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:
2012/00238

FEB 29 2012

William J. Leady, P.E.
Colonel, U.S. Army
Commander
U.S. Army Engineer District, Sacramento
1325 J Street
Sacramento, California 95814-2922

Dear Colonel Leady,

This document transmits NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Enclosure 1) for the U.S. Army Corps of Engineers' (Corps) operation and maintenance of Englebright and Daguerre Point dams and Englebright Reservoir on the Yuba River. The biological opinion reviews the effects of the action on federally listed threatened Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened California Central Valley steelhead (*O. mykiss*), the threatened Southern distinct population segment of North American green sturgeon (*Acipenser medirostris*), 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.*).

On December 20, 2011, the U.S. District Court, Eastern District of California, ordered NMFS to file a new biological opinion by February 29, 2012. Your request for reinitiation of formal consultation, which included the final biological assessment, was received on January 27, 2012.

The proposed action is the Corps' continued operation and maintenance of Englebright and Daguerre Point dams on the lower Yuba River, and recreational facilities on and around Englebright Reservoir. Operation includes the issuance and administration of new and existing permits, licenses and easements to: (1) non-Federal entities for their operations of water diversion and power generation facilities at the dams; (2) Federal, State, and local agencies, commercial interests and private individuals for maintaining public utilities and right-of-way purposes on some Corps' lands around Englebright Reservoir; and (3) non-Federal entities holding use and occupation easements for properties in the Yuba Goldfields. Maintenance includes service contracts for maintenance activities.

The attached document is NMFS' final biological opinion on the proposed action, in accordance with section 7 of the ESA. The request for formal consultation was received on January 27, 2012. The attached final biological opinion supersedes the March 23, 2007, NMFS biological opinion on operations of Englebright Dam/Englebright Lake and Daguerre Point Dam on the Yuba River, California.

The attached final biological opinion is based on: (1) the biological assessment provided by the Corps on January 17, 2012; (2) key information included in the 2007 *Lower Yuba River Fisheries Agreement* (Yuba Accord) and 2009 *Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon, and the Distinct Population Segment of Central Valley Steelhead* , published by NMFS (2009); (3) studies conducted for NMFS on the upper Yuba River watershed and fish passage at Englebright Dam; (4) information provided by scientific and commercial experts; and (5) scientific literature and reports. A complete administrative record of this consultation is on file at the NMFS, Central Valley Office.

Based on the best available scientific and commercial information, including our review of biological assessment, this biological opinion concludes that implementation of the proposed action is likely to jeopardize the above species or adversely modify designated critical habitat. NMFS has included a Reasonable and Prudent Alternative that avoids jeopardizing the species and 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 the Reasonable and Prudent Alternative to the proposed action.

NMFS considers the Yuba River Development Project, Yuba-Bear Project, and the Drum-Spaulding Project to be interrelated and interdependent with operation and maintenance of Englebright and Daguerre Point dams. This is because operational decisions made by Yuba County Water Agency (YCWA), Pacific Gas & Electric (PG&E), and Nevada Irrigation District affect flows and operational decisions at PG&E's Narrows I powerhouse and YCWA's Narrows II powerhouse, and in the lower Yuba River. This biological opinion only covers effects related to Corps operations and maintenance of Daguerre Point Dam, Englebright Dam and Englebright Reservoir. The full range of effects for each of the interrelated and interdependent hydropower projects will be addressed through separate consultations with the Federal Energy Regulatory Commission, in accordance with section 7(a)(2) of the ESA.

The Corps should reinitiate formal consultation on the long-term effects of operation and maintenance of Englebright and Daguerre Point dams and Englebright Reservoir on the Yuba River by January 31, 2020, on spring-run Chinook salmon, Central Valley steelhead, and green sturgeon and their designated critical habitat in accordance with section 7(a)(2) of the ESA. The reason for this is to integrate ESA consultation on FERC licensing and other collaborative fish passage planning efforts in the Yuba River watershed.

If you have any questions regarding this correspondence please contact Mr. Gary Sprague in our Central Valley Office, 650 Capitol Mall, Suite 5-100, Sacramento, California 95814. Mr. Sprague may be reached by telephone at (916) 930-3615 or by Fax at (916) 930-3629.

Sincerely,

Rodney R McInnis

Rodney R. McInnis
Regional Administrator

Enclosure (1)

cc: Copy to file: 151422SWR2006SA00071
Corps, Doug Grothe
YCWA, Curt Aikens

Enclosure 1

BIOLOGICAL OPINION

ACTION AGENCY:	**U.S. Army Corps of Engineers**
ACTION:	**Continued Operation and Maintenance of Englebright Dam and Reservoir, Daguerre Point Dam, and Recreational Facilities On and Around Englebright Reservoir**
CONSULTATION CONDUCTED BY:	**National Marine Fisheries Service, Southwest Region**
COVERED SPECIES:	**Threatened Central Valley spring-run Chinook salmon evolutionarily significant unit (ESU), threatened California Central Valley steelhead distinct population segment (DPS), and threatened Southern DPS of North American green sturgeon**
CRITICAL HABITAT:	**Central Valley spring-run Chinook salmon ESU, California Central Valley steelhead DPS, and Southern DPS of North American green sturgeon**
FILE NUMBER:	**151422SWR2006SA00071**
PCTS TRACKING	**2012/00238**
DATE ISSUED:	**_February 29, 2012____**

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ACRONYMS

AFRP – Anadromous Fish Restoration Program
BLM – U. S. Bureau of Land Management
CDFG and DFG – California Department of Fish and Game
cfs – cubic feet per second
CEQA – California Environmental Quality Act
Corps – U. S. Army Corps of Engineers
CHRT – Critical Habitat Review Team
CVP – Central Valley Project
CVPIA – Central Valley Project Improvement Act
dph – days post hatch
DIDSON – Dual Frequency Identification Sonar camera
DO – dissolved oxygen
DPS – Distinct Population Segment
DWR – California Department of Water Resources
ESA – Endangered Species Act of 1973, as amended
ESU – Evolutionarily Significant Unit
FERC – Federal Energy Regulatory Commission
FRFH – Feather River Fish Hatchery
GAIP – Gravel/Cobble Augmentation Implementation Plan
GCID – Glenn-Colusa Irrigation District
JSA – Jones and Stokes
LWM – Large Woody Material
LYRFTWG – Lower Yuba River Fisheries Technical Working Group
NEPA – National Environmental Policy Act
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
OCAP – Operations Criteria and Plan (joint operations of CVP and SWP)
O&M – Operations and Maintenance
PCE – Primary Constituent Element
PG&E – Pacific Gas and Electric Company
PSMFC – Pacific States Marine Fisheries Commission
RBDD – Red Bluff Diversion Dam
RIPPLE – a software model for analyzing salmonid populations
RMT – River Management Team
RPA – Reasonable and Prudent Alternative
SHIRAZ – Salmon Habitat Integrated Resource Analysis
SWP – State Water Project
SYRCL – South Yuba River Citizens League
USFWS – U. S. Fish and Wildlife Service
UYRSPST – Upper Yuba River Studies Program Study Team
VAKI – Company name of the producer of the Riverwatcher fish counter
YCWA – Yuba County Water Agency
VSP – Viable Salmonid Population

I. ENVIRONMENTAL SETTING AND CONSULTATION HISTORY

A. Environmental Setting

The proposed action is located on the Yuba River in Yuba and Nevada counties, California. The Yuba River watershed is historical habitat for the threatened Central Valley spring-run Chinook salmon (spring-run Chinook salmon) (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU), threatened California Central Valley steelhead (Central Valley steelhead) (*O. mykiss*) distinct population segment (DPS), and the threatened Southern DPS of North American green sturgeon (green sturgeon or green sturgeon Southern DPS) (*Acipenser medirostris*). Within the Yuba River watershed, Englebright Dam defines the present upstream extent of spring-run Chinook salmon and Central Valley steelhead. Daguerre Point Dam defines the present upstream extent of green sturgeon. The sympatric Central Valley fall/late fall-run Chinook salmon is an unlisted salmon ESU that occupies the lower Yuba River and is significantly more abundant that the threatened species.

The Yuba River watershed has a history of hydraulic mining, which resulted in geographic changes that continue to affect the Yuba River today. The upper watershed has multiple dams and facilities that store water for delivery and energy generation. Downstream of Englebright Dam is a narrow gorge (called the narrows), followed by an extensive area of placer mining debris called the Yuba Gold Fields.

1. Englebright Dam

Englebright Dam is at river mile 24.1 on the Yuba River. The dam was constructed in 1941 to retain hydraulic mining debris. It is 260 feet high and stores 70,000 acre-feet of water. The area downstream of Englebright Dam is referred to as the lower Yuba River, and the area upstream is referred to as the upper Yuba River. The U. S. Army Corps of Engineers (Corps) administers the operation and maintenance of Englebright Dam.

Englebright Dam has no fish ladders. Salmon, steelhead, and sturgeon have been blocked from accessing the upper Yuba River and watershed since 1941. Since 1963 flow releases from Englebright Reservoir have been generally governed by guidelines outlined within the Federal Energy Regulatory Commission (FERC) license, commonly referred to as “FERC minimum flows.”

The majority of releases from the Englebright Reservoir into the lower Yuba River are made through two hydroelectric power facilities, one of which (Narrows II) is located just downstream of the base of the dam and the other (Narrows I), is located approximately 0.2 mile downstream. Water releases from the reservoir are administered by the Yuba County Water Agency (YCWA) and Pacific Gas and Electric Company (PG&E) for hydroelectric power generation, irrigation and maintenance of the downstream riverine ecosystem.

2. Daguerre Point Dam

Daguerre Point Dam is 12.6 miles downstream of Englebright Dam. Daguerre Point Dam is 26 feet high and was built in 1906 to retain hydraulic mining debris. The dam is not operated for flood control because of the uniform flow over the crest of the dam (ogee crest/ogee spillway), and the entire reservoir behind the dam has been filled with hydraulic mining debris and sediments. Although Daguerre Point Dam has two fish ladders, adult salmonid passage is impaired due to ladder design deficiencies and irregular maintenance. Green sturgeon are unable to ascend the fish ladders. There are three conjunctive-use irrigation diversions from the Daguerre Point Dam pool, and the three diversions have a combined capacity of 1,085 cubic-feet-per-second (cfs). Daguerre Point Dam completely blocks upstream migration of sturgeon.

3. Upper Yuba River Barriers

There are major, human-made fish passage barriers upstream of Englebright Dam. These barriers are discussed and analyzed in part in the environmental baseline section of this biological opinion, because operational decisions made at each dam affect operational decisions at Englebright Dam. We have included upper Yuba River habitat capacity in this biological opinion.

a. New Bullards Bar Dam

New Bullards Bar Dam is on the North Yuba River, 38.2 miles upstream of Englebright Dam. It is 635 feet high and operated for hydropower and water storage. The dam is a complete barrier to fish passage. New Bullards Bar Dam is discussed and included in the analysis of the environmental baseline in this biological opinion, because operational decisions made at each dam affect operational decisions at Englebright Dam. Its operations are not part of the proposed action.

b. Log Cabin Diversion Dam

Log Cabin Diversion Dam is on Oregon Creek, 4.1 miles upstream of the confluence of Oregon Creek and the Middle Yuba River. The dam is 55 feet high and is a partial barrier to fish passage, with impaired passage during low and very high flow conditions. Most of the *O. mykiss* in the vicinity of Log Cabin Diversion Dam are entrained at the Log Cabin pool (water held back by the Log Cabin Diversion Dam) and diverted to New Bullards Bar Reservoir through the Comptonville Tunnel.

c. Our House Diversion Dam

Our House Diversion Dam is on the Middle Yuba River, 12.1 miles upstream of the confluence of the Middle Yuba River and the mainstem Yuba River. The dam is 70 feet high and is an upstream barrier to fish passage. Most of the *O. mykiss* in the vicinity of Our House Diversion Dam are likely to be entrained at the Our House pool (water held back by the Our House Diversion Dam) and diverted through the Lohman Ridge Tunnel to the Log Cabin pool on Oregon Creek.

d. Spaulding Dam

Spaulding Dam, on the South Yuba River, is the major impoundment for storing and diverting water out of the Yuba River watershed. It is 41.1 miles upstream of the slackwater at

Englebright Reservoir. Spaulding Dam is 92 feet high and is an upstream barrier to fish passage. Spaulding Dam is part of the Drum-Spaulding Project which, in conjunction with the Yuba Bear Project, diverts an average of 410,000 acre-feet per year out of the Yuba River watershed. Low flows from Spaulding Dam in the South Yuba River create a thermal barrier to fish passage during the summer and fall.

e. Jackson Meadows and Milton Dams

Operating together, Jackson Meadows and Milton dams are on the Middle Yuba River. They are upstream of a natural barrier to fish passage; however, they impound water that is diverted to Spaulding Reservoir and out-of-basin to several other watershed. Flows from sidestreams downstream of Milton Dam are captured and diverted at Our House Diversion Dam to New Bullards Bar Reservoir.

B. History of Consultation

1. 2002 Consultation with the Corps on Operations of Englebright Dam and Daguerre Point Dam on the Yuba River, California

On March 27, 2002, NOAA's National Marine Fisheries Service (NMFS) issued a biological opinion which analyzed the effects of the Corps' operations of Englebright and Daguerre Point Dams on the Yuba River in Yuba and Nevada Counties, California, on threatened Central Valley spring-run Chinook salmon and threatened Central Valley steelhead. The biological opinion covered a five-year period, and the conclusion found that the proposed action was not likely to jeopardize the continued existence of the spring-run Chinook salmon ESU or Central Valley steelhead DPS, and was not likely to destroy or adversely modify designated critical habitat for these species over that time period. The 2002 biological opinion expired on March 27, 2007.

2. 2005 Consultation with FERC on the Yuba River Development Project License Amendment (FERC No. 2246)

NMFS issued a final biological and conference opinion to the FERC on November 4, 2005, on a license amendment to FERC License No. 2246, allowing for construction of a full-flow bypass structure on the Narrows II hydropower facility at Englebright Dam. The final biological and conference opinion for the proposed Yuba River Development Project license amendment analyzed the effects of the bypass on spring-run Chinook salmon and Central Valley steelhead, designated critical habitat for spring-run Chinook salmon and Central Valley steelhead, and the proposed threatened green sturgeon Southern DPS. The final biological and conference opinion concluded that construction of the bypass was not likely to jeopardize the continued existence of Central Valley spring-run Chinook salmon ESU, Central Valley steelhead DPS, or green sturgeon Southern DPS of and was not likely to destroy or adversely modify designated critical habitat for the spring-run Chinook salmon ESU or Central Valley steelhead DPS.

3. 2007 Consultation with the Corps on Operations of Englebright Dam/Englebright Lake and Daguerre Point Dam on the Yuba River, California

On March 23, 2007, the Corps delivered to NMFS' Sacramento Area Office, an initiation package including a cover letter requesting the initiation of formal consultation under section 7 of the Endangered Species Act (ESA) for the proposed action along with a biological assessment and Essential Fish Habitat assessment for the proposed action. Included in the Corps' March 23, 2007, cover letter was a request for the extension of the timeframe covered by the 2002 biological opinion in order to maintain coverage for the proposed action until a new consultation could be completed and a new long-term biological opinion issued.

On April 27, 2007, NMFS issued a preliminary biological opinion, which analyzed the effects of continuation of operation of the proposed action for a period of one year. On November 21, 2007, NMFS adopted the preliminary biological opinion as the final biological opinion for the proposed action, which analyzed the effects of long-term continuation of operation of the proposed action into the foreseeable future (NMFS 2007). Both of these biological opinions concluded that the proposed action would not jeopardize spring-run Chinook salmon, Central Valley steelhead, or green sturgeon, or destroy or adversely modify designated spring-run Chinook salmon and Central Valley steelhead critical habitat.

4. Litigation

In December 2006, the South Yuba River Citizens League (SYRCL) and Friends of the River, filed suit in U.S. District Court against both the Corps and NMFS under the Administrative Procedures Act. The suit was amended on March 12, 2007, after a required 60-day notice period, to include complaints under the ESA. The plaintiffs alleged that NMFS unlawfully issued an inadequate biological opinion and failed to reinitiate consultation with the Corps. The suit further alleged that the Corps has failed to comply with the requirements of the biological opinion, including improving the effectiveness and reliability of the existing fish ladders at Daguerre Point Dam, developing a plan to remove sediment from the ladders and egress at Daguerre Point Dam, and augmenting spawning gravels in reaches downstream of Englebright Dam.

5. U. S. District Court, Eastern District of California, 2010 Ruling and 2011/2012 NMFS Consultation with the Corps on Continued Operation and Maintenance of Englebright Dam and Reservoir, Daguerre Point Dam, and Recreational Facilities On and Around Englebright Reservoir

On July 8, 2010, a Federal judge determined that the existing NMFS biological opinion on the operation of Englebright and Daguerre Point dams was inadequate. NMFS was directed to provide a more explicit analysis of effects to the species and to include analysis of the effects of hatcheries, the San Francisco Bay Delta, overall salmonid viability, poaching, and global warming on the species. NMFS was also asked to explain how the species will be able to tolerate cumulative effects such as the Wheatland project (a new water-delivery project).

On October 17, 2011, the Corps provided NMFS with a draft biological assessment on the proposed action. On December 2, 2011, NMFS notified the Corps that the draft biological assessment was insufficient. On January 27, 2012, the Corps initiated formal consultation on the proposed action and submitted the final biological assessment and references to NMFS.

C. Key Consultation Considerations

1. 2007 Lower Yuba River Fisheries Agreement

The 2007 *Lower Yuba River Fisheries Agreement* (Yuba Accord) established flows in the lower Yuba River until the 2016 expiration of YCWA's hydropower license on the Narrows II Powerhouse. Instream flow schedules for the lower Yuba River were developed through negotiations between YCWA, California Department of Fish and Game (CDFG), South Yuba River Citizens League, Friends of the River, Trout Unlimited, and the Bay Institute. The U. S. Fish and Wildlife Service (USFWS) and NMFS provide expertise through the River Management Team's planning and operations groups (Section 5.2 of Yuba Accord).

NMFS was actively engaged in development of the flow schedules, River Management Team provisions and biological studies program that are all key elements of the Yuba Accord. NMFS believes that implementation of the provisions of the Accord's Fisheries Agreement provides a level of protection for salmonids and green sturgeon in the lower Yuba River that is equal to or greater than what had previously been provided under the California State Water Quality Control Board's July 2003 Revised Water Right Decision-1644. Key elements of the Accord such as implementation of flow schedules and funding of biological studies in the Lower Yuba River are important steps in the recovery of listed anadromous fish which occur the lower Yuba River. These improvements most certainly have increased protections for federally listed anadromous fish, but the NMFS Draft Recovery Plan recognizes that they may not be substantial enough to restore the viability of Yuba River anadromous fish populations.

2. 2009 NMFS Draft Recovery Plan

In 2009 NMFS published the *Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon, and the Distinct Population Segment of Central Valley Steelhead* (Draft Recovery Plan). The Draft Recovery Plan included an extensive analysis of the status of these species and addressed aspects of habitat condition in the Yuba River watershed.

Historically, there were 18 or 19 viable independent populations of spring-run Chinook salmon in the Central Valley, with 11 of those populations occurring in the Northern Sierra Nevada Diversity Group, including the Yuba River population that historically spawned at elevations higher than 500m (Lindley et al. 2004). Currently, there is only 1 viable independent spring-run Chinook salmon population (Butte Creek) in the Central Valley (NMFS 2011). It is clear that more viable independent populations of spring-run Chinook salmon are needed to recover that species. The Draft Recovery Plan for Central Valley Chinook Salmon and Steelhead (Draft Recovery Plan) has identified the Yuba River upstream of Englebright Dam as a primary area to reintroduce spring-run Chinook salmon (NMFS 2009). Re-establishing a viable independent population of spring-run Chinook salmon in the Yuba River will directly contribute to meeting the recovery criteria identified in the Draft Recovery Plan

3. FERC Hydropower Relicensing and Water Exports

Several major hydroelectric power and water delivery projects are in the Yuba River watershed and influence operation and flows at Englebright Dam and flows at Daguerre Point Dam. These are the (1) Yuba River Development Project (FERC License No. 2246); (2) Narrows I Project (FERC License No. 1403); (3) the Yuba-Bear Project (FERC License No. 2266); (4) Drum-Spaulding Project (FERC License No. 2310); Hallwood-Cordua diversion at Daguerre Point Dam (Corps License No. DACW03-01-592); and (5) South Yuba/Brophy diversion at Daguerre Point Dam (Corps expired License No. DACW05-3-85-537).

