. *Volume 2. Aboriginal Uses of California's Indigenous Plants*. Koelz Scientific Books USA/Germany. 210 pp.

Stromberg, J.C. 1993. *Fremont cottonwood-goodding willow riparian forest: a review of their ecology, threats, and recovery potential*. J. Arizona-Nevada Acad. Sci. 27:97-110.

Stromberg, J.C. 1998. *Functional equivalency of saltcedar (Tamarix chinensis) and Fremont cottonwood (Populus fremontii) along a free-flowing river*. Wetlands 18(4):675-686.

Thompson, K. 1977. *Riparian forests of the Sacramento Valley, California*. Pages 35-38 IN: Anne Sand (ed.). Riparian Forests in California. Their Ecology and Conservation.

Tilford, G.L. 1997. *Edible and medicinal plants of the West*. Mountain Press Publishing Company, Missoula, Montana.

Trapp, G.R., G.L. Linck & E.D. Whisler 1984. *The status of ecological research on the mammal fauna of California's central valley riparian communities*. Pages 942-949 IN: R.E. Warner and K. Hendrix, eds. California riparian systems; ecology, conservation, and productive management. University of California Press, Berkeley, California.

USDA, Natural Resources Conservation Service 1992. *Soil bioengineering for upland slope protection and erosion protection*. USDA, NRCS, Engineering Field Handbook. Chapter 18.

USDA, Natural Resources Conservation Service 1998. *1998 annual interagency riparian report*. Plant Materials Center, Los Lunas, New Mexico.

USDA, NRCS 1999. *The PLANTS database*. National Plant Data Center, Baton Rouge, Louisiana. <http://plants.usda.gov> Version: 990405.

U. S. General Accounting Office 1988. *Public rangelands: some riparian areas restored but widespread improvement will be slow*. Washington, DC, USA. GAO/RCED-88-01.

Warner, R.E. and K.M. Hendrix 1979. *California riparian systems: Ecology, conservation, and productive management*. University of California Press, Berkeley, California.

Wheat, M.M. 1967. *Survival arts of the primitive Paiutes*. University of Nevada Press, Reno, Nevada. 117 pp.

Williams, D.F. & K.S. Kilburn 1984. *Sensitive, threatened, and endangered mammals of riparian* *and other wetland communities in California*. Pages 950-956 IN: Warner, R.E., and K.E. Hendrix (eds.), *California riparian systems: ecology, conservation, and productive management*. University of California Press, Berkeley, California. 1035 pp.

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w&sw N.A. California Native: CP, VG, OW, FW, ME, PF (Riparian) (*CA*); (IRR: H/H/H/H/H/H)

## *Salix lasiolepis*

### ARROYO WILLOW

Salicaceae. No Sunset zones. Jepson *WET,SUN:1-5,**6-9**,10-13,**14-24**;STBL; INV. Deciduous. Native throughout the California Coast Ranges, Central Valley, and Sierra Nevada foothills, including southern California, along rivers and streambanks, and from Washington and Idaho to western Nevada, New Mexico, and Texas into Mexico. Growth rate fast to 10-30' tall, shrubby, with many trunks, often forming thickets, or with a single, heavy, many-forked trunk, and an open, rounded crown. Leaves are alternate, simple, 2-5" long by 1/2-1" wide, shiny green, rather thick and leathery, oblanceolate, with glabrous uppersides, whitish pubescent and slightly hairy undersides, entire or with finely, barely serrate edges, without conspicuous glands at the upper end of leaf stalks, and yellow fall color. Flowers are dioecious male and female catkins, 1-2" long, with black to brown densely hairy scales, occurring in late spring, followed by light brown, 1/4" long, hairless seed capsules in early summer. Twigs are shiny, reddish or yellow, hairless. Bark is thin, pale, blotchy, grayish brown, darkening and becoming rough and deeply furrowed, with broad ridges.

A common and useful riparian habitat tree or large shrub, effective as soil binder along streams. Smaller than yellow willow (*Salix lasiandra*). Attractive trimmed up to expose smooth gray bark, which often has blotchy white colorations in areas that receive fog. Longevity estimated to be 40-50 years in habitat. Series associations: Mulefat shrub series; **Arrwillow**, Blawillow, Calsycamore, Fanpalm, Frecottonwoo, Mixwillow, Redalder, Watbirch; Monwetshrhab habitat.

9. f. 2.

# TREES OF THE CALIFORNIA LANDSCAPE

Charles R. Hatch

mountains of northern California, at elevations from 1,000 m (3,500 ft) to 3,500 m (11,500 ft). It grows along montane and subalpine creeks and meadows.

**REMARKS:** Jepson willow appears to be a Sierra Nevada relative of Sitka willow, but with smaller and narrower leaves. The two species' ranges meet in the Klamath Mountains.

## RED WILLOW *Salix laevigata*

**DESCRIPTION:** A tree that may grow to be 13.5 m (45 ft) tall. **LEAVES** have a broad elliptical shape, are 6 cm (2.5 in.) to 15 cm (6 in.) long, and have finely scalloped margins. The upper blade surfaces are pale green and glossy. The lower blade surfaces are white and waxy. Stipules are small with glandular teeth. **INFLORESCENCES** appear on leafy stalks as or after the leaves emerge. Fruiting catkins droop and are 4 cm (1.5 in.) to 10 cm (4 in.) long. **FRUITS** are capsules covered with fine gray hairs. **TWIGS** are red to yellowish brown and initially hairy, but they lose the hair with age. Bud-scale margins are free and overlapping. **BRANCHES** are dark brown and hairless.