4. North Yuba Reintroduction Initiative

The North Yuba Reintroduction Initiative is an effort by YCWA to look at the reintroduction of spring-run Chinook salmon and Central Valley steelhead into the North Yuba River upstream of New Bullards Bar Dam. This collaborative process was begun by YCWA in 2011, but is not tied to the relicensing of the Yuba River Development Project which includes hydroelectric facilities at Englebright Dam and New Bullards Bar Dam.

Currently, the North Yuba Reintroduction Initiative is a discretionary exercise in early planning for conservation efforts in the Yuba River watershed. It is included as a consultation consideration, because it is a reasonable remedy for implementing recovery measures for spring-run Chinook salmon; however, there is no solid commitment or guaranteed funding for implementing this reintroduction effort, and it is purely voluntary.

5. 2009 Yuba Salmon Forum

The Yuba Salmon Forum is a multi-party forum comprised of State and Federal agencies, municipalities, and environmental groups collaborating to develop measures to conserve salmonids in the Yuba River watershed. Many of the technical activities of the Yuba Salmon Forum involve conceptual agreements on process and direction. There are no identified or guaranteed funding sources for conservation actions associated with the Yuba Salmon Forum, but it collectively introduced the parties to the conservation need of fish passage at Englebright Dam.

6. 2007 Upper Yuba River Watershed Chinook Salmon and Steelhead Habitat Assessment

The Upper Yuba River Studies Program Study Team (UYRSPST 2007) conducted an in-depth analysis of the ability of existing and enhanced (50 cfs) flows to support steelhead and Chinook salmon in the Middle and South Yuba rivers. This document provided locations of habitat with suitable features. Numeric estimates of habitat suitability from the UYRSPST were utilized in this biological opinion. The results of the modeling are discussed in the environmental baseline section of this biological opinion.

7. Englebright Dam Fish Passage Studies and Designs

NMFS funded a study to research the feasibility of various fish passage alternatives for reintroduction of anadromous fishes above Englebright Dam. The *Yuba River Fish Passage: Conceptual Engineering Project Options* (MWH Americas 2010) addressed both volitional and assisted passage options.

8. Daguerre Point Dam Fish Passage Improvement Studies

There are two recent studies on measures to improve fish passage conditions at Daguerre Point Dam: the 2003 (Wood Rodgers, Inc.) *Draft Daguerre Point Dam Fish Passage Improvement Project: Alternative Concepts Evaluation* and the Corps' 2011 *Preliminary Fish Passage Improvement Study: Daguerre Point Dam, Yuba River, California*.

9. 2011 Stillwater Sciences Draft Habitat Capacity Modeling in the Upper Yuba River Watershed

NMFS funded a study to model that habitat capacity of the upper Yuba Watershed, which resulted in a January 2012 technical report: *Modeling habitat capacity and population productivity for spring-run Chinook salmon and steelhead in the Upper Yuba River watershed* (Stillwater Sciences 2012). The model output from the draft technical report provides a metric of the population potential of historical habitat blocked by Englebright and New Bullards Bar dams.

10. 2010 Lower Yuba River Flow Studies

In 2010 the USFWS published flow-habitat relationships for spring and fall-run Chinook salmon and steelhead/rainbow trout (rainbow trout are a non-anadromous, resident *O. mykiss*) in the lower Yuba River (USFWS 2010a-c). The analyses included flows for spawning, redd success, and juvenile survivorship (USFWS 2010a-c). Flow-habitat relationships were derived for spring- and fall-run Chinook salmon and steelhead/rainbow trout spawning in the Yuba River between Englebright Dam and the Feather River. Habitat availability was evaluated using a two-dimensional hydraulic and habitat model, while habitat suitability criteria were derived using logistic regression and a technique to adjust for availability of deeper waters with suitable velocities and substrates (Gard 1998). The U.S. Fish and Wildlife Service conducted the investigations on anadromous salmonid habitat in the Yuba River between Englebright Dam and the Feather River, as part of the Central Valley Project Improvement Act (CVPIA) Instream Flow Investigations—a 6-year effort which began in October, 2001. Title 34, Section 3406(b)(1)(B) of the CVPIA, P.L. 102-575, requires the Secretary of the Interior to determine instream flow needs for anadromous fish for all Central Valley Project controlled streams and rivers, based on recommendations of the U.S. Fish and Wildlife Service after consultation with the California Department of Fish and Game. The purpose of these investigations was to provide scientific information to the U.S. Fish and Wildlife Service's Central Valley Project Improvement Act Program to assist in developing flow recommendations for Central Valley rivers. The objective of the scientific inquiry was to produce models predicting habitat discharge relationships in the Yuba River for spring and fall-run Chinook salmon and steelhead/rainbow trout spawning, redd success, and juvenile survival.

11. Interrelated and Interdependent Actions

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02 *Effects of the action*). Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

The integrated operations of the Narrows I and Narrows II powerhouses interrelates the hydropower licenses in the Yuba River watershed with facilities at Englebright Dam—where operational decisions are made to determine which powerhouse will receive water from Englebright Reservoir. These powerhouses have agreements, licenses, and easements from the Corps.

NMFS considers the Yuba River Development Project to be interrelated and interdependent with operation and maintenance of Englebright and Daguerre Point dams, because: (1) Englebright and Daguerre Point dams are basic structural features used by the Yuba River Development Project and the Narrows II powerhouse; (2) the Yuba River Development is uses the dams to provide the hydraulic head for hydropower and water delivery; (3) the operation and maintenance activities that keep these dams in place are essential activities intended to perpetuate the status quo of conjunctive use on these dams; (4) easements, agreements, and licenses are issued and entered into by the Corps for the Yuba River Development Project; and (5) operational decisions made by the Corps at both dams are dependent upon operational decisions made by the YCWA in its operation of the Yuba River Development Project.

NMFS considers the Yuba-Bear/Drum-Spaulding Project to be interrelated and interdependent with operation and maintenance of Englebright and Daguerre Point dams, because: (1) operational decisions made by PG&E and Nevada Irrigation District affect flows and operational decisions at the PG&E Narrows I powerhouse and YCWA’s Narrows II powerhouse; (2) the PG&E Narrows I powerhouse is dependent upon the baseline existence of the Englebright to provide the hydraulic head for hydropower; (3) the operation and maintenance activities that keep Englebright Dam in place are essential activities intended to perpetuate the status quo of conjunctive use at Englebright Dam; (4) Narrows I and Narrows II powerhouses have integrated operations administered by YCWA; (5) a licenses from the Corps is needed for PG&E to continue to utilize outlet facilities and storage space in its current manner; (6) mitigation for the PG&E license from FERC includes trout planting in Englebright Reservoir; and (7) operational decisions made by the Corps at both dams are dependent upon operational decisions made by the YCWA in its operation of the Narrows I powerhouse in conjunction with the Yuba River Development Project.

Permits, licenses, and easements considered for issuance as part of the proposed action include issuance of a long-term easement to YCWA for South Screen access, operations and maintenance of facilities associated with diversions at the South Yuba/Brophy diversion structure located near Daguerre Point Dam on the lower Yuba River.

The interrelated and interdependent actions of hydropower and water delivery projects, together with other permits, licenses, contracts, and easements that are required from the Corps (for continuing activities by non-Federal entities; Federal, State, and local agencies; commercial interests; and private individuals) are identified individually in the description of the proposed action, environmental baseline, and effects of the proposed action sections of this biological opinion.

12. Water Rights

The Corps has no water rights or authority to regulate water rights on the Yuba River. Water right issues on the Yuba River are not within the Corps' authority or discretion to regulate.

13. VAKI Riverwatcher Fish Counter

A VAKI Riverwatcher infrared and photogrammetric system is installed in the fish ladders at Daguerre Point Dam. The license for the VAKI River Watcher expires July 31, 2012.

D. Action Area

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

The action area for this proposed action includes the active stream channels and riparian corridors of the Yuba River starting at and including New Bullards Bar Dam and reservoir, Log Cabin Diversion Dam, Our House Diversion Dam and pool, Spaulding Dam, Lake Spaulding, Milton Reservoir, and Lake Bowman (historic habitat that was accessible to spring-run Chinook salmon and Central Valley steelhead prior to the construction of Englebright Dam); extending past and through Englebright Dam and reservoir, and Daguerre Point Dam and pool; downstream to the lower Feather River and the Sutter Bypass to the confluence with the Sacramento River.

The action are includes areas of historic habitat upstream from Englebright Reservoir because the continued operations and maintenance of Englebright Dam perpetuates the ongoing presence of the dam itself, which, as currently operated, causes the continuation of blocked passage to these upstream reaches. Although the presence of the dam is not part of the proposed action, it does block upstream fish passage to historic habitat described above.

The action area also includes interrelated and interdependent actions at hydropower facilities and water diversion facilities that influence or are influenced by Englebright and Daguerre Point dams and operations, and the service areas supplied with water from diversions from the Daguerre Point Dam pool. For example, the water management at New Bullards Bar Reservoir is an interrelated action with the Corps' easement and the diversion of the water at the South Yuba/Brophy Diversion; thus linking the area upstream of Englebright Dam on the North Yuba River to the downstream reaches of the lower Yuba River to the point of the South Yuba/Brophy Diversion.

Another example includes how operations of the dams and reservoirs (New Bullards, Our House, Log Cabin, Milton and Jackson Meadows) on the North Yuba River and Middle Yuba River affect which Lower Yuba River Accord flow schedule is implemented in a given year.

The flow schedule that is implemented is based on the calculation of the North Yuba Index. The variables used in determining the North Yuba Index are: (1) New Bullards Bar Reservoir Active Storage and (2) Forecasted Total Annual Inflow to New Bullards Bar Reservoir. The second variable is calculated based on: (a) calculated inflows to New Bullards Bar Reservoir, including diversions; (b) an inflow coefficient; (c) forecasted flows at the Smartsville stream gage (downstream of Englebright Dam); (d) a coefficient for the Smartsville forecasted flows; and (e) flows from Deer Creek (downstream of Englebright Dam). The amount of active storage in New Bullards Bar Reservoir is affected by the operations of New Bullards Bar Reservoir and Dam, and by the operations of Our House Dam on the Middle Yuba River, Log Cabin Dam on Oregon Creek, and by Milton and Jackson Meadows dams and reservoirs on the Middle Yuba River. Flows in the Middle Yuba River are partially regulated by Milton Dam and Jackson Meadows Dam. The flows coming down the Middle Yuba River are then diverted at Our House Dam to Oregon Creek and from Oregon Creek at Log Cabin Dam to New Bullards Bar Reservoir. The effects of these operations can cause a change in the calculation of the Lower Yuba River Accord Instream Flow Requirements. The Lower Yuba River Accord flows at Marysville in July reduce from 700 cfs in Schedule 1, to 500 cfs in schedule 2. The flows at Smartsville in February reduce from 700 cfs in Schedule A, to 550 cfs in Schedule B. Additionally, the water development projects on the North Yuba River and South Yuba River, plus Bowman and Spaulding dams in the South Yuba River watershed, through storage and diversions affect the flows into Englebright Reservoir, and the flow in the Yuba River downstream of Englebright Dam. The water development projects on the Middle Yuba River and South Yuba River divert on average 410,000 acre-feet of water annually out of the Yuba River watershed. This diversion of water out of the watershed directly affects the amount of water available for instream flows downstream of Englebright Dam.

The operational decisions of large woody material (LWM) extraction and burning at New Bullards Bar and Spaulding reservoirs affect the amount of woody material available in the Yuba River watershed for salmonid habitat. If reintroduced to the watershed downstream of these dams, some of this material could make it past Englebright Reservoir and contribute to salmonid juvenile rearing habitat. LWM extraction as part of the interrelated and interdependent hydropower licenses extends the action area to the headwaters of these reservoirs.

The downstream extent of the action area is defined to the point where there are measurable effects to river flow and habitat availability associated with the proposed action. The reason for including the upper Yuba River in the action area is management and operational decisions made at upper Yuba River dams affect the temperature, flow timing and volume, and velocities in the lower Yuba River. The Corps' Englebright and Daguerre Point dams function as run of the river dams, although Englebright Reservoir provides some limited function to re-regulate river flows and has an influence on water temperatures, flow timing, and velocities in the lower Yuba River by providing the water storage and hydraulic head for the conjunctive uses of water delivery and power generation. The upstream extent of this action area was determined by the reservoirs and diversions that affect water flow and timing decisions at the two licensed and permitted powerhouses at Englebright Dam and the licensed water diversions at Daguerre Point Dam.

Downstream from the Feather River the flows are mixed with natural flows and those related to the operation of the Central Valley Project (CVP) and the State Water Project (SWP), so that the effects of these co-mingled flows and their effects on spring-run Chinook salmon, Central Valley steelhead and green sturgeon are not easily segregated. The broader effects of the co-mingled flows of the coordinated operations of the CVP and SWP on these species are analyzed in the NMFS biological opinion for the coordinated operations of the CVP (Operations Criteria and Plan/OCAP biological opinion). These include the effects of the co-mingled flows of the CVP and SWP in the lower Sacramento River, downstream from the confluence of the Feather River with the Sacramento River, through the Sacramento-San Joaquin River Delta, Suisun Bay, San Pablo Bay, and San Francisco Bay, and westward to the Pacific Ocean. Therefore, this biological opinion does not include Sacramento River reaches downstream from the Feather River as part of the action area, although they are considered in general terms in the Status of the Species and Critical Habitat sections of this biological opinion.

II. DESCRIPTION OF THE PROPOSED ACTION

The proposed action is the Corps' continued operation and maintenance (O&M) of Englebright and Daguerre Point dams on the lower Yuba River, and recreational facilities on and around Englebright Reservoir. Operation includes the issuance and administration of new and existing permits, licenses and easements to: (1) non-Federal entities for their operations of water diversion and power generation facilities at the dams; (2) Federal, State, and local agencies, commercial interests and private individuals for maintaining public utilities and right-of-way purposes on some Corps' lands around Englebright Reservoir; and (3) non-Federal entities holding use and occupation easements for properties in the Yuba Goldfields. Maintenance includes service contracts for maintenance activities.

A. Englebright Dam Operations and Maintenance Activities

Englebright Dam and Reservoir are located downstream of New Bullards Bar Dam on the Yuba River. Englebright Dam and development of power was authorized by the Rivers and Harbors Act of 1935, ch.831, 49Stat. 1028 (P. L. 409, 74th Congress, 1st Session, 49 Stat. p. 1028-1049). Englebright Dam was constructed by the California Debris Commission in 1941 to trap sediment originating in upstream areas. Englebright Dam completely blocks passage of anadromous fish and does not have any fish passage facilities. Englebright Dam is 260 feet high, and the storage capacity of Englebright Reservoir was 69,700 acre-feet at the time of construction, as estimated by the U.S. Geological Survey (USGS) using a pre-dam elevation model (Childs *et al*. 2003 as cited in YCWA 2010). Upon decommissioning of the California Debris Commission authorized by Section 1106 of the 1986 Water Resources Development Act (P. L. 99-662, 99th Congress, 2nd Session, November 7, 1986), administration of Englebright Dam was assumed by the Corps.

Englebright Dam was constructed as a sediment retention facility, and it does not contain a low-level outlet. Unregulated flood flows spill over Englebright Dam. Following construction of Englebright Dam in 1941 and extending until approximately 1970, controlled flow releases from Englebright Dam were made through the PG&E Narrows I Project facilities. Since about 1970 to the present, controlled flow releases from Englebright Reservoir into the lower Yuba River have been made from the PG&E Narrows I and the YCWA Narrows II power plants.

The Corps has responsibilities associated with ongoing maintenance of Englebright Dam infrastructure that pertain to dam maintenance, safety and security. The Corps has the authority and discretion to minimize effects to the environment through Corps-funded actions and through terms and conditions in contracts, easements, leases, licenses, and agreements. The Corps may be restricted to the use of the full range of management tools only upon expiration of existing contracts, easements, leases, licenses, and agreements. The Corps may be restricted to the use of the full range of management tools only upon expiration of existing contracts, easements, leases, licenses, and agreements. The water stored in Englebright Reservoir provides recreation and hydroelectric power, and YCWA and PG&E administer water releases for hydroelectric power, irrigation, and other beneficial uses (*e.g.*, instream flow requirements).

1. Ongoing Infrastructure Maintenance at Englebright Dam

Ongoing infrastructure maintenance at Englebright Dam includes dam maintenance, safety and dam security, as described below.

a. Dam Maintenance and Safety

The Corps' responsibilities and activities associated with dam maintenance and safety in general, applicable to Englebright Dam, are described in the document titled USACE - Engineering and Design Safety of Dams – Policy and Procedure ER 1110-2-1156 Regulation No. 1110-2-1156 (Corps 2003a). The Corps conducts two different types of regular inspections: (1) annual pre-flood inspections; and (2) periodic inspections every 5 years. These inspections are conducted to address the requirement that the Corps shall maintain in good order and repair Englebright Dam and outlet facilities in accordance with its authorized purposes. The purpose of the Corps' periodic inspections is to evaluate the condition of the critical components of Englebright Dam in order to assure the safety, continuing structural integrity, and operational adequacy of the structure (Corps 2004).

The Corps also conducts pre-flood inspections for Englebright Dam. At the onset of each inspection, Englebright Reservoir water surface elevation and the maximum pool elevation attained during the season are recorded, as well as mean total outflow, weather conditions and air temperature. Based upon Corps observations and information provided from past inspections (Corps 2004; Corps 2008a), examples of the Englebright Dam facilities and appurtenant features addressed as part of the pre-flood inspection process generally include the following:

- Overflow and non-overflow sections of the crest are checked for signs of distress, surface delamination, concrete deterioration and movement of the training wall,
- The downstream face of the dam is inspected for signs of cracking, seepage, and other structural problems that could affect the structural integrity of the dam,
- Upstream and downstream areas of the left and right abutments are checked for notable movement, instability, seepage and debris,
- Corps gatehouse interior and gate chamber, and the bulkhead gate, are inspected for signs of concrete deterioration, distress, and misalignment,
- The adit portal, including internal and external examination of the concrete bulkhead wall, the projecting conduit and the riveted dished head closure of the projecting conduit are inspected for possible structural or corrosion problems,
- The Reservoir rim is inspected from a Corps patrol boat,

- New and/or previously identified relief landslides are located, photographed, compared to aerial photos, and occasionally identified for further monitoring to determine whether a landslide has the potential to present a hazard to the dam from slope-failure induced seiches or to affect nearby roadways,
- The PG&E Narrows I Hydropower Project intake structure, trash rack, and surface of the penstock are regularly inspected on a five-year cycle by the Corps. The Corps also inspects the YCWA Narrows II hydropower penstock on a regular basis (*i.e.*, on a five-year inspection cycle), and
- The plunge pool and downstream overflow sections at Englebright Dam will be mapped, if funding is approved by congressional appropriation, and will be inspected during the periodic inspection if water elevations allow for inspection.

In addition to dam safety, the 2008 Englebright Project Safety Plan (Corps 2008b) provides a safety plan for the Englebright Reservoir recreation area to: (1) minimize employee, volunteer, contractor and visitor accidents by establishing procedures and responsibilities relative to safety; (2) assist employees, volunteers, contractors and visitors in the development of a safety attitude; and (3) identify precautionary measures to be taken to eliminate unsafe conditions. The Hazard Communication Program (Corps 2007b) ensures that all field offices within the Corps' Sacramento District comply with the OSHA Hazard Communication Standard as defined by Title 29 CFR Part 1910.1200. This program provides information for the use of Material Safety Data Sheets, chemical product labeling, handling and storage, training, documentation, and record keeping requirements.

b. Dam Security

The baseline security posture for Corps dams will be based on the completion of project specific Vulnerability and Risk Assessments which take into account project criticality, threat (criminal or terrorist), current physical security posture and law enforcement response capabilities. Once established, the baseline security posture will become the norm (Corps 1992). All dams will have a project specific Physical Security Plan. The format for this plan is expected to follow the format as detailed within Appendix F of USACE Engineering and Design Safety of Dams – Policy and Procedure ER 1110-2-1156 Regulation No. 1110-2-1156 (Corps 2003a).