**HABITAT AND RANGE:** Grows throughout California's wetlands, at elevations below 1,500 m (5,000 ft). Outside of California it ranges throughout the western states south into Central America.

**REMARKS:** Red willow is one of the California willows in which the bud-scale margins are not fused. The other is black willow, differentiated by its glossy leaves.

## ARROYO WILLOW *Salix lasiolepis*

**DESCRIPTION:** A shrub or small tree that often grows to be 12 m (40 ft) tall. The largest lives in Wallowa County, Oregon, and is 8.2 m (27 ft) tall and 34 cm (13.5 in.) in diameter. **LEAVES** are lance shaped and 5 cm (2 in.) to 12.5 cm (5 in.) long, with fine-toothed or smooth margins. The upper blade surfaces are dark green and shiny and covered with fine hairs that are lost with age. The lower blade surfaces have a waxy covering. Stipules are small or lacking. **INFLORESCENCES** appear on short leafy stems before the leaves emerge. Fruiting catkins are 3 cm (1.25 in.) to 7 cm (2.75 in.) long. **FRUITS** are hairless



Figure 188
Shining willow,
*Salix lucida*

capsules. **TWIGS** are yellow or brown and covered with fine hairs that are lost with age. Bud-scale margins are fused.

**HABITAT AND RANGE:** An abundant species in wetlands below 2,100 m (7,000 ft) in the western United States.

**REMARKS:** Over its broad range, Arroyo willow varies sufficiently that various forms have been given names; few of these names are now used. Arroyo willow widely hybridizes with Hooker willow along the north coast.

## SHINING WILLOW (Fig. 188) *Salix lucida*

**DESCRIPTION:** A multistemmed tree or shrub that typically grows to be 18 m (60 ft) tall. The largest lives in Traverse City, Michigan, and is 22.5 m (74 ft) tall and 104 cm (41 in.) in diameter. **LEAVES** are lance shaped, measure 2.5 cm (1 in.) to 10 cm (4 in.) long, and have fine-toothed, gland-tipped margins. The upper blade surfaces are shiny green. The lower blade surfaces are pale green. Glands can be found where the blade meets the petiole. The small, round stipules have glandular teeth. **INFLORESCENCES** appear on short leaf stems along with the



9. f. 3

appear on leafy stalks as the leaves emerge. Fruiting catkins are 6 mm (.25 in.) to 5 cm (2 in.) long. **TWIGS** are gray to yellowish brown, with hair that they lose as they age. Bud-scale margins are fused. **BRANCHES** are long and droop to the ground.
**HABITAT AND RANGE:** A commonly planted ornamental tree that has escaped cultivation. It occurs in disturbed locales throughout the state at elevations below 900 m (3,000 ft).
**REMARKS:** Weeping willow plants are part of a clone from China that has been propagated for 300 years. Many ornamental forms exist, especially hybrids with the European white willow (*S. alba*). Golden weeping willow (*S. a.* var. *vitellina*) is also commonly planted in California. These species and their many forms naturalize and hybridize with native willows, adding to identification problems.

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## SIERRA WILLOW — *Salix eastwoodiae*

**DESCRIPTION:** A shrub that may grow to be 2 m (6.5 ft) tall. **LEAVES** are elliptical and 2.5 cm (1 in.) to 10 cm (4 in.) long, with fine-toothed or gland-tipped margins. Both blade surfaces are covered with gray, tightly pressed hairs. Older blades become hairless. A pair of glands generally occurs where the blade meets the petiole. Stipules are small and round. **INFLORESCENCES** appear on leafy stalks along with the leaves. Fruiting catkins are 6 mm (.25 in.) to 25 mm (1 in.) long. **FRUITS** are capsules covered with fine gray hairs. **TWIGS** are dark brown and waxy and have fine hairs. Older twigs become hairless. Bud-scale margins are fused.
**HABITAT AND RANGE:** Grows in subalpine and alpine riparian zones and meadows in northern California's mountains, at elevations from 1,600 m (5,200 ft) to 3,000 m (10,000 ft). It ranges east into the northern Rocky Mountains.
**REMARKS:** In the Sierra Nevada, Sierra willow may grow with *S. orestera*, which also has gray leaves.

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## NARROWLEAF WILLOW (Fig. 186) — *Salix exigua*

**DESCRIPTION:** A multistemmed shrub that typically grows



Figure 186
Narrowleaf willow,
*Salix exigua*

to be 6 m (20 ft) tall. The largest lives in Criglersville, Virginia, and is 11 m (36 ft) tall and 56 cm (22 in.) in diameter. **LEAVES** are linear and 5 cm (2 in.) to 12.5 cm (5 in.) long, with entire to coarsely toothed margins. Both blade surfaces are gray to green and covered thinly or thickly with long, silky hairs. Stipules are lacking. **INFLORESCENCES** appear on long, leafy stems during or after leaf emergence. Fruiting catkins are 2 cm (.75 in.) to 5 cm (2 in.) long. **FRUITS** are hairy capsules. **TWIGS** are slender and may have fine white hairs. Bud-scale margins are fused.
**HABITAT AND RANGE:** A common wetland plant that occurs throughout North America. It grows best in moist, sandy soils. In California it is found from sea level to 2,400 m (8,000 ft).
**REMARKS:** Narrowleaf willow has a variety of forms over its broad range. Some books have considered some forms to be species, subspecies, or varieties. Think of this willow as the silvery willow of sandy habitats.

CALIFORNIA NATURAL HISTORY GUIDES

# TREES and SHRUBS OF CALIFORNIA

JOHN D. STUART *and* JOHN O. SAWYER

*Illustrated by Andrea J. Pickart*