Inspections are conducted when no prior physical security inspection exists, at regularly scheduled intervals, and when directed by a competent authority. Whenever possible, security is included in annual, periodic, and special inspections of projects. In addition, Corps dams will have dam security systems, which also are inspected during regular dam safety inspections. Dam security inspections are conducted to determine whether the features are safe from vandalism, sabotage, acts of terrorism, or any other acts that could cause the project to fail to function properly and safely for its intended purpose.

In addition to dam security, the 2008 Englebright Lake Security Plan (Corps 2008c) provides for the physical security of Englebright Reservoir during normal operations, and during periods of increased security. Physical security threats include terrorism, natural disasters, civil disturbances, theft, and vandalism.

c. Ongoing Maintenance of Recreational Facilities on and around Englebright Reservoir

Recreation-related O&M activities on and around Englebright Reservoir are identified and described in the 2007 Harry L. Englebright Lake Operational Management Plan (Corps 2007) The types of ongoing activities include:

Trout Stocking
Maintenance Facilities Upkeep
Park Office Facility Upkeep
Maintenance of Recreation Area Buildings
Equipment Maintenance
Vehicle Maintenance
Vessel Maintenance
Grounds Maintenance
Roads and Parking Area Maintenance
Narrows Day Use Facility Improvements
Roads and Parking Area Maintenance
Boat Ramps and Courtesy Docks Maintenance
Sign and Waterway Marker Maintenance
Campground Repairs and Renovations
Campground Fire Break Clearing
Herbicide and Pesticide Application
Wastewater Monitoring Plan

Along the 24 miles of Englebright Reservoir's shoreline, the Corps has developed facilities including: (1) 96 campsites; (2) 9 picnic sites; (3) 1 group picnic shelter with 4 tables; (4) 2 boat launching ramps (Narrows and Joe Miller Ravine) maintained by the Corps; (5) a private marina operated by a concessionaire; and (6) 5 parking lots containing a total of 163 parking spaces. The 800-acre Englebright Reservoir attracts large numbers of boaters and campers during the summer months and has an excellent year-round trout fishery (Corps 2007). Even though there are ten other reservoirs within a 50-mile radius, the boat-in only style of camping and the scenic steep canyons make it a popular destination. Unlike most area reservoirs that are affected by summer draw-downs, Englebright Reservoir water surface levels remain fairly constant throughout the year. This results in an influx of park users during the late summer months especially during drought years (Corps 2007).

The trout fishery in Englebright Reservoir is almost exclusively supported by planted catchable trout. PG&E stocks Englebright Reservoir with catchable size (7 to 10 inch) rainbow trout as a condition of its Narrows I FERC license.

The Narrows and Joe Miller Recreation Areas are the primary visitor access points to the lake. Both have launch ramps, restrooms and parking areas, but only Narrows Day Use Facility has a picnic area with individual tables and a reservable group shelter. Privately-owned Skipper's Cove Marina has a small number of slips operated by lease agreement with the Corps and is situated adjacent to Corps' recreational facilities.

B. Daguerre Point Dam Operation and Maintenance Activities

Daguerre Point Dam (Figure II-a) is located on the lower Yuba River approximately 11.5 River Miles (RM) upstream from the confluence of the lower Yuba and lower Feather rivers. The Rivers and Harbors Act of 1902 authorized the construction of the Yuba River Debris Control Project, of which Daguerre Point Dam is a part. Construction of Daguerre Point Dam was funded through a 50-50 cost share between the California Debris Commission and the State of California. Construction was completed, and Daguerre Point Dam became operational in 1910. Upon decommissioning of the California Debris Commission, administration of Daguerre Point Dam was assumed by the Corps.

The original purpose of the Daguerre Point Dam was to retain hydraulic mining debris. The Hallwood-Cordua diversion predated construction of Daguerre Point Dam and was licensed by the Secretary of War to continue their water diversion at Daguerre Point Dam. Later, the hydraulic head from the dam began to be used for other diversions of water for irrigation, primarily between April and October. The dam is not operated for flood control. The dam and appurtenances consist of an overflow concrete ogee spillway with concrete apron and concrete abutments, concrete fishways on both abutments, and a locally owned and operated irrigation diversion structure at the northern end of the dam (Corps 1966). Two fish ladders, and three licensed irrigation diversions, depend on either the hydraulic head created by the dam or the continuance of diversion capabilities due to the influence of the dam preventing additional channel incision upstream of the dam. The park personnel of the Corps administer the operation of the fish ladders and maintenance of the dam in coordination with CDFG.

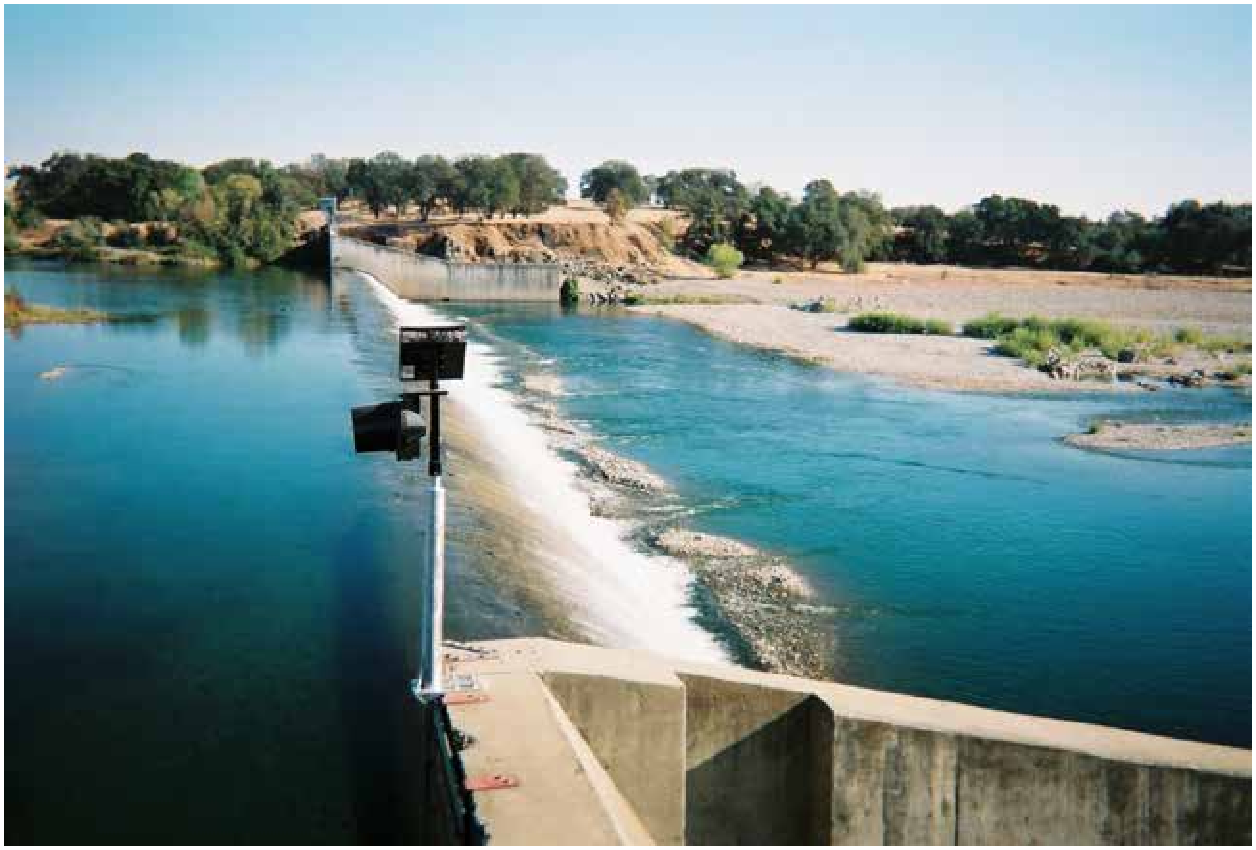

Figure II-a. Daguerre Point Dam (photo by D. Simodynes, October 9, 2009).

1. Daguerre Point Dam Inspection and Maintenance Activities

The Corps’ 1966 *Operations and Maintenance Manual, Yuba River Debris Control Project* (Daguerre Point Dam O&M Manual) describes the Corps' Sacramento District and CDFG’s O&M requirements for the Daguerre Point Dam. The general intent of the O&M procedures is to ensure that the structures and facilities are continuously maintained to provide maximum operational capability. The Daguerre Point Dam O&M Manual is used in conjunction with

Corps of Engineers Engineering Manuals EM 1130-2-203 (Project Operation Maintenance Guide) and EM 385-1-1 (General Safety Requirements).

The Daguerre Point Dam O&M Manual states that periodic inspections shall be made as required, to determine maintenance measures necessary to insure serviceability of the facility during flood conditions. Such inspections shall be made immediately prior to the beginning of the flood season, and immediately after each high water period. Immediate steps shall be taken to correct dangerous conditions disclosed by such inspections, and regular maintenance repair measures shall be accomplished during the appropriate season as determined by the Corps. The ongoing inspection and maintenance activities address the Daguerre Point Dam structure, the fishways, encroachment or trespass on Right-of-Way, and permits for Right-of-Entry or Use of Right-of-Way.

a. Daguerre Point Dam Structure

The Corps will inspect the following:

- Condition of the concrete (*e.g.*, erosion, pop-out, movement and vibration, cracks in or settlement of concrete in overflow and non-overflow sections),
- Excessive abrasion of concrete,
- Rock and derrick stone backfills,
- Foundation and backfill drainage—the outlets of all drains shall be inspected when river stages permit access to them, and shall be cleaned a minimum of every 5 years or more often if required—At other times the drainage manholes at either end of the overflow section shall be inspected and cleaned a minimum of every 3 years or more often if required,
- Record water level in drainage manholes, and check drainage pipe outlets, if accessible,
- Roadways and parking areas (*e.g.*, condition of pavement, shoulders and ditches, sloughing, slides), and
- Corrective action taken since the last inspection.

b. Daguerre Point Dam Fishways

Fishways (fish ladders) (Figures II-b and II-c) on the north and south abutments of Daguerre Point Dam will be inspected by the Corps for the following:

- Cracks or settlement of concrete structures,
- Misuse of structures, such as burning of debris in them,
- Debris of all kinds,
- Condition of the stop logs, stop gates and guides,
- Misuse of structures,
- Corrective action taken since the last inspection, and
- Record any burning of debris in structures, and amount of flood debris in each fishway bay.

If maintenance repairs are necessary, the Corps' Chief of Construction-Operations Division will request the Corps' Chief of Engineering Division to prepare plans, specifications, and cost estimates for the repairs. All maintenance cost estimates will be submitted to the State of California for approval. After approval, the Corps' Construction-Operations Division will accomplish the maintenance work, and the cost of the work will be shared equally by the Government and the State of California.

c. Encroachment or Trespass on Right-of-Way

The Corps does not allow encroachments or trespasses at Daguerre Point Dam that would adversely affect the efficient operation or maintenance of the project. The Corps has posted "No Trespassing" signage along the project right-of-way. Requests for permits for temporary right-of-way or use of portions of the Government owned rights-of-way shall be carefully reviewed to determine that such use will not adversely affect maintenance operations, or the safety and functioning of the project structures.

d. Permits for Right-of-Entry or Use of Right of Way

All requests for permits for temporary right-of-entry or use of portions of the Government owned rights-of-way shall be carefully reviewed to determine that such use will not adversely affect maintenance operations, or the safety and functioning of the project structures.

2. <u>Daguerre Point Dam Operations</u>

The Corps works with CDFG and NMFS to determine when O&M work at Daguerre Point Dam is able to be conducted during a time that is least stressful to fish. Corps and CDFG joint O&M activities include cleaning the lower bays and adjusting the flashboards to improve attraction flows. These coordinated activities generally do not occur prior to June or July because flow conditions prohibit access earlier in the year. The Corps and NMFS hold monthly meetings to coordinate about O&M activities and other issues pertaining to the lower Yuba River.

a. Fish Ladder Maintenance

The Corps has implemented a plan, in cooperation with CDFG, of inspecting and routinely clearing debris from the two fish ladders at Daguerre Point Dam. The ladders are generally inspected weekly. Any debris that could affect fish passage is generally removed as soon as possible. Since August 2010, the Corps has also conducted sub-surface inspections of the ladders, after NMFS advised the Corps of the possibility of sub-surface debris.

CDFG is responsible for inspecting and clearing the portion of the ladders containing the VAKI device and the Corps is responsible for all other parts of the ladder. A log boom adjacent to the north ladder is used to divert debris away from the ladder. Flashboards in the lower bays of the south fish ladder improve attraction flows to the south ladder. The Corps is presently working with CDFG to make additional adjustments to the flashboards as well as performing some additional clearing of debris from the lower bays of the ladders. The Corps will conduct additional debris clearing when lower Yuba River flows are low and the lower bays can be safely accessed.

The Corps issued License No. DACW03-01-592 to Cordua Irrigation District for installation of seasonal flashboards on the Daguerre Point Dam spillway, to direct some flow from the dam face to the fish ladders.

Although the Corps' authorized O&M activities and planning activities associated with the fish ladders may include making minor modifications as part of the proposed action, the Corps' operation and maintenance authorization does not include major ladder reconfigurations or reconstruction. Such activities would require additional Congressional authorization and appropriation of necessary funding (per ER 1165-2-119, Corps 1982).

Figure II-b. North fish ladders at Daguerre Point Dam (photo by D. Simodynes, October 9, 2009).

Figure II-c. South fish ladders at Daguerre Point Dam during high flow conditions (YCWA 2010).

b. Fish Ladder Gates

Past operational criteria required that the ladders be physically closed when water elevations reached 130 feet, or when flows were slightly less than 10,000 cfs (SWRCB 2003), and to keep them closed until the water recedes to an elevation of 127 feet (CALFED and YCWA 2005). However, current operation of the fish ladder gates differs from that which was described in the Daguerre Point Dam O&M Manual. The Corps is collaborating with resource agencies to improve fish passage by keeping the ladders open at water elevations higher than 130 feet, and reopening the ladders before the water elevation recedes to 127 feet. Additionally, the Corps is coordinating with CDFG and the Yuba Accord River Management Team (RMT) regarding gate operations and the operation/safety of the VAKI Riverwatcher system installed in the ladders at Daguerre Point Dam.

c. Fish Passage Monitoring

In 2003, the Corps granted CDFG a license (DACW05-3-03-550) to install and operate electronic fish counting devices, referred to as a VAKI Riverwatcher infrared and photogrammetric system, in the fish ladders at Daguerre Point Dam. The license term ends July 31, 2012. CDFG pays the cost, as determined by the Corps, of producing and/or supplying any utilities and other services furnished by the Government or through Government-owned facilities for the use of CDFG, including CDFG's proportionate share of the cost of operation and maintenance of the Government-owned facilities by which such utilities or services are produced or supplied.

The license specifies that CDFG keep the premises in good order and in a clean, safe condition by and at the expense of CDFG. CDFG is responsible for any damage that may be caused to property of the United States by CDFG activities and must exercise due diligence in the protection of all property located on the premises.

d. Operations and Maintenance of Fish Passage Facilities

Occasionally, a project may deserve modification because its original development was inherently deficient. Given certain conditions and qualifications, measures to correct such deficiencies may be undertaken. The Corps' authorized O&M activities and planning activities associated with the fish ladders may include making minor modifications. The protective measures described in each of the various plans below are consistent with the Corps' understanding of authorized, minor modifications associated with the fish ladders and associated passage facilities at Daguerre Point Dam. Additionally, the Corps has committed to incorporate these protective measures and plans into the next update of the 1966 Daguerre Point Dam O&M Manual.

e. Daguerre Point Dam Flashboard Management

The 2011 Flashboard Management Plan addresses the use, placement, monitoring and removal of flashboards at Daguerre Point Dam through coordination with CDFG and NMFS. It includes operations to achieve suitable flow conditions through the fish ladders at Daguerre Point Dam. This plan includes specific operations of the fish ladder gates (slide gates) at the ladder exits over all flow conditions, including high flows. This plan also specifies that the fish ladder gates will be closed only if necessary to protect against damage to the gates during extreme high flows, or when necessary for maintenance purposes, and that the Corps will routinely inspect the gates to ensure that no third parties close them. Routine inspections will occur at least weekly, and may be conducted under agreement with CDFG.

To improve management of the flashboards at Daguerre Point Dam on a long-term basis, the Flashboard Management Plan will be incorporated into the Corps license renewal process with Cordua Irrigation District. Installation of these flashboards was intended to direct some flow into the north fish ladder instead of over the top of Daguerre Point Dam. In accordance with the terms of the license, Cordua Irrigation District is responsible for the installation and removal of the flashboards and must coordinate its activities with the Corps, NMFS, CDFG and USFWS. Long-term flashboard operations developed by the Corps includes the following:

- <u>Conditions of Placement</u>. Flashboards will be used in periods of low flow to direct water toward the fish ladders to provide optimal flow conditions. Since there is no recorded flow information at this time to set a flow-based trigger, the flashboards will be set in place when the flows recede to a point that only part of the dam has water flowing over it. Flows will be recorded at the time of placement to determine the flow rate trigger for future placement.

- Period of Placement. Flashboards will be installed as described above, but only after April 15 and will be removed before November 1 of each year. Further, flashboards will be removed within 24 hours if directed by the NMFS or CDFG.
- Flashboard Adjustments. Flashboards will be closely monitored in accordance with monitoring and inspection activities (see below) to ensure they have been placed in a manner that leads to actual improvement in fish passage and will be adjusted accordingly based on such monitoring. All adjustments will be coordinated with NMFS and CDFG. Any recommended adjustments will be made within 24 hours of notification.
- Method of Placement. Flashboards will be installed using metal brackets that are attached to the dam with anchor bolts. The brackets will be fabricated of material that is light enough that it will break away if the flows increase too rapidly before they can be removed.
- Location of Placement. When flashboard placement is required, they will be placed in the center portion of the dam in such a way that the flows are directed toward both fish ladders. This will ensure adequate flows through the fish ladders to promote optimal flow conditions and attraction flows to the fish ladders. The number of boards placed and the exact location will be determined based upon flow conditions and channel position. Adjustments will be made as necessary to provide optimal attraction and passage. All adjustments will be coordinated with NMFS and CDFG.
- Flashboard Material. Flashboard material will be 2” x 10” Douglas fir or equal. Material will be free of any contaminants – no pressure treated material will be used.
- Monitoring and Inspection. Once the flashboards have been placed, fish passage will be closely monitored for the first week after placement to confirm that the flashboard installation improves fish passage. This monitoring will be conducted via the VAKI in coordination with the RMT. Additionally, during the period that flashboards are installed in accordance with this plan, the Corps will monitor and inspect the flashboards at least once per week to make sure that the flashboards have not collected debris that might contribute to juvenile fish mortality.
- Updates. The Corps will update and adjust this plan as required based upon new information generated through monitoring efforts. Furthermore, the Corps will review and update this plan as necessary upon issuance by NMFS of a biological opinion for the continued operation and maintenance of Englebright Dam and Daguerre Point Dam. As part of the Cordua Irrigation District license renewal and approval process, the Corps may refine the description of specific operations addressing the placement, timing and configuration of the flashboards at Daguerre Point Dam and incorporate the revised Flashboard Management Plan into the terms and conditions for the Corps license to be re-issued to Cordua Irrigation District, and Cordua Irrigation District will be responsible for implementing the flashboard operations. Except for administration of the license (*i.e.*, ensuring that the Cordua Irrigation District is complying with the terms and conditions of the license), the Corps assumes no responsibility or liability for the Cordua Irrigation District’s operations of the flashboards at Daguerre Point Dam.

In addition to the aforementioned description of the long-term flashboard operations developed by the Corps, additional refinements for the license may include the following:

- The flow conditions in the lower Yuba River flow that will prompt the placement and removal of the flashboards,
- The responsibility of Cordua Irrigation District for monitoring the flashboards at least once a week to make sure that they have not collected debris that might contribute to juvenile fish mortality,
- The responsibility of Cordua Irrigation District for monitoring the effects of the flashboards on juvenile salmonids and the potential for direct mortality due to entrainment or concentrating juveniles in a manner that promotes predation, and
- If the Corps does not renew the license to Cordua Irrigation District, then the Corps will assume responsibility for implementing the operations and maintenance activities addressing the placement, timing and configuration of the flashboards at Daguerre Point Dam that are described in the Flashboard Management Plan on a long-term basis.

f. Fish Ladder Debris Monitoring and Operations Plan

Through coordination with CDFG and NMFS, the Corps will develop a protocol for clearing accumulated debris and blockages in the fish ladders at Daguerre Point Dam. This plan will specify that CDFG is responsible for inspecting and clearing the portion of the ladders containing the VAKI device, and that the Corps is responsible for all other parts of the ladders. Inspections will include sub-surface inspections of the ladders. This plan also will specify that routine inspection and clearing of debris from the two fish ladders at Daguerre Point Dam may be conducted by CDFG pursuant to agreement with the Corps, or by other parties, such as the PSMFC, under CDFG direction. Routine inspections and debris clearing will occur weekly, although more frequent inspections and debris clearing activities may be conducted by CDFG, or other parties (*e.g.*, PSMFC) under CDFG direction.

g. Fish Ladder Protection Plan

To prevent poaching within the fish ladders and to prevent fish from jumping out of the ladders, the Corps will continue to coordinate with NMFS and CDFG to develop a Fish Ladder Protection Plan, which will be completed no later than six months after the date of this biological opinion.

h. Daguerre Point Dam Sediment Management

The Corps routinely removes the gravel and sediment that accumulates upstream of Daguerre Point Dam. The Corps' 2009 Daguerre Point Dam *Fish Passage Sediment Management Plan* describes the methods used to manage the sediment that accumulates upstream of Daguerre Point Dam and impedes upstream fish passage. The plan was developed by the Corps with cooperation and advice from NMFS, CDFG, and USFWS. The Corps has updated and revised the *Fish Passage Sediment Management Plan* to improve flows to the ladders at Daguerre Point Dam, to provide suitable adult salmonid migratory habitat conditions upstream of the Daguerre Point Dam Fish ladders, and to provide access to the ladders downstream of Daguerre Point Dam.

The goal of the sediment management plan is to maintain an adequate water depth across the upstream face of the dam to allow unimpeded fish passage from the ladders to the main channel of the lower Yuba River upstream from Daguerre Point Dam. An adequate water depth is defined as a "channel" at least 30 feet wide when measured from the face of the dam upstream, and 3 feet deep when measured from the crest of the dam to the riverbed.

Water depth measurements will be taken across the face of the dam to determine the depth of the channel during June of each year. If the flows are too high in June to take the measurements, they will be taken as soon as conditions are safe. If the water depth measurements show that the channel is still at least 30 feet wide by 3 feet deep, no sediment removal is required for that year. If the water depth measurements show that sediment has encroached and the channel has filled in to less than 30 feet wide by 3 feet deep, sediment removal will be conducted during the first 2 weeks in August (1-15). During sediment removal, the channel is widened to 45 feet and deepened to 5 feet.

The Corps also will inspect the channel as soon as practicable following a "high flow event". A "high flow event" is defined as a storm "*that generates Yuba River flow exceeding 20,000 cfs as measured at the Marysville gage or flow that is sufficient to move sediment loads into the bed of the river*." If the "high flow event" inspection reveals significant sediment buildup that risks impairing fish passage, the Corps will dredge the channel in a manner that minimizes adverse impact risks to fish. The Corps plans to reconsider the need for "high flow event" inspections.

A tracked excavator will be used to remove the sediment/gravel. The excavator will be cleaned of all oils and greases, and will be inspected and re-cleaned daily as necessary to insure no contaminants are released into the lower Yuba River. All hydraulic hoses and fittings also will be inspected to insure there are no leaks in the hydraulic system.

Material removed will be managed in one of two ways. If all required permits can be obtained (expected to occur during the summer of years when excavation is necessary), then it is anticipated that the excavated material will be placed on a downstream bank of the lower Yuba River in a location that will provide an opportunity for the gravel to be mobilized by the river during high flow conditions and transported downstream to augment downstream spawning gravels. If permits cannot be obtained or conditions do not allow for the downstream placement, then the material will be removed and stored above the ordinary high water mark until it can be moved downstream to a location where the gravel could be mobilized by the river during high flow conditions and transported downstream.

The plan will address the inspection and maintenance of the channels leading to the Daguerre Point Dam fish ladders. If the inspections conducted each May reveal that the channels are less than three feet deep, but still appear to be sufficiently functional for fish passage, then the Corps will submit a dredging plan for NMFS and CDFG approval that would be implemented between mid-July and mid-August. If the inspections reveal significant sediment buildup that would prohibit access to the fish ladder entrances, then by June 1 the Corps will provide to NMFS and CDFG a dredging plan for review and approval, to be implemented prior to mid-June. Disposition of sediments dredged from the channels leading to the Daguerre Point Dam fish ladders will conform with the direction provided by NMFS and CDFG.

i. Staff Gage

Hydrologic facilities consist of a staff gage on the right abutment of Daguerre Point Dam. As described in the Daguerre Point Dam O&M Manual (Corps 1966), the Corps' Engineering Division is responsible for maintaining, reading, and filing all records obtained from this gage.

C. Actions Associated with Corps' Issuance and Administration of Permits, Licenses, Easements, Agreements, and Contracts

The Corps will continue the issuance and administration of new and existing permits, licenses, easements, agreements, and contracts to: (1) non-Federal entities for their operations of water diversion facilities at the dams; (2) Federal, State, and local agencies, commercial interests and private individuals for maintaining public utilities and right-of-way purposes on some project lands around Englebright Reservoir; and (3) non-Federal entities holding use and occupation easements for properties in the Yuba Goldfields.

Permits, licenses, and easements considered for issuance as part of the biological assessment includes issuance of a long-term easement to YCWA for South Screen access, operations and maintenance of facilities associated with diversions at the South Yuba/Brophy diversion structure located near Daguerre Point Dam on the lower Yuba River. Other existing and ongoing permits, licenses and easements to be administered by the Corps as part of this action include: (1) PG&E Narrows I Hydroelectric Project; (2) YCWA's Narrows II Hydroelectric Generation Facility; (3) various other outgrant leases, licenses and easements described in the 2007 Harry L. Englebright Lake Outgrant Monitoring Plan, including maintenance service contracts at Englebright Dam and Reservoir; and (4) use and occupation easements issued to properties in the Yuba Goldfields.

1. <u>Hydroelectric Generation Facilities in the Vicinity of Englebright Dam</u>

Besides flood flow spills over the top of Englebright Dam, releases from Englebright Reservoir are made through two hydroelectric power facilities, one of which (YCWA's Narrows II) is located just downstream of the base of the dam, and the other of which (PG&E's Narrows I) is located approximately 0.2 mile downstream (Corps 2007; NMFS 2007) (Figure II-d). Water releases from Englebright Reservoir are administered by YCWA and PG&E for hydroelectric power generation, irrigation and maintenance of the downstream flows, including the minimum flows required in the Yuba Accord.

a. Narrows I

On February 11, 1993, PG&E received License No. 1403-004 from the Federal Energy Regulatory Commission (FERC), which grants PG&E the continued operation and maintenance of the Narrows I Hydroelectric Project located a short distance downstream of Englebright Dam. On March 28, 1994, the Corps issued License No. DACW05-9-95-604 to PG&E for Narrows I, granting permission for the powerhouse to be operated and maintained and for PG&E to utilize Corps outlet facilities and storage space between elevation 450 and 527 in Englebright Reservoir. The 1994 agreement (assigned License No. DACW05-9-95-604 by the Corps) between the

Corps and PG&E for operation and maintenance of the Narrows I Hydroelectric Project states that the Corps is responsible for maintaining Englebright Dam and the outlet facilities, including the first 700 feet of the outlet tunnel, in good order and repair, while PG&E is responsible for the operation and maintenance of the hydroelectric facility (Corps 2007).

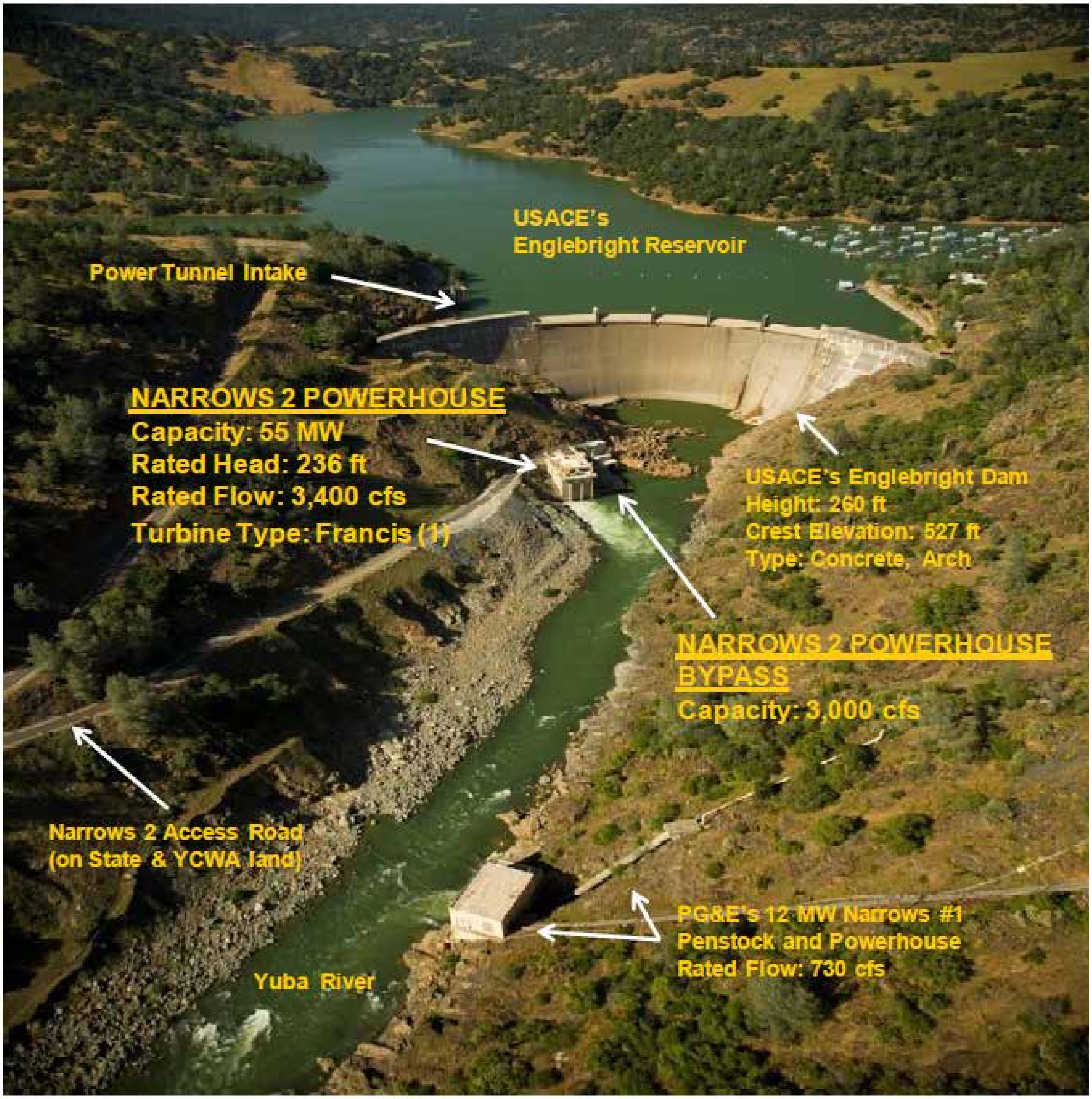

Figure II-d. Hydroelectric generation facilities in the vicinity of Englebright Dam (YCWA 2010).

The specific Corps operation and maintenance activities for the Narrows I Hydroelectric Project are specified in the 1994 agreement, the relevant portions of which are summarized as follows:

- PG&E shall grant the Corps access to, through, and across all Narrows I Hydroelectric Project lands and appurtenances whenever it is required for performance of their official duties, as well as during times when such access would be required to protect public health and safety. The Corps will provide PG&E with timely notification when access for normal O&M and inspection duties are required.
- During emergency situations (including but not limited to earthquakes, flood, downstream emergency, excessive leakage into the abutment, mechanical failure of gates or valves, or any other event) as determined by the Corps that presents a dam safety or public safety threat, the Corps will provide notice of the situation to PG&E prior to taking appropriate action, including closing the emergency gate.
- The Corps reserves the right to direct PG&E to cease operation of the Narrows I Hydroelectric Project if it is deemed to be detrimental to the water quality or water control objectives of Englebright Dam and Reservoir, public safety, or any other event as determined by the Corps that threatens structural integrity or control of Englebright Dam and Reservoir.
- The Corps has the right to inspect the Narrows I Hydroelectric Project's water conveyance system (*i.e.*, tunnel, penstock, gates, valves, etc.) during its pre-flood and periodic inspections of Englebright Dam. If required by the Corps, PG&E shall shut down the power plant and dewater the tunnel to facilitate inspection. The plant shall also be shut down upon notification by the Corps to permit inspection of its facilities when a significant seismic event has occurred, as defined in the Corps' publication SPK OM 1110-2-4, as amended.
- The Corps' and PG&E's operation and maintenance activities shall be conducted to provide reasonable protection of the lives and health of the employees and other persons, prevention of damage to property, material, suppliers and equipment and, where such jurisdiction is applicable, shall comply with the Standards issued by the Secretary of Labor at 29 CFR part 1926 and 1910, all pertinent provisions of the Corps' Safety and Health Requirements Manual, EM 385-1-1, dated October 1992, as amended.

The Corps also has issued Easement No. DACW05-2-95-587 to PG&E for electric transmission lines that run from the Corps' gatehouse (where the control for the bulkhead gate is located) to the Narrows 1 substation, and Easement No. DACW05-2-69-102 to PG&E for a right of way for power transmission lines that runs from the Narrows I substation to Narrows II. Related to ongoing operations and maintenance responsibilities for the power transmission line easements, Corps personnel perform compliance inspections on outgranted lands. The compliance inspections are performed on an annual basis, or more often if circumstances dictate. Corps personnel also perform interim inspections on outgrants in connection with day-to-day administration, and instances of unsatisfactory outgrantee performance are noted and reported immediately. Corrective actions will be immediately taken if emergency health or safety is involved (Corps 2007).

b. Narrows II

On February 14, 1966, the Corps entered into an agreement (Contract No. DA-04-167-CIVENG-66-95) with YCWA regarding the use of Englebright Dam and Reservoir for the generation of power at the Narrows II powerplant. The term of the 1966 agreement extends through the term of the license for FERC Project No. 2246 (April 30, 2016), and may be extended annually according to the conditions and provisions included in the agreement.

The 1966 agreement specifies that operations and maintenance of the intake works, tunnel, power plant, access roads and appurtenances are the responsibility of YCWA, and are not the responsibility of the Corps. The 1966 Agreement does not indicate that the Corps conducts inspections, with the exception of the Corps review of plans and specifications for construction, of the Narrows II facilities. However, the Corps conducts: (1) inspections of the Narrows II power intake tunnel for safety purposes; and (2) facility inspections to address environmental concerns. According to the May 2010 assessment report, the Corps inspection protocols related to environmental reviews conducted at the Narrows II facility include activities such as: (1) petroleum, oil and lubricant management; (2) hazardous waste management; and (3) hazardous materials management.

In 1975, the Corps issued Easement No. DACW05-2-75-716 to YCWA for a right-of-way for the construction of the Narrows II power plant, intake works and tunnel. The term of this easement is for a fifty (50) year period beginning August 14, 1967, and ending August 13, 2017. Also, in 1975, the Corps issued right-of-way easement No. DACW05-2-75-715 to YCWA for the construction, use and maintenance of access roads, including culverts and other drainage facilities. The term of this easement is for a fifty (50) year period beginning August 14, 1967, and ending August 13, 2017. The Corps has no ongoing operation and maintenance responsibilities associated with these two easements.

In 2005, the Corps issued a Right of Entry (No. DACW05-9-06-510) to YCWA for the construction of the Narrows II Full Flow Bypass. In 2006, YCWA constructed a full-flow bypass on Narrows II powerhouse which allows approximately 3,000 cfs (or 88 percent of the full 3,400 cfs capacity of the powerhouse) to be bypassed around the power generation facilities to maintain river flows during emergencies, maintenance, and accidental shut-downs of the powerhouse. The Corps has no ongoing operation and maintenance responsibilities associated with this easement.

2. Englebright Dam and Reservoir Recreation

a. Maintenance Service Contracts

According to the 2007 Harry L. Englebright Lake Operational Management Plan (Corps 2007), the types of maintenance service contracts currently in use at Englebright Reservoir include the following:

Garbage pickup
Portable restroom pumping
Janitorial service
Water quality testing
Herbicide application
Maintenance of facilities

The proposed action includes the continuance of the maintenance service contracts at Englebright Reservoir.

b. Outgrant Leases, Licenses, and Easements

According to the 2007 Harry L. Englebright Lake Operational Management Plan (Corps 2007), the Corps administers leases, licenses, and easements related to the Corps' outgrants for Project lands used to maintain public utilities and right-of-way purposes. The types of ongoing leases, licenses, permits and easements include:

- Concessionaire Lease at the Englebright Dam Marina,
- CDFG Daguerre Point Dam Fish Counting Device License,
- Road Right-of-Way Permits and Easements,
- Power Transmission Line Easements, and
- Telephone Line License.

The Corps conducts annual compliance inspections on outgranted lands, including lands outgranted for commercial concessions. As of December 2007, as many as 14 outgrants were issued to various entities (Corps 2007). The proposed action includes the continuance of the 14 outgrant leases, licenses and easements.

3. Irrigation Facilities

There are three water diversions associated with Daguerre Point Dam, which depend on the elevated head created by the dam, or the influence of the dam in the prevention of additional river channel incision, to gravity-feed their canals. The three diversions are the Hallwood-Cordua diversion, the South Yuba/Brophy diversion, and the Browns Valley Irrigation District (BVID) diversion. YCWA has contractual agreements to deliver water to these irrigation districts, and the three diversions have a combined capacity of 1,085 cfs. Two of the irrigation diversions are licensed by the Corps (Hallwood-Cordua and South Yuba/Brophy) and one diversion (BVID) does not require a license.

Operation and maintenance responsibilities associated with each of the diversion facilities are the responsibility of each of the respective individual non-Federal irrigation districts. The Corps does not assume responsibility for the continued operations and maintenance of these facilities.

a. Hallwood-Cordua Water Diversion Operations

The license issued by the Secretary of War to the Hallwood Irrigation Company and the Cordua Irrigation District (formerly the Stall Ditch Company) in 1911 allowed Hallwood and Cordua to continue their diversions of water from the Yuba River, which pre-dated the construction of Daguerre Point Dam. The Hallwood-Cordua diversion is located on the north side of Daguerre Point Dam with the intake facilities directly connected to the superstructure of the dam (Figure II-e). In 1997, the Corps assigned License No. DACW05-3-97-549 to the Hallwood Irrigation Company. The term "perpetual" has been used in previous BAs and biological opinions (Corps 2000; Corps 2007; NFMS 2007) in connection with the Hallwood-Cordua license. The term "perpetual" is not explicit in the license, but refers to the fact that no end date is specified in the license.

Although the Corps' administration of the Hallwood-Cordua license is part of the proposed action, there are no routine administrative actions undertaken by the Corps associated with this license. Additionally, no compliance terms are specified by the Corps in this license. The Corps has no ongoing operation and maintenance responsibilities associated with Hallwood-Cordua diversions or diversion facilities.

The Corps issued a license to Cordua Irrigation District on May 13, 2009 for installation of flashboards on the Daguerre Point Dam spillway. Installation of the flashboards was intended to address the issues of sheet flow over the top of Daguerre Point Dam and direction of some of these flows to the north fish ladder. The license expired on September 1, 2011, and the Corps anticipates renewing the license. In accordance with the terms of the license, Cordua Irrigation District is responsible for the installation and removal of the flashboards and must coordinate its activities with the Corps, NMFS, CDFG, and USFWS.

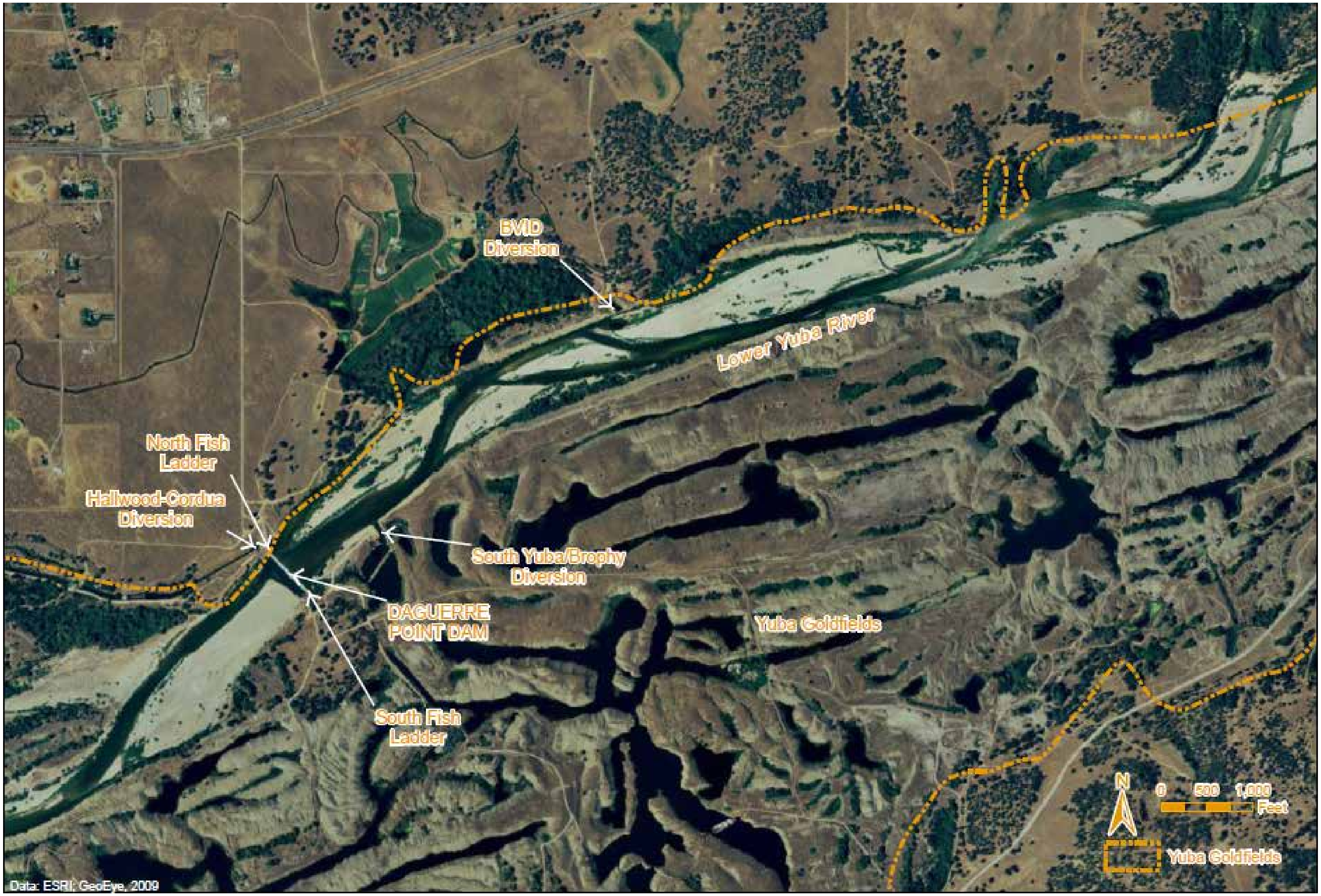

Figure II-e. Non-Federal water diversion facilities in the vicinity of Daguerre Point Dam on the lower Yuba River (HDR 2011).

b. South Yuba/Brophy Water Diversion Operations

Approximately 1,000 feet upstream of Daguerre Point Dam on the south side of the Yuba River, the South Yuba/Brophy Diversion Canal and Facilities divert water through an excavated channel. License No. DACW05-3-85-537 was issued to South Yuba Water District on March 15, 1985, for the South Yuba/Brophy diversion. This license is currently in a hold-over status, because it expired in March 2000. A Bureau of Land Management (BLM) Right-of-Way Grant (Serial No. CACA 44390) to YCWA was issued by the BLM on June 24, 2002. It grants YCWA the right to operate, maintain, and terminate an existing canal on public lands until December 31, 2031 (30-year term). YCWA's activities under the grant are limited to operations and maintenance of the existing facility.

The South Yuba/Brophy diversion facility includes a 450-foot long porous rock weir fitted with a fine-mesh barrier (geotextile cloth) within the weir intended to protect juvenile fish from becoming entrained into the canal (Corps 2007). Although the diversion structure addressed CDFG fish screening requirements at the time of construction in 1985, fish screening requirements have changed over time and the diversion structure does not meet current NMFS or CDFG screening criteria. Screening criteria issues associated with the diversion structure include potential non-compliance with: (1) screen space size (*i.e.*, 3/32 inch mesh size); (2) screen porosity; (3) uniformity of approach velocity; (4) sweeping flow; and (5) cleaning frequency. Additional issues associated with the diversion structure include predation in the channel that leads to the diversion and at the face of the rock weir, and overtopping of the weir and subsequent entrainment of juvenile salmonids behind the weir.

The proposed action does not include operation and maintenance of the irrigation diversion facilities located at or in the vicinity of Daguerre Point Dam. Operation and maintenance responsibilities associated with each of the diversion facilities are, and will remain, the responsibility of each of the respective individual non-Federal irrigation districts. The Corps is not responsible for continued operations and maintenance of these facilities.

As part of the proposed action, the Corps will issue a long-term easement to YCWA to authorize access, operation and maintenance of a new fish screen and diversion infrastructure at the South Yuba/Brophy diversion location. As discussed above, ESA compliance required to address potential effects of construction-related activities that will be necessary for South Yuba/Brophy Diversion Canal and Facilities to meet NMFS and CDFG approval will be conducted through a separate ESA consultation process. Both Federal and State ESA consultation regarding construction will be completed as part of the National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA) processes to select the final design for the proposed screen. A condition of the long-term easement will require that the fish screen and appurtenant facilities meet NMFS and CDFG approval of screening or other criteria equally protective of the listed species acceptable to NMFS and CDFG prior to June 2018. License number DACW05-3-85-537 was issued to South Yuba Water District on March 15, 1985, for the South Yuba/Brophy diversion located on the south side of the river. This license is currently in a hold-over status, as it expired in March 2000. The holdover status of this license will terminate when the long-term easement is issued to YCWA. The Corps is not responsible for the operations and maintenance of the fish screen or the diversion facility, nor will the Corps be responsible for these activities in the future.

c. Additional South Yuba/Brophy Water Diversion

YCWA's New South Yuba/Brophy Diversion Facilities at Daguerre Point Dam have been completed, except for a proposed new fish screen. The Corps will issue a long-term easement to YCWA to authorize access, operation, and maintenance of a new fish screen and diversion infrastructure at the South Yuba/Brophy diversion location. A separate ESA consultation will occur to address the additional take associated with construction of the fish screen. Take from additional water diversion is not covered in this biological opinion.

As a condition of the Corps' issuance of a long-term easement to YCWA (applicant), the Corps will require that YCWA construct, operate and maintain a fish screen and associated appurtenances for the South Yuba/Brophy diversion that is compliant with current NMFS and CDFG fish screening criteria or other criteria equally protective of the listed species acceptable to NMFS and CDFS prior to June 2018. The Corps will have no operation and maintenance responsibilities associated with South Yuba/Brophy diversion facilities and will require that responsibility for such activities be assumed by YCWA. The proposed action includes a commitment by YCWA to construct the new South Yuba/Brophy diversion facilities at Daguerre Point Dam as follows:

- Proposed Easement Condition: The following language shall be included in a new easement issued to YCWA for the operation and maintenance of the South Yuba/Brophy Diversion Canal and Facilities: "During the term of this easement, Licensee shall operate and maintain fish screening facilities for the South Yuba/Brophy Diversion Canal and Facilities. The fish screening facilities will meet the published fish screen requirements and criteria of NMFS and CDFG, or other criteria equally protective of the listed species as may be agreed to by Licensee, NMFS and CDFG. Licensee shall construct required fish screening facilities as soon as is practicable, in accordance with the following implementation schedule."

YCWA re-initiated the CEQA process, as well as a parallel NEPA process with the Corps in September 2011. It is anticipated that the final preferred alternative design will be determined during the NEPA/CEQA environmental review process. Construction will commence in 2018.

4. Use and Occupation Easements in the Yuba Goldfields

The Corps holds use and occupation easements along the lower Yuba River, including those lands where the "training walls" constructed by the California Debris Commission during the early 1900s are located. On the lower Yuba River, Daguerre Point Dam was constructed at the downstream end of the enormous gravel deposit, and about 16 miles of "training walls" were erected to channelize the river by piling gravel on both the north and south banks, as well as down the center of the river in some places to create two channels. These activities were two of the major features of the "1898 Project" (see Section 6.2.2.2), which was completed in 1935 (Hagwood 1981). By that time, three training walls existed, having a total length of 85,100 feet which provided two 500-foot channels. In 1944, the California Debris Commission issued a permit to the Yuba Consolidated Gold Fields to dredge a 600-foot channel and build training walls to take the place of the pair of 500-foot channels completed in 1935 (Hagwood 1981). The effect of the training walls was to keep the river from spreading in its floodplain and to turn this stretch of the lower Yuba River into a channel that conveys water downstream to serve agricultural and municipal users (California Coast and Ocean 2009). Downstream of Daguerre Point Dam, the Yuba River has resumed a meandering course through the fluvial tailings. Down-cutting of the streambed downstream of Daguerre Point Dam has exposed the bedrock of Daguerre Point (Hunerlach *et al*. 2004).

In 2008, the Corps wrote a letter (Corps 2008) to the vested rights applicants outlining the Corps position related to mining near the training walls, which is summarized below:

- While the real property interests in the Yuba Goldfields are complicated, with several public agencies and private landowners claiming ownership of various rights and interests, it is well established that the Corps has use and occupation easements on numerous parcels in the Yuba Goldfields.
- Corps' records and investigations with the BLM have confirmed the Corps' acquisition of use and occupation easements through the California Debris Commission on the western portion of the Yuba Goldfields.
- Should Western Aggregates, Ltd. possess such rights where the Corps holds use and occupation easements, it would be necessary for Western Aggregates, Ltd. to obtain the prior written consent of the Corps before commencing any mining activity.
- If at some later date the Corps chooses to exercise its rights to use and occupation of the easement lands, Western Aggregates, Ltd. may be required to cease and desist its operations within the easement lands at its own expense.
- Because other stakeholders in the Yuba Goldfields have expressed concerns about the "training walls" that were constructed under the auspices of the California Debris Commission in conjunction with mining in the area, the Corps asserts its use and occupation of those lands where the "training walls" are located. Mining of aggregates or precious metals is restricted in the Corps easements from a line 500 feet south of the toe of the southern edge of the "training walls" adjacent to the Yuba River in the Yuba Goldfields, and in the bed of the Yuba River as it is currently restrained by those existing "training walls" and Daguerre Point Dam.

The proposed action includes continuance of the Corps' use and occupation easements associated with the training walls adjacent to the Yuba River in the Yuba Goldfields. The Corps has not issued any permits, licenses or easements to other parties, and does not conduct inspection or maintenance activities associated with the training walls.

5. Waterway 13

The Yuba Goldfields, consisting of more than 8,000 acres, are located along the Yuba River near Daguerre Point Dam. As a result of the high permeability of the Goldfields' rocky soil, water from the Yuba River freely migrates into and through the Goldfields, forming interconnected ponds and canals throughout the undulating terrain. Generally, water from the Yuba River enters the Goldfield area from upstream of Daguerre Point Dam, then migrates down-gradient through the Goldfields. A portion of this migrating water eventually returns to the Yuba River approximately 1 mile downstream of Daguerre Point Dam via an outlet canal, referred to as Waterway 13. According to the California Department of Water Resources (DWR) this outlet canal helps to drain water out of the Goldfields to the Yuba River, which reduces the impact of high water levels on current mining and aggregate operations (DWR 1999).

The land containing the return channel is part of a small triangular tract of public land consisting of 81.74 acres (BLM 1995). Located within the Yuba Goldfields, the land is an isolated piece of public land along the south bank of the Yuba River approximately 7 miles east of Marysville, California. The fish barrier, intended to prevent upstream migrating adult salmonids from entering Waterway 13, is believed to be on Corps land.

Corps will work with local stakeholders and resource agencies to identify potential biological concerns associated with Waterway 13 and will support the development of measures to repair the barrier. As part of these activities, the Corps will collaborate with the stakeholders involved to develop a shared agreement (*e.g.*, a right-of-way or easement) that would provide access to those parties that would conduct future maintenance activities that may become necessary if and when the fish barrier at Waterway 13 washes out again in the future.

D. Proposed Conservation Measures

The Corps has committed to incorporate several conservation measures as part of its responsibilities for project operations and maintenance, which are intended to avoid or minimize potential effects and to improve conditions for listed salmonids in the lower Yuba River.

1. <u>Gravel Injection downstream of Englebright Dam</u>

The Corps will: (1) expeditiously complete the monitoring and evaluation of its November 2010 gravel placement specified in the Gravel/Cobble Augmentation Implementation Plan (GAIP); and (2) continue the long-term gravel augmentation plan described in the GAIP (*i.e.*, by injecting approximately 8,000 tons of additional gravel at the locations specified in the GAIP), if completion of monitoring of the 2010 program monitoring supports such actions. If the monitoring suggests alterative locations or gravel injection methods, then the Corps will continue the long-term gravel augmentation program accordingly. In addition, the frequency of gravel augmentation will be dependent upon annual monitoring results.

Recently, a two-year gravel monitoring effort to study the in-river effects of the 2010 gravel placement began in October 2011. Preliminary observations associated with this monitoring suggest that the relatively high flows that occurred during winter and spring during 2011 distributed the injected gravels downstream of the gravel placement site (near the Narrows I powerhouse). With the exception of intermittent patches of gravel associated with large hydraulic roughness elements, and the additional exception of a gravel bar located across from the Smartsville gaging station, much of the injected gravel was moved downstream of the first rapid in the Englebright Dam Reach (Englebright Dam to Deer Creek). However, additional monitoring including a complete bathymetric survey comparing volumetric differences between current distribution and baseline map is necessary to further evaluate the disposition of the 2010 gravel augmentation program.

Additionally, the Corps has funded PSMFC to conduct weekly redd surveys in the Englebright Dam Reach to investigate whether Chinook salmon and steelhead are utilizing areas where the 2010 gravel placement occurred. As of October 6, 2011, PSMFC staff has identified 16 Chinook salmon redds in the Englebright Dam Reach where previously suitable spawning gravels did not exist prior to the Corps' 2010 gravel injection program.

2. Woody Instream Material Management Program

The Corps will: (1) develop a plan or policy for management of LWM, consistent with recreation safety needs; (2) conduct a pilot project to identify suitable locations and evaluate the efficacy of placing large in-stream woody material to modify local flow dynamics to increase cover and diversity of instream habitat for the primary purpose of benefitting juvenile salmonid rearing, anticipated to occur within one year of this biological opinion; and (3) based upon the outcomes of the pilot program, develop and implement a long-term LWM management plan for the lower Yuba River, anticipated to occur within one year following completion of the pilot program.

3. Daguerre Point Dam Fish Passage Reconnaissance Study

The 2007 NMFS biological opinion required the Corps to complete the feasibility study of a fish passage improvement project at Daguerre Point Dam within five years (*i.e.*, November 21, 2012) and to begin implementing the Corps' preferred alternative within ten years (*i.e.*, November 21, 2017).

On September 1, 2009, the Corps submitted a legislative proposal to its Headquarters office in Washington, DC seeking legislative authority and funding to conduct a reconnaissance study regarding fish passage in the Yuba River. The President's Budget for fiscal year 2012 for the Corps' Civil Works program included $100,000 for an environmental reconnaissance study regarding fish passage at Englebright and Daguerre Point dams. However, funding for the reconnaissance study was subsequently removed from the 2012 budget that was approved by Congress in 2011. If funded by Congress, a reconnaissance study is usually completed in 12 months and is intended to accomplish the following four tasks:

1. Identify the water and related land resource problems and determine whether Federal participation in a feasibility study is warranted.
2. Define the Federal interest.
3. Prepare a Project Management Plan.
4. Assess the level of interest and support from non-Federal entities in cost sharing a feasibility study and any construction that may result.

If the Corps receives Congressional authorization to undertake a feasibility study, the reconnaissance phase ends when a non-Federal sponsor enters into a feasibility cost sharing agreement with the Corps. If the Corps does not obtain a Congressional authorization for a feasibility study, the Corps will use the reconnaissance study as the basis to seek Congressional authorization and appropriation for such a study. Corps will continue to seek the appropriate authority and funding.

As a conservation measure, the Corps will initiate the reconnaissance study upon receipt of funds. The Corps is committed to continue to diligently pursue funding and authorization to conduct the additional studies to address issues associated with the Daguerre Point Dam fish ladders.

III. ANALYTICAL APPROACH

Pursuant to section 7(a)(2) of the ESA, 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. Below, NMFS outlines the conceptual framework and key steps and assumptions utilized in the jeopardy and critical habitat destruction or adverse modification analyses.

A. Legal and Policy Framework

The purposes of the ESA, "*…are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section*." To help achieve these purposes, the ESA requires that, "*Each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat…*"

1. Jeopardy Standard

The "jeopardy" standard has been further interpreted in regulation (50 CFR 402.02) as a requirement that Federal agencies insure that their actions are not likely to result in *appreciable reductions in the likelihood of both the survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution*. It is important to note that the purpose of the analysis is to determine whether or not appreciable reductions are reasonably expected, but not to precisely quantify the amount of those reductions. As a result, our assessment often focuses on whether an appreciable reduction is expected or not, but not on detailed analyses designed to quantify the absolute amount of reduction or the resulting population characteristics (absolute abundance, for example) that could occur as a result of proposed action implementation.

For the purposes of this analysis, NMFS equates a listed species' probability (or risk) of extinction with the likelihood of both the survival and recovery of the species in the wild for purposes of conducting jeopardy analyses under section 7(a)(2) of the ESA. In the case of listed salmonids, we use the Viable Salmonid Populations (VSP) framework (McElhany *et al.* 2000) as a bridge to the jeopardy standard. A designation of "a high risk of extinction" or "low likelihood of becoming viable" indicates that the species faces significant risks from internal and external processes that can drive it to extinction. The status assessment considers and diagnoses both the internal and external processes affecting a species' extinction risk.

For salmonids, the four VSP parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the survival and recovery of the listed salmonid species (McElhany *et al*. 2000). The VSP parameters of productivity, abundance, and population spatial structure are consistent with the "reproduction, numbers, or distribution" criteria found within the regulatory definition of jeopardy (50 CFR 402.02) and are used as surrogates for "numbers, reproduction, and distribution." The VSP parameter of diversity relates to all three jeopardy criteria. For example, numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained, resulting in reduced population resilience to environmental variation at local or landscape-levels.

NMFS is currently in the process of finalizing a recovery plan for the listed Central Valley salmon and steelhead species. During the drafting of the recovery plan a technical recovery team was established to assist in the effort. One of the technical recovery team products, Lindley *et al*. (2007), provides a "Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin." Along with assessing the current viability of the listed Central Valley salmon and steelhead species, Lindley *et al*. (2007) provided recommendations for recovering those species. A public review draft of the recovery plan was issued in 2009 (NMFS 2009). Lindley *et al*. (2007) was relied on to establish the current status of the listed Central Valley salmon and steelhead species, and both Lindley *et al*. (2007) and the Draft Recovery Plan were utilized to evaluate whether the proposed action does not "reduce appreciably the likelihood of survival and recovery."

2. Destruction or Adverse Modification Standard

For critical habitat, NMFS did 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 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.

Additional requirements on the analysis of the effects of an action are described in regulation (50 CFR 402) and our conclusions related to "jeopardy" and "destruction or adverse modification" generally require an expansive evaluation of the direct and indirect consequences of the proposed action, related actions, and the overall context of the impacts to the species and habitat from past, present, and future actions as well as the condition of the affected species and critical habitat [for example, see the definitions of "cumulative effects," "effects of the action," and the requirements of 50 CFR 402.14(g)].

Recent court cases have reinforced the requirements provided in section 7 regulations that NMFS must evaluate the effects of a proposed action within the context of the current condition of the species and critical habitat, including other factors affecting the survival and recovery of the species and the functions and value of critical habitat. In addition, the courts have directed that our risk assessments consider the effects of climate change on the species and critical habitat and our prediction of the future impacts of a proposed action.

Consultations designed to allow Federal agencies to fulfill these purposes and requirements are concluded with the issuance of a biological opinion or a concurrence letter. For biological opinions, section 7 of the ESA and the implementing regulations (50 CFR 402), and associated guidance documents (*e.g.*, USFWS and NMFS 1998) require the biological opinions to present: (1) a description of the proposed Federal action; (2) a summary of the status of the affected species and its critical habitat; (3) a summary of the environmental baseline within the action area; (4) a detailed analysis of the effects of the proposed action on the affected species and critical habitat; (5) a description of cumulative effects; and (6) a conclusion as to whether it is reasonable to expect the proposed action is not likely to appreciably reduce the species' likelihood of both surviving and recovering in the wild by reducing its numbers, reproduction, or distribution or result in the destruction or adverse modification of the species designated critical habitat.

B. Ecological Conceptual Framework

NMFS uses a conceptual model of the species and its critical habitat to evaluate the impact of proposed actions. For this consultation, this conceptual model is structured around the listed spring-run Chinook salmon ESU, Central Valley steelhead DPS, green sturgeon Southern DPS, and critical habitat for these species. For the species, the conceptual model is based on a hierarchical organization of individual fish, population, and ESU. The guiding principle behind this conceptual model is that the likelihood of survival and recovery of a species is dependent on the likelihood of survival and recovery of populations which comprise the species (organized by diversity strata[1] comprising the species, ESU, or DPS); and the likelihood of survival and recovery of each population unit is dependent upon the fitness (growth, survival, or reproductive success) of the individuals that comprise that population.

A prerequisite for predicting the effects of a proposed action on a population and a species includes an understanding of the condition of the population and species in terms of their chances of surviving and recovering. To do this, we evaluate their current condition and assess their chances of recovery given their current condition and the existing and future threat regime. To assist in this evaluation we use the guidance provided in the *Viable Salmonid Populations* (VSP) document by McElhany *et al.* (2000). As defined in the VSP document, viability is the state in which extinction risk of a population is negligible over 100 years and full evolutionary potential is retained (McElhany *et al*. 2000). Importantly, a viable population (or species) is not necessarily one that has recovered as defined under the ESA. To meet recovery standards, the species may need to achieve higher levels of resiliency to allow for activities such as commercial harvest and the existing threat regime would need to be abated or ameliorated as detailed in a recovery plan. As a result, we evaluate the current status of the species to diagnose how near, or far, the species is from this viable state because it is an important metric indicative of a self-

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[1] Diversity strata are defined as groups of populations that span the diversity of environments and distribution that currently exists or historically existed within the ESU.

sustaining species in the wild, but we also consider the ability of the species to recover in light of its current condition and the status of the existing and future threat regime. Generally, NMFS folds this consideration of current condition and ability to recover into a conclusion regarding the "risk of extinction" of the population or species.

We equate the risk of extinction of the species with the "likelihood of both the survival and recovery of the species in the wild" for purposes of conducting jeopardy analyses under section 7(a)(2) of the ESA because survival and recovery are conditions on a continuum with no bright dividing lines. Similar to a species with a low likelihood of both survival and recovery, a species with a high risk of extinction does not equate to a species that lacks the potential to become viable. Instead, a high risk of extinction indicates that the species faces significant risks from internal and external processes and threats that can drive a species to extinction. Our jeopardy assessment, therefore, focuses on whether a proposed action appreciably increases extinction risk, which is a surrogate for appreciable reductions in the likelihood of survival and recovery.

NMFS uses the general life cycle approach outlined by the VSP report (McElhany *et al.* 2000) in this biological opinion. NMFS uses the concepts of VSP as an organizing framework in this biological opinion to systematically examine the complex linkages between project effects and VSP parameters while also considering and incorporating key risk factors such as climate change and ocean conditions (Behrenfeld *et al*. 2006). Four principal parameters were used to evaluate the risk of extinction risk of the Central Valley spring-run Chinook salmon ESU, California Central Valley steelhead trout DPS, and green sturgeon Southern DPS: abundance, population growth rate (productivity), population spatial structure, and population diversity. These specific parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of the spring-run Chinook salmon ESU, Central Valley steelhead DPS, and green sturgeon Southern DPS [2] (Anderson *et al.* 2009, McElhany *et al*. 2000). These four parameters are consistent with the "reproduction, numbers, or distribution" criteria found within the regulatory definition of jeopardy (50 CFR 402.02) and are used as surrogates for numbers, reproduction, and distribution. The fourth VSP parameter, diversity, relates to all three jeopardy criteria. For example, numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained, resulting in reduced population resilience to environmental variation at local or landscape-level scales.

For critical habitat, the organizational structure is generally based around the primary constituent elements or essential features of the critical habitat within the action area, the essential habitat types those features support within the action area as organized by reaches within the mainstem Yuba River, the area encompassing the diversity stratum[3] in which the affected essential habitat features and types are found, and then the overall designated area of critical habitat at the ESU or DPS scale. The basis of the analysis is to evaluate the function and role of the critical habitat in

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[2] Although not a salmonid, the VSP parameters were applied to the southern DPS of the green sturgeon for the sake of analytical consistency.

[3] In cases where the extent of designated critical habitat is smaller than the boundaries of a defined area such as a diversity stratum, our analysis would focus on the extent of the designation within that area and not artificially extend critical habitat boundaries.

the conservation of the species. As a result, the structure is organized around the structure of the species to be conserved. Importantly, NMFS bases the critical habitat analysis on the affected areas and functions of critical habitat essential to the conservation of the species and not on how individuals of the species will respond to changes in habitat quantity and quality.

C. General Overview of the Approach and Models Used

NMFS uses a series of sequential analyses to assess the effects of Federal actions on endangered and threatened species and designated critical habitat. These sequential analyses are illustrated in Figure III-a. For the purposes of this consultation, NMFS considers the proposed action to be composed of the purpose of the action (operate and maintain the dams) and the components of the action described in section II "Description of the Proposed Action" as it is deconstructed. The first analysis identifies those physical, chemical, or biotic aspects of proposed actions that are likely to have individual, interactive, or cumulative direct and indirect effects on the environment (we use the term "stressors" for these aspects of an action). Because the proposed action entails continuation of baseline conditions, the stressors and impacts to the population are first identified in section V "Environmental Baseline" and addressed again in sections VI and VI under "Effects of the Action on Listed Species" and "Effects of the Action on Critical Habitat". As part of this step, we identify the spatial extent of any potential stressors and recognize that the spatial extent of those stressors may change with time (the combined spatial extent of these stressors is the "action area" for a consultation).

The second step of our analyses starts by identifying the endangered species, threatened species, or designated or proposed critical habitat that are likely to occur in the same space and at the same time as these potential stressors. Then we try to estimate the nature of that co-occurrence (these represent our *exposure analyses*). In this step of our analyses, we try to identify the number and age (or life stage) of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent or the specific areas and primary constituent elements of critical habitat that are likely to be exposed.

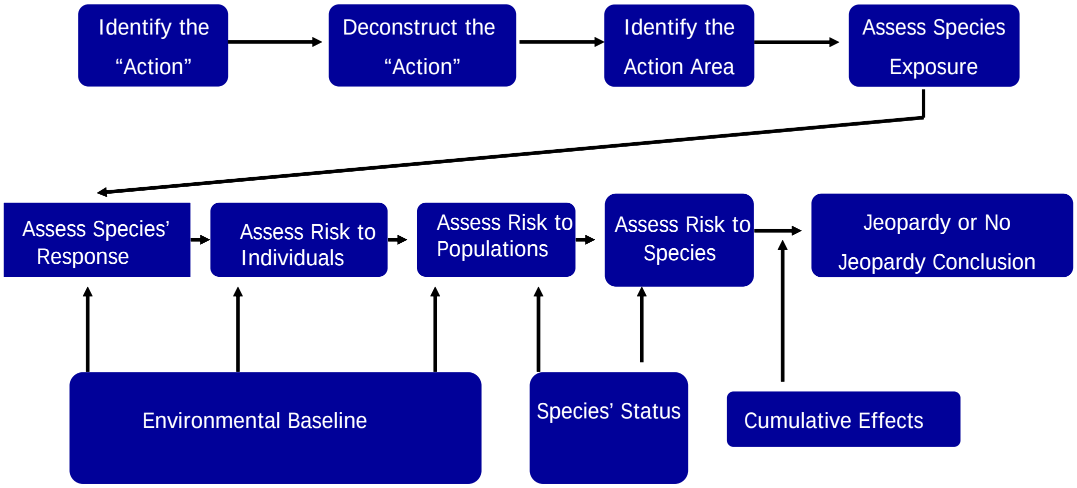


Figure III-a. General Conceptual Model for Conducting Section 7 as Applied to Analyses for Listed Species.

Once we identify which listed resources (endangered and threatened species and designated critical habitat) are likely to be exposed to potential stressors associated with an action and the nature of that exposure, in the third step of our analyses, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our *response analyses*). The final steps of our analyses - establishing the risks those responses pose to listed resources - are different for listed species and designated critical habitat and are further discussed in the following sub-sections (these represent our *risk analyses*).

D. Application of the Approach and to Listed Species Analyses

Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species and how those "species" have been listed (*e.g.*, as true biological species, subspecies, or distinct population segments of vertebrate species). Because the continued existence of listed species depends on the fate of the populations that comprise them, the probability of extinction, or probability of persistence of listed species depends on the probabilities of extinction and persistence of the populations that comprise the species. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our analyses reflect these relationships between listed species and the populations that comprise them, and the individuals that comprise those populations. We identify the probable risks that actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individuals risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

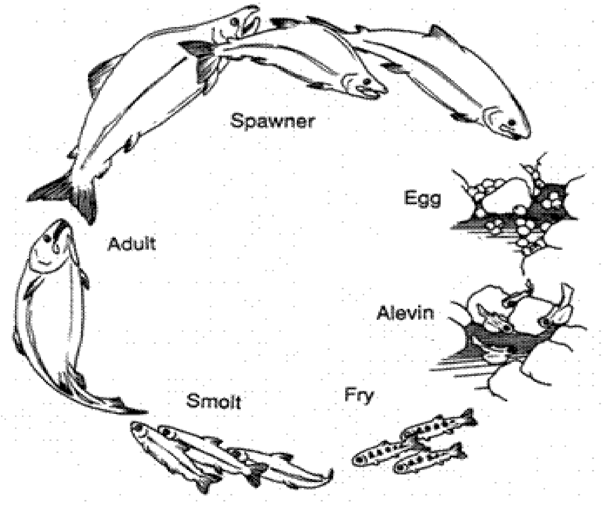
We measure risks to listed individuals using the individual's "fitness," which are changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable response to an action's effects on the environment (which we identify in our *response analyses*) are likely to have consequences for the individual's fitness.

When individuals, whether they are listed plants or animals, are expected to experience reductions in fitness, we would expect those reductions to also reduce the abundance, reproduction rates, or growth rates (or increase variance in one or more of these rates) of the populations those individuals represent (see Stearns 1992). Reductions in one or more of these variables (or one of the variables we derive from them) is a *necessary* condition for increases in a population's probability of extinction, which is itself a *necessary* condition for increases in a species' probability of extinction.

If we conclude that listed plants or animals are likely to experience reductions in their fitness, our assessment tries to determine if those fitness reductions are likely to be sufficient to increase the probability of extinction of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, diversity, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). In this step of our analyses, we use the population's base condition (established in the *Status of the Species* section of this biological opinion) as our point of reference. Generally, this reference condition is a measure of how near to or far from a species is to extinction or recovery.

An important tool we use in this step of the assessment is a consideration of the life cycle of the species. The consequences on a population's probability of extinction as a result of impacts to different life stages are assessed within the framework of this life cycle and our current knowledge of the transition rates (essentially, survival and reproductive output rates) between stages, the sensitivity of population growth to changes in those rates, and the uncertainty in the available estimates or information. An example of a Pacific salmonid life cycle is provided in Figure III-b.

Various sets of data and modeling efforts are useful to consider when evaluating the transition rates between life stages and consequences on population growth as a result of variations in those rates. These data are not available for all species considered in this biological opinion; however data from surrogate species may be available for inference. Where available, information on transition rates, sensitivity of population growth rate to changes in these rates, and the relative importance of impacts to different life stages is used to inform the translation of individual effects to population level effects. Except when there is significant removal of a juvenile cohort, we assume that the consequences of impacts to older reproductive and pre-reproductive life stages are more likely to affect population growth rates than impacts to early life stages. But it is not always the adult transition rates that have the largest effect on population growth rate. For example, absolute changes in the number of smolts that survive their migration to the ocean may have the largest impact on Chinook salmon population growth rate (Wilson 2003) followed by the number of alevins that survive to fry stage.



http://www.dfo-mpo.gc.ca/

Figure III-b. Conceptual diagram of the life cycle of a Pacific salmonid.

Similarly, in some sturgeon species, growth rate is most sensitive to young-of-the-year and juvenile survival, and less sensitive to annual adult fecundity and survival (Caswell 2001). Thus, habitat alterations that decrease the survival of young-of-the-year or any class within the juvenile life stage will more strongly influence the affected population's growth rate than if the alteration will only affect fecundity or survival of adults (Gross *et al*. 2002).

In addition, we recognize that populations may be vulnerable to small changes in transition rates. As hypothetically illustrated in figure III-c, small reductions across multiple life stages can be sufficient to cause the extirpation of a population through the reduction of future abundance and reproduction of the species.

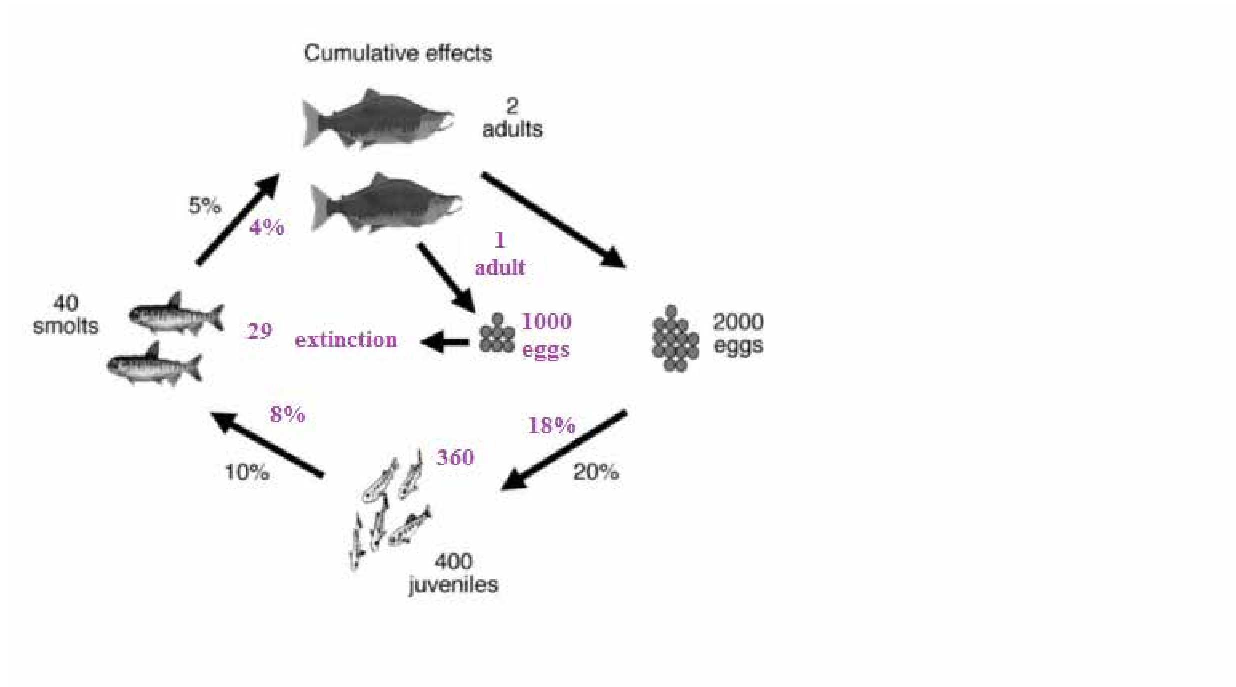
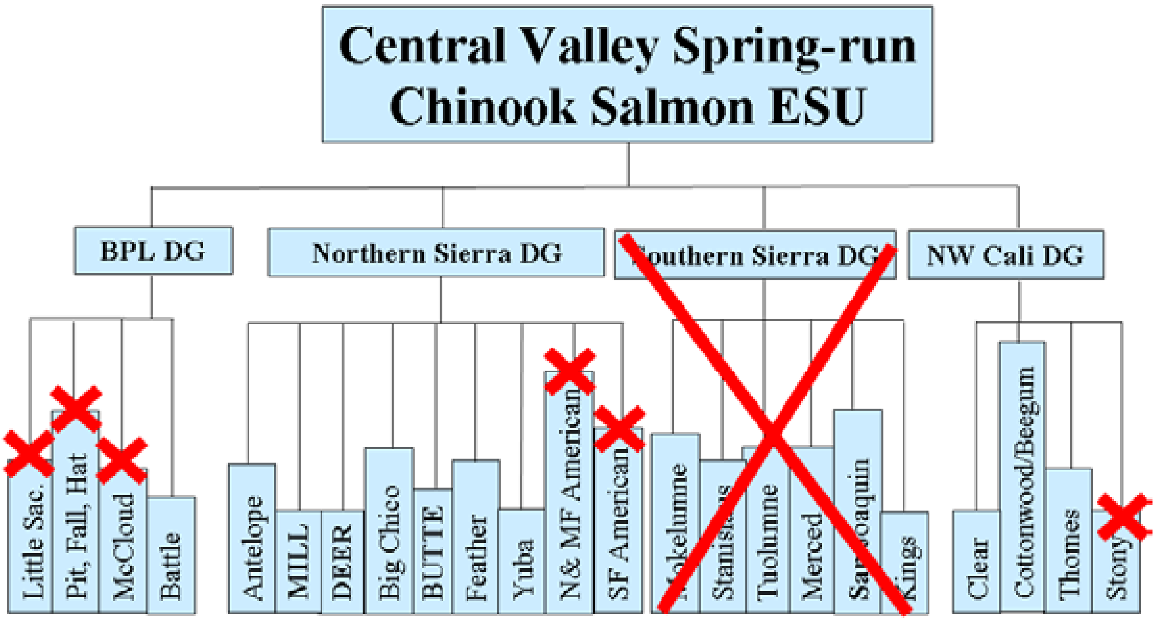


Figure III-c. Illustration of cumulative effects associated with different life stages of Pacific salmon. It is possible to increase population size or drive the population to extinction by only slight changes in survivorship at each life history stage. (Originally Figure 9 in Naiman and Turner 2000—reproduced with permission from the publisher.)

Finally, our assessment tries to determine if changes in population viability are likely to be sufficient to reduce the viability of the species those populations comprise. In this step of our analyses, we use the species' status (established in the *Status of the Species* section of this biological opinion) as our point of reference. We also use our knowledge of the population structure of the species to assess the consequences of the increase in extinction risk to one or more of those populations. Our *Status of the Species* section discussed the available information on the structure and diversity of the populations that comprise the listed species and any available guidance on the role of those populations in the recovery of the species. A conceptual model of the population structure of spring-run Chinook salmon is provided in figure III-d. This model illustrates the historic structure of the species and notes those populations that have been extirpated to provide a sense of the existing and lost diversity and structure within the species. Both the existing and lost diversity and structure are important considerations when evaluating the consequences of increases in the extinction risk of an existing population or effects to areas that historically had populations.



BPL – Basalt and Porous Lava
NW Cali - Northwest California
DG – Diversity Group

Figure III-d. Population structure of the Central Valley spring-run Chinook salmon ESU. Red crosses indicate populations and diversity groups that have been extirpated. Extant independent populations are identified in all capital letters. It should be noted that all four independent populations which historically occurred in the Feather River watershed tributaries (*i.e.*, north, middle, and south forks, and the west branch) are now extinct, however, a hatchery population does currently occur in the Feather River downstream of Oroville Dam. Chinook salmon exhibiting spring-run characteristics occur in the mainstem Sacramento River downstream of Keswick Dam.

For example, the Central Valley Domain technical recovery team recommended that, for spring-run Chinook salmon and Central Valley steelhead, all extant (still surviving) populations should be secured and that, "…*every extant population be viewed as necessary for the recovery of the ESU [Evolutionarily Significant Unit]*" (Lindley *et al*. 2007). Based on this recommendation, it was assumed that if appreciable reductions in any population's viability are expected to result from implementation of the proposed action, then this would be expected to appreciably reduce the likelihood of both the survival and recovery of the diversity group the population belongs to as well as the listed ESU/DPS.

Figure III-e outlines the basic hierarchy in the analysis. A linear logic path is followed and is used to organize the jeopardy risk assessment. For each analysis, actions that negatively affect breeding, feeding, sheltering, or migration of the listed species are identified as stressors. The linear model for determining effects to the species is as follows: (1) the life history stage and location of individuals in relation to an identified stressor is identified; (2) the timing of the life history stage in relationship to the stressor is called out, unless timing and life history stage are one and the same; (3) the stressor frequency and duration is estimated; (4) the response or expected outcome for individuals is calculated or estimated; (5) the probable fitness of individuals after exposure to the stressor is postulated; (6) the population response, in terms of numbers or reproduction, is estimated; and (7) a level of risk to the population from exposure of individuals to the stressor is identified as a probable or likely outcome.

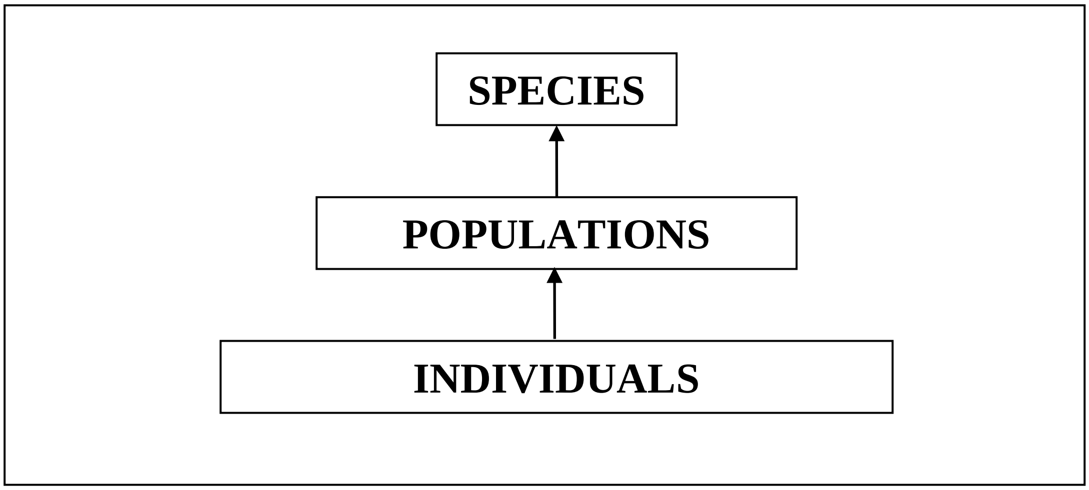


Figure III-e. Conceptual model of the hierarchical structure that is used to organize the jeopardy risk assessment.

1. The Viable Salmonid Populations Framework in Listed Salmonid Analyses

In order to assess the survival and recovery of any species, a guiding framework that includes the most appropriate biological and demographic parameters is required. This has been generally defined above. For Pacific salmon, McElhany *et al*. (2000) defines VSP as an independent population that has a negligible probability of extinction over a 100-year time frame. The VSP concept provides specific guidance for estimating the viability of populations and larger-scale groupings of Pacific salmonids such as ESU or DPS. Four VSP parameters form the key to evaluating population and ESU/DPS viability: (1) abundance; (2) productivity (*i.e*., population growth rate); (3) population spatial structure; and (4) diversity (McElhany *et al.* 2000). These four parameters and their associated attributes are presented in figure III-f. In addition, the condition and capacity of the ecosystem upon which the population (and species) depends plays a critical role in the viability of the population or species. Without sufficient space, including accessible and diverse areas the species can utilize to weather variation in their environment, the population and species cannot be resilient to chance environmental variations and localized catastrophes. As discussed in the *Status of the Species*, salmonids have evolved a wide variety of life history strategies designed to take advantage of varying environmental conditions. Loss or impairment of the species' ability to utilize these adaptations increases their risk of extinction.

ABUNDANCE (N)

A population should be large enough to survive and be resilient to environmental variations and catastrophes such as fluctuations in ocean conditions, local contaminant spills, or landslides.

Population size must be sufficient to maintain genetic diversity.

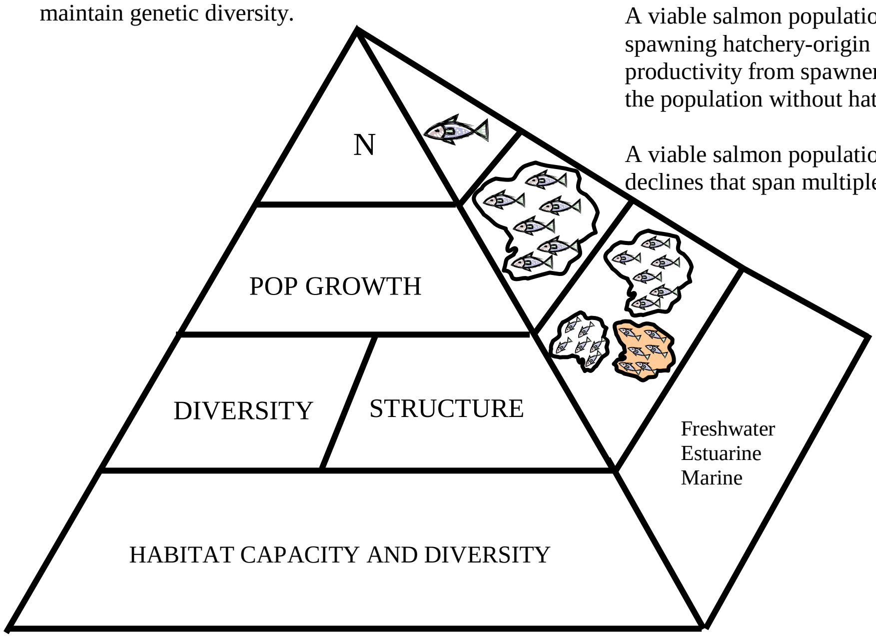
PRODUCTIVITY
(POPULATION GROWTH RATE)

Natural productivity should be sufficient to reproduce the population at a level of abundance that is viable.

Productivity should be sufficient throughout freshwater, estuarine, and nearshore life stages to maintain viable abundance levels, even during poor ocean conditions.

A viable salmon population that includes naturally spawning hatchery-origin fish should exhibit sufficient productivity from spawners of natural origin to maintain the population without hatchery subsidy.

A viable salmon population should not exhibit sustained declines that span multiple generations.



DIVERSITY

Human-caused factors such as habitat changes, harvest pressures, artificial propagation, and exotic species introduction should not substantially alter variation in traits such as run timing, age structure, size, fecundity (birth rate), morphology, behavior, and genetic characteristics.

The rate of gene flow among populations should not be altered by human caused factors.

Natural processes that cause ecological variation should be maintained.

SPATIAL STRUCTURE

Habitat patches should not be destroyed faster than they are naturally created.

Human activities should not increase or decrease natural rates of straying among salmon sub-populations.

Habitat patches should be close enough to allow the appropriate exchange of spawners and the expansion of population into underused patches.

Some habitat patches may operate as highly productive sources for population production and should be maintained.

Due to the time lag between the appearance of empty habitat and its colonization by fish, some habitat patches should be maintained that appear to be suitable, or marginally suitable, even if they currently contain no fish.

Figure III-f. Viable salmonid population (VSP) parameters and their attributes. In addition, the quality, quantity and diversity of the habitat (habitat capacity and diversity) available to the species in each of its three main habitat types (freshwater, estuarine and marine environments) is a critical foundation to VSP. Salmon cannot persist in the wild and withstand natural environmental variations in limited or degraded habitats.

As presented in Good *et al*. (2005), criteria for VSP are based upon measures of the VSP parameters that reasonably predict extinction risk and reflect processes important to populations.

Abundance is critical, because small populations are generally at greater risk of extinction than large populations. Stage-specific or lifetime productivity (*i.e.*, population growth rate) provides information on important demographic processes. Genotypic and phenotypic diversity are important in that they allow species to use a wide array of environments, respond to short-term changes in the environment, and adapt to long-term environmental change. Spatial structure reflects how abundance is distributed among available or potentially available habitats, and can affect overall extinction risk and evolutionary processes that may alter a population's ability to respond to environmental change.

The VSP concept also identifies guidelines describing a viable ESU/DPS. The viability of an ESU or DPS depends on the number of populations within the ESU or DPS, their individual status, their spatial arrangement with respect to each other and to sources of potential catastrophes, and diversity of the populations and their habitat (Lindley *et al*. 2007). Guidelines describing what constitutes a viable ESU are presented in detail in McElhany *et al*. (2000). More specific recommendations of the characteristics describing a viable Central Valley salmon population are found in Table 1 of Lindley *et al.* (2007).

Along with the VSP concept, NMFS uses a conceptual model of the species to evaluate the potential impact of proposed actions. For the species, the conceptual model is based on a bottom-up hierarchical organization of individual fish at the life stage scale, population, diversity group, and ESU/DPS (figure III-g). The guiding principle behind this conceptual model is that the viability of a species (*e.g*., ESU) is dependent on the viability of the diversity groups that compose that species and the spatial distribution of those groups; the viability of a diversity group is dependent on the viability of the populations that compose that group and the spatial distribution of those populations; and the viability of the population is dependent on the four VSP parameters, and on the fitness and survival of individuals at the life stage scale. The anadromous salmonid life cycle (see figure III-b) includes the following life stages and behaviors, which were evaluated for potential effects resulting from the proposed action:

- Adult Migration;
- Adult Holding;
- Spawning;
- Egg Incubation and Fry Emergence;
- Juvenile Rearing; and
- Juvenile and Smolt Outmigration.

2. Approach to Green Sturgeon Southern DPS

Although McElhany *et al*. (2000) specifically addresses viable populations of salmonids, NMFS has determined that the concepts and viability parameters in McElhany *et al*. (2000) can also be applied to the green sturgeon. This approach has been supported by the *Independent Review of a Draft Version of the 2009 NMFS CVP/SWP operations Biological Opinion* (Anderson *et al*. 2009). Therefore, in this consultation, NMFS applies McElhany *et al*. (2000) and the viability parameters in its characterization of the environmental baseline and analysis of effects of the action to the green sturgeon.

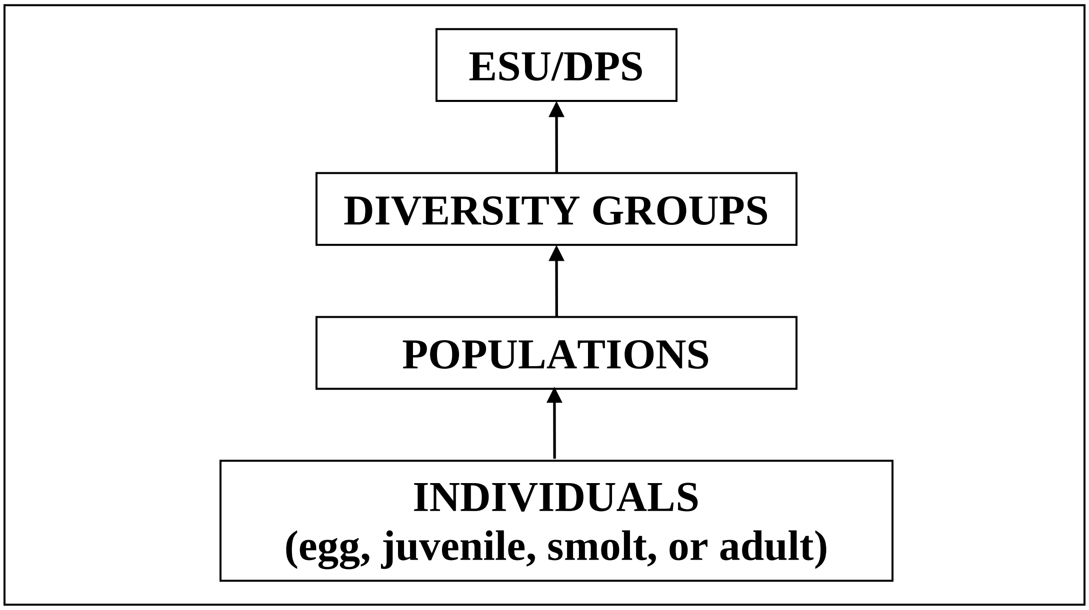


Figure III-g. Conceptual model of the hierarchical structure that is used to organize the jeopardy risk assessment for anadromous salmonids.

E. Concept of the Natural Flow Regime

Throughout the sections of the biological opinion, NMFS uses the concepts of a natural flow regime to guide the analytical approach. The natural flow regime of a river is the characteristic pattern of flow quantity, timing, rate of change of hydrologic conditions, and variability across time scales (hours to years), all without the influence of human activities (Poff *et al*. 1997). Variability of the natural flow regime is inherently critical to ecosystem function and native biodiversity (Poff *et al.* 1997; Puckridge *et al*. 1998; Bunn and Arthington 2002; Beechie *et al*. 2006). Because aquatic species have evolved life history strategies in direct response to natural flow regimes (Taylor 1991; Bunn and Arthington 2002; NRC 2004; Beechie *et al*. 2006), maintenance of natural patterns of longitudinal and lateral connectivity is essential to the viability of populations of many riverine species (Poff *et al*. 1997; Bunn and Arthington 2002).

Because humans have now altered the flow regimes of most rivers (Poff *et al*. 1997; Bunn and Arthington 2002), understanding the link between the adaptation of aquatic and riparian species to the flow regime of a river is crucial for the effective management and restoration of running water ecosystems (Beechie *et al*. 2006).

There are four components of a natural flow regime (NRC 2005): (1) *Subsistence flow* is the minimum flow needed during critical drought periods to maintain tolerable water-quality conditions and to provide minimal aquatic habitat space for the survival of aquatic species; (2) *Base flow* is the “normal” flow condition between storms; (3) *High-flow pulses* are short duration flows following storms; and (4) *Overbank flow* is an infrequent, high-flow event that breaches riverbanks.

F. Risk Assessments

As described above, the regulations implementing section 7(a)(2) of the ESA direct NMFS to assess impacts of the proposed action on listed species and critical habitat. These regulations are in order to ensure that the proposed action is not likely to jeopardize the listed species or result in the destruction or adverse modification of critical habitat. In our biological opinions, NMFS conducts two separate but related analyses to make these determinations. To conduct these assessments, NMFS uses a basic exposure-response-risk framework adapted from other accepted risk analysis frameworks such as EPA 1992 and 1998.

Generally, NMFS first identifies the environmental “stressors” (physical, chemical or biotic) directly or indirectly caused by the proposed action to which spring-run Chinook salmon, Central Valley steelhead, and green sturgeon may be exposed. NMFS also identifies critical habitat that may be exposed, the nature of any exposure, and the life stages or essential habitat features exposed. Next, NMFS evaluates the likely response of the spring-run Chinook salmon ESU, steelhead DPS, and green sturgeon Southern DPS and critical habitat exposed to such stressors. This evaluation is based on the best scientific and commercial information available and includes observations of how past similar exposures have affected the species and habitat, and future similar exposure is likely to affect the species and habitat, as described in the *Environmental Baseline*. Since habitat modification represents the primary mechanism by which the proposed action has potential effects on individual spring-run Chinook salmon, steelhead, and green sturgeon and critical habitat, NMFS utilizes a habitat-based assessment in the *Analysis of Effects* section. By river reach and time of year, NMFS first describes the hydrological modifications that result from the proposed action in the action area. NMFS then examines the effects of these hydrological modifications to critical habitat and individuals of the species given the biological and ecological needs of spring-run Chinook salmon, steelhead, and green sturgeon in the Yuba River as described in the *Environmental Baseline*. NMFS assesses whether the conditions that result from the proposed action, in combination with conditions influenced by other past and ongoing activities and natural phenomena as described in the *Environmental Baseline*, will affect the function and value of critical habitat or the growth, survival, or reproductive success (*i.e.*, fitness) of individual spring-run Chinook salmon, Central Valley steelhead, or green sturgeon. The final steps in NMFS risk assessments are described below in the sections reviewing the adverse modification and jeopardy risk assessments.

G. Destruction or Adverse Modification Risk Assessment Approach

To determine if the proposed action is likely to result in the destruction or adverse modification of designated critical habitat for spring-run Chinook salmon, Central Valley steelhead, or green sturgeon, we analyzed the effects of the action on the elements of critical habitat identified as essential to the conservation of the species. In the *Status of the Species and Critical Habitat* sections, our critical habitat destruction or adverse modification risk assessment begins with a discussion of the biological and physical features (primary constituent elements or essential features) essential to the conservation of the Central Valley spring-run Chinook salmon at the

ESU scale and Central Valley steelhead and green sturgeon at the DPS scale. We included the current conditions of such features, and the factors responsible for those current conditions. Next, in the *Environmental Baseline* section, NMFS discusses the current condition of critical habitat in the action area, the factors responsible for that condition, the conservation role of those specific areas, and the relationship of critical habitat designated in the action area to the entire designated critical habitat at the ESU or DPS scale to the conservation of the species. We followed the hierarchical organization outlined above in the *Ecological Conceptual Framework*. In the *Effects of the Action* section, NMFS analyzes the effects of the proposed action on critical habitat within the action area. This analysis builds on the habitat-based assessment described for the jeopardy analysis, above. That is, using the best scientific and commercial data available, we estimate the effect of the proposed action on water quantity/quality and instream habitat because these effects may influence substrate and sediment levels, water quality conditions, and other general conditions of watersheds that support the biological and ecological requirements of the species. If the effects of the proposed action, when added to the environmental baseline and combined with cumulative effects, are not reasonably likely to destroy or adversely modify the value of constituent elements essential to the conservation of the Central Valley spring-run Chinook salmon ESU, Central Valley steelhead DPS, and green sturgeon Southern DPS in the action area, then the action is not likely to destroy or adversely modify designated critical habitat as a whole. Conversely, if the conservation value of the affected essential habitat features in the action area is likely to be destroyed or adversely modified, NMFS must then determine whether the impacts reduce the function of the overall critical habitat at the ESU scale for the conservation of the species or reduce the current ability of the critical habitat to establish essential habitat features and functions. Different areas and features of critical habitat will have varying roles in the recovery of natural, self-sustaining salmon populations. For the final steps, NMFS evaluates whether, with implementation of the proposed action, critical habitat would remain functional to serve the intended conservation role for the Central Valley spring-run Chinook salmon ESU, Central Valley steelhead DPS, and green sturgeon Southern DPS critical habitats or retain the habitat's current ability to establish those features and functions essential to the conservation of the species.

H. Jeopardy Risk Assessment Approach

The jeopardy risk assessment begins with a diagnosis of the current status of the spring-run Chinook salmon ESU, Central Valley steelhead DPS, and green sturgeon Southern DPS, throughout their geographic ranges. In other words, NMFS evaluates the current risk of extinction of these species given their exposure to human activities and natural phenomena throughout its geographic distribution. As discussed above, NMFS utilizes the VSP conceptual framework for this assessment. The diagnosis describes the species legal status, identifies existing threats, and details the distribution and trends of threats throughout the range of the species. We describe the species' status in terms of the VSP characteristics of the ESU and DPSs and the diversity strata within the ESU and DPSs that are affected by the proposed action. In addition, we consider the effects of ongoing changes in climate conditions and the influence of ocean conditions on the species. Because NMFS' biological opinion as to whether an action is or is not likely to jeopardize a species is based on the species-as-listed scale (Central Valley spring-run Chinook salmon ESU, Central Valley steelhead DPS, and green sturgeon Southern DPS), the diagnoses presented in the *Status of the Species and Critical Habitat* sections of this biological opinion provide a point-of-reference that NMFS uses in its final steps in the jeopardy analysis within the *Integration and Synthesis* section of this biological opinion.

Our jeopardy risk assessment continues with the *Environmental Baseline* section, which is designed to assess the current risk of extinction of the Central Valley spring-run Chinook salmon, Central Valley steelhead, or green sturgeon Southern DPS population units at the action area scale given their exposure to human activities and natural phenomena. As specified under section 7 regulations, 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. The *Environmental Baseline* section of this biological opinion identifies the antecedent conditions, including those that likely have resulted from Corps' past and current operation of the proposed action, on individual spring-run Chinook salmon, steelhead, or green sturgeon and the viability parameters of these populations at the action area scale. The evaluation of the current risk of extinction of each species' population unit within the Yuba River watershed provides a reference condition at the population unit scale to which NMFS will add the effects of the proposed action. Because our jeopardy analysis must consider the effects of the proposed action within the context of the other impacts experienced by the species, some information provided in the *Environmental Baseline* section is also used to describe the conditions faced by the same individuals that will be affected by the future proposed operations of the proposed action. NMFS uses the analysis of how activities other than proposed operations have impacted the fitness (growth, survival, or reproduction) of individual spring-run Chinook salmon, steelhead, and green sturgeon to provide the context or condition of the animals that the proposed action operations will impact for the next eight years.

The *Environmental Baseline* section is organized into several sequential parts. First, NMFS discusses the natural flow regime to summarize the conditions under which spring-run Chinook salmon, steelhead, and green sturgeon evolved in the action area. We present this information to provide the reader with an understanding of the patterns and variability in flow within and between years that support the ecological requirements of the populations of these species. This information is later used to discuss how the populations of these species are expected to respond to the hydrological effects of the proposed action. Second, existing scientific and commercial information related to the seasonal periodicity and life history traits and biological requirements of the spring-run Chinook salmon, steelhead, and green sturgeon within the Yuba River and its tributaries is presented. Understanding the spatial and temporal occurrence of these species in the Yuba watershed and its tributaries is a key step in evaluating how they are exposed to current human activities and natural phenomena. NMFS next summarizes past and current human activities and describes how these activities influence current habitat conditions for the spring-run Chinook salmon, steelhead, and green sturgeon populations in the action area. NMFS then describes how these habitat conditions influence the current risk of extinction of each population unit using the four key population viability parameters (*i.e.*, abundance, productivity, spatial structure, and diversity).

In the *Effects of the Action* section, NMFS evaluates the likely effects of the proposed action to spring-run Chinook salmon, steelhead, and green sturgeon within the action area. We use the exposure and response framework described above to identify the probable risks that individual spring-run Chinook salmon, steelhead, and green sturgeon are likely to experience as a result of the proposed action.

Once we have determined how the proposed action when added to environmental baseline conditions will affect the fitness of individual spring-run Chinook salmon, steelhead, and green sturgeon, the final steps in NMFS' jeopardy risk assessment are to evaluate whether these fitness consequences, in combination with cumulative effects and including future environmental variation, are reasonably likely to result in changes in the risk of extinction of Yuba River spring-run Chinook salmon, steelhead, and green sturgeon populations. We complete this assessment by relying on the information available about the species and the specific population units in terms of current and needed levels of abundance, productivity, diversity, and spatial structure characteristics, as presented in the *Status of the Species and Critical Habitat* and the *Environmental Baseline* sections. For example, survival resulting from loss or reduction of rearing habitat may reduce abundance. This same reduction can reduce the productive capacity of the river system and impact the productivity of the population, or constrain the ability of individuals of the species to track environmental changes, affecting the diversity and spatial structure of the population. If a population unit is at high risk of extinction due to the current condition of one or more of these characteristics, negative impacts to those same vulnerable characteristics are more likely to increase appreciably the risk of extinction of a population unit. Impacts to less vulnerable characteristics or to a population unit facing a low risk of extinction (generally, a higher likelihood of being at or near a viable state) are less likely to increase the population's risk of extinction.

NMFS may conclude that an action is likely to jeopardize the species through estimated or measured increases in the risk of extinction of the species or decreases in the chance that the species can become viable or be recovered. If the effects of the action are reasonably likely to increase the risk of extinction of the Yuba River spring-run Chinook salmon population, we then assess whether this increase is reasonably likely to increase the risk of extinction of the species. Increases in the extinction risk of the species are considered appreciable reductions in the likelihood of both survival and recovery of the species. Conversely, if no increases in a population's risk of extinction are expected, we could conclude that the ESU or DPS is not appreciably affected by the proposed action. However, for the purposes of the jeopardy analysis, NMFS also assesses whether the proposed action is expected to reduce the likelihood of an affected diversity stratum contributing to the viability of the species by impacting the ability of one or more of the stratum's member populations to fulfill their intended role in stratum viability. The intended roles of all the populations in the ESU have not yet been defined through a recovery strategy for the species, however, each population within a diversity stratum is expected to fulfill one of two roles. For a stratum to be viable, 50 percent of the independent populations in the stratum must be viable (if there are three or less independent populations in a stratum, at least two of the independent populations must be viable; Williams *et al.* 2007). For example, the Northern Sierra Diversity Group of the spring-run Chinook salmon ESU will need at least four viable independent populations for the stratum to be viable. In addition, the total aggregate abundance of the core populations selected to satisfy this criterion must meet or exceed 50 percent of that historically predicted for the diversity stratum based on the spawner density for population viability. This second stratum criterion requires that proposed recovery scenarios must include historically independent populations that, by virtue of their size and location, were disproportionately important to stratum and ESU function and persistence. For populations not selected to satisfy the independent population criterion above, their role in stratum viability is that they must exhibit occupancy that indicates sufficient immigration is occurring from the core populations (Williams *et al.* 2007).

For the spring-run Chinook salmon ESU, steelhead DPS, and green sturgeon Southern DPS to be viable, each stratum must be viable (Williams *et al.* 2007). Following on the example above, if the effects of the proposed action reduce the likelihood that the Northern Sierra Nevada Diversity Group becomes viable through increases in the risk of extinction of one or more of its member populations, the likelihood that the Central Valley steelhead DPS could be viable is reduced based on the proposed viability criteria. Therefore, reductions in the likelihood of Northern Sierra Nevada Diversity Group achieving viability are also reasonably likely to reduce the likelihood the Central Valley steelhead DPS would achieve viability; which is to say that the likelihood of both the survival and recovery of the species would be appreciably reduced.

I. Analytical Foundation and Key Assumptions

NMFS relied on certain assumptions when assessing effects of the proposed action on spring-run Chinook salmon, steelhead, green sturgeon, and critical habitat for these species. While minor assumptions can be found elsewhere in this biological opinion, the assumptions listed here possess a heightened importance in our ability to analyze effects of the proposed action. If new information indicates an assumption is invalid, the Corps and NMFS may be required to re-assess effects of the proposed action on these species and critical habitat and reinitiation of consultation may be warranted.

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

1. Analytical Foundation

This biological opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species.

a. Environment without Proposed Action

To analyze the effects of the proposed action, NMFS considered each easement, permit, license, contract, and agreement of which NMFS is aware and reflected on the environmental consequence of the Corp making an administrative decision not to renew. These environmental consequences were added to recreation or other conjunctive uses that are not authorized by the Corps.

b. Climate Change

Climate change is a global environmental phenomenon that would occur irrespective of any Corps operations at Englebright and Daguerre Point Dams. The impact of climate change introduces greater uncertainty into the way in which water is managed in California. Precipitation and runoff patterns are changing, creating increased uncertainty for ecosystem functions (Feng and Hu 2007). The average snowpack in the Sierra Nevada Mountains decreased by 10 percent in the last century, which translates into a loss of 1.5 million acre-feet of snowpack storage (DWR 2008). California's air temperature has already increased by 1^{o}F, mostly at night in winter, with the higher elevations experiencing the highest increase. A corresponding increase in water temperature is likely to reduce the available habitat for species that depend on cold water like spring-run Chinook salmon that require over summer holding pools. Increasing water temperatures will also accelerate biological processes that impact anadromous fish like increased algae growth and decreased dissolved oxygen (DO). Climate change will affect the effectiveness of salmon habitat restoration (Battin *et al*. 2007) and affects the entire life cycle of salmonids and sturgeon through warmer ocean periods, changes in age and size at maturity, decline in prespawn survival and fertility due to higher stream temperatures, and a loss of lower elevation habitat (Crozier *et al*. 2008).

As generally described here, and in greater detail in the biological assessment, the best available information indicates that climate change will negatively affect the Central Valley listed species and their proposed or designated critical habitats. The following are general statements in Lindley *et al*. (2007) regarding how climate change will continue to impact the Central Valley, based on their analyses of recent climate change modeling:

- The average precipitation will decline over time, while the variation in precipitation is expected to increase substantially. Extreme discharge events are predicted to become more common, as are critically dry water years. Peak monthly mean flows will generally occur earlier in the season due to a decline in the proportion of precipitation falling as snow, and earlier melting of the (reduced) snowpack (Dettinger *et al.* 2004 *op. cit*. Lindley *et al*. 2007, VanRheenen *et al*. 2004 *op. cit*. Lindley *et al*. 2007);
- Temperatures in the future will warm significantly, total precipitation may decline, and snowfall will decline significantly.
- Spring-run Chinook salmon are likely to be negatively impacted by the shift in peak discharge (needed for smolt migration), and juvenile steelhead are likely to be negatively impacted by reduced summer flows. All Central Valley salmonids are likely to be negatively affected by warmer temperatures, especially those that are in freshwater during the summer.
- Increased frequency of scouring floods might be expected to reduce the productivity of populations, as egg scour becomes a more common occurrence. The flip side of frequent flooding is the possibility of more frequent and severe droughts.

- Uncertainties abound at all levels. We have only the crudest understanding of how salmonid habitats will change and how salmonid populations will respond to those changes, given a certain climate scenario.

NMFS agrees with the above general statements, and adopts them as our assessment of the impacts of climate change for the purposes of the analysis in this biological opinion. NMFS also agrees with much of the assessment of Global Climate Change as presented in the Biological Assessment (pages 5-36 through 5-39). One notable exception is the following statement: "Presently, the lower Yuba River is one of the few Central Valley tributaries that consistently has suitable water temperatures for salmonids throughout the year." While the lower Yuba River does have generally cool water temperatures, they are not consistently suitable for salmonids throughout the year. Information presented in Yuba River Management Team (2010) confirms that water temperatures in the lower Yuba River are sometimes stressful for salmonids, particularly during the following life stages:

- Spring-run Chinook salmon adult immigration and holding;
- Steelhead adult immigration and holding;
- Steelhead spawning;
- Steelhead embryo incubation; and
- Steelhead smolt emigration.

2. Assumptions

a. The Corps will continue to own and operate Englebright and Daguerre Point dams.

b. The Corps will continue to maintain Englebright and Daguerre Point dams to assure their continued existence into the future.

c. The Corps will renew all easements, permits, and licenses associated with the proposed action and operation and maintenance of the dams, facilities, and properties.

d. The Corps has the Authority to condition easements on Federal land and to put terms and conditions in any licenses or permits for use of any physical or biological resource associated with Englebright or Daguerre Point dams and their operation and maintenance.

e. Based on the confirmed presence and observed spawning behavior of adult green sturgeon downstream of Daguerre Point Dam during the green sturgeon spawning season and the confirmed successful spawning of adult green sturgeon nearby in the Feather River, green sturgeon spawn in the Yuba River.

f. The Corps has the authority to engineer and construct modifications to Corp facilities, installations, and projects.

g. Hydraulic head and water storage associated with Englebright Dam will allow the Narrows I and Narrows II powerhouses to be conjunctively operated as they are today.

h. If not for the Daguerre Point Dam pool, the South Yuba/Brophy, Hallwood-Cordua, and Browns Valley diversions would not be operated as they are today.

i. The 10-foot falls on the Middle Yuba River are not a barrier to migrating salmonids except under low-flow conditions (per UYRSPST 2007 technical report).

j. PG&E's operational decisions at Spaulding Dam, Milton Dam, Bowman Dam, and the Bowman-Spaulding Canal affect flows and management decisions related to operation of the Narrows I Powerhouse at Englebright Dam.

k. Marine-derived nutrients (Bilby *et al.* 1996, Bilby *et al.* 1998, Moore *et al.*2007, Wipfli and Baxter 2010, Zhang *et al*. 2003) are deficient in the watershed upstream of Englebright Dam, because historical exclusion of anadromous salmonids prevents the nutrient contribution of ocean foraging spring-run Chinook salmon and Central Valley steelhead from entering the upper Yuba River watershed and contributing to the food web.

l. Fall-run Chinook salmon spawn after spring-run Chinook salmon in the same spawning locations. Based on analysis in the biological assessment the arrival timing of fall-run Chinook salmon at the Daguerre Point Dam fish ladders temporally overlaps the spawning migration timing of spring-run Chinook salmon. There is generally a 22 percent overlap of run timing, and there are up to ten times more fall-run Chinook salmon than spring-run Chinook salmon. Fall-run Chinook and spring-run Chinook have similar preferences for spawning habitat (e.g. velocities and depths).

m. New Bullards Bar Reservoir will continue to deliver cold water to the Yuba River. Due to the size of this reservoir, the amount of cold water in this reservoir, and the intake depth for the powerhouse, cold water is expected to continue to be released from this reservoir into the future.

n. Gravel availability is a limiting factor for salmon reproduction in the Yuba River downstream of Englebright Dam (Pasternack 2010a). Because the Yuba River downstream of Englebright Dam, down to Deer Creek, is devoid of spawning gravel (other than that placed by the Corps), and the Timbuctoo Bend reach is cutting down, spawning gravel is a limiting factor in the Englebright Dam reach, and a concern in other reaches.

IV. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following federally-listed anadromous species ESUs or DPSs and designated critical habitat occur in the action area and may be affected by the Corps' continued operation and maintenance of Englebright and Daguerre Point dams on the lower Yuba River, and recreational facilities on and around Englebright Reservoir:

- Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*), threatened (June 28, 2005, 70 FR 37160)
- Central Valley spring-run Chinook salmon designated critical habitat (September 2, 2005, 70 FR 52488)

- California Central Valley steelhead DPS (*O. mykiss*), threatened (January 5, 2006, 71 FR 834)
- California Central Valley steelhead designated critical habitat (September 2, 2005, 70 FR 52488)
- Southern DPS of North American green sturgeon DPS(*Acipenser medirostris*), threatened (April 7, 2006, 71 FR 17757)
- Southern population North American green sturgeon DPS critical habitat (October 9, 2009, 74 FR 52300)

A. Species and Critical Habitat Listing Status

NMFS has recently (August 2011) completed an updated status review of five Pacific salmon ESUs and one steelhead DPS, including both the Central Valley spring-run Chinook salmon ESU and Central Valley steelhead DPS, and concluded that the species' status should remain as previously listed (76 FR 50447). The 2011 Status Reviews (NMFS 2011a, NMFS 2011b) additionally stated that although the listings will remain unchanged since the 2005/2006 reviews, the status of these populations have worsened over the past five years and recommended that their status be reassessed in two to three years as opposed to waiting another five years. The status reviews in 2005 and 2006 had also concluded that the species' status should remain as previously listed (70 FR 37160 and 71 FR 834).

Central Valley spring-run Chinook salmon were listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of all spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Hatchery (FRFH) spring-run Chinook salmon population was included as part of the Central Valley spring-run Chinook salmon ESU in the 2005 modification of the Central Valley spring-run Chinook salmon listing status (70 FR 37160, June 28, 2005). Critical habitat was designated for Central Valley spring-run Chinook salmon on September 2, 2005 (70 FR 52488). It includes stream reaches such as those of the Feather and Yuba rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the main stem of the Sacramento River from Keswick Dam through the Delta; and portions of the network of channels in the northern Delta.

California Central Valley steelhead were listed as threatened under the ESA on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento and San Joaquin rivers (inclusive of and downstream of the Merced River) basins in California's Central Valley. The Coleman National Fish Hatchery and FRFH steelhead populations have been included as part of the Central Valley steelhead DPS in the 2006 modification of the Central Valley steelhead listing status (71 FR 834, January 5, 2006). These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for steelhead in the Central Valley on September 2, 2005 (70 FR 52488). Critical habitat includes the stream channels to the ordinary high water line within designated stream reaches such as those of the American, Feather, and Yuba rivers, and Deer, Mill, Battle, Antelope, and Clear creeks in the Sacramento River basin; the Calaveras, Mokelumne, Stanislaus, and Tuolumne rivers in the San Joaquin River basin; and the Sacramento and San Joaquin rivers and the entire Delta.

The Southern DPS of North American green sturgeon was listed as threatened on April 7, 2006 (71 FR 17757). The green sturgeon Southern DPS presently contains only a single spawning population within the Sacramento River basin, primarily in the main stem Sacramento River downstream of Keswick Dam but spawning has been documented to occur in the Feather River downstream of Oroville Dam and potentially in the Yuba River where adults exhibiting spawning behavior have been observed. Adults and juveniles occur within the Delta and both life history stages may occur within the action area at any time of the year. Critical habitat was designated for the Southern population North American green sturgeon DPS on October 9, 2009 (74 FR 52300). Critical habitat includes the stream channels and waterways in the Delta to the ordinary high water line except for certain excluded areas. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, and the Feather River upstream to the fish barrier dam adjacent to the FRFH. Coastal Marine areas include waters out to a depth of 60 meters from Monterey Bay, California, to the Juan De Fuca Straits in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are also included as critical habitat for the green sturgeon Southern DPS.

B. Central Valley Spring-Run Chinook Salmon

1. General Life History of Chinook Salmon

Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). “Stream-type” Chinook salmon reside in freshwater for a year or more following emergence, whereas “ocean-type” Chinook salmon migrate to the ocean (outmigrate) as fry or parr within their first year. Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over-summering by adults and/or juveniles.

Chinook salmon typically mature between 2 and 6 years of age (Myers *et al.* 1998). Freshwater entry and spawning timing generally are thought to be associated with 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). Spring-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. 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).

During their upstream migration, adult Chinook salmon require streamflows sufficient to provide olfactory and other orientation cues used to locate their natal streams. Adequate streamflows are necessary to allow adult passage to upstream holding habitat. The preferred temperature range for upstream migration is 38ºF to 56ºF (Bell 1991, CDFG 1998). Boles (1988) recommends water temperatures below 65°F for adult Chinook salmon migration, and Lindley *et al.* (2004) report that adult migration is blocked when temperatures reach 70°F, and that fish can become stressed as temperatures approach 70°F. Reclamation reports that spring-run Chinook salmon holding in upper watershed locations prefer water temperatures below 60°F; although Chinook salmon can tolerate temperatures up to 65°F before they experience an increased susceptibility to disease (Williams 2006).

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, for several days at a time, while migrating upstream (CALFED 2001a). 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 express 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 spring-run Chinook salmon in lower Mill Creek, a tributary to the Sacramento River, occurring in the 4-hour period before sunrise and again after sunset.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction, and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools (USFWS 1995). The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad. The upper preferred water temperature for spawning Chinook salmon is 55°F to 57°F (Chambers 1956, Smith 1973, Bjornn and Reiser 1991, and Snider 2001). Exposure to high temperatures prior to spawning can result in lower egg viability even if the eggs are incubated under optimum conditions (Berman 1990).

Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, freezing, disease, predation, poor gravel percolation, poor water quality, flow fluctuations, exposure to sunlight, and vibrations. Studies of Chinook salmon egg survival to hatching conducted by Shelton (1995) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. The optimal water temperature for egg incubation ranges from 41°F to 56°F [44°F to 54°F (Rich 1997), 46°F to 56°F (NMFS 1997), and 41°F to 55.4°F (Moyle 2002)]. A significant reduction in egg viability occurs at water temperatures above 57.5°F and total embryo mortality can occur at temperatures above 62°F (NMFS 1997). Alderdice and Velsen (1978) found that the upper and lower temperatures resulting in 50 percent pre-hatch mortality were 61°F and 37°F, respectively, when the incubation temperature was held constant. As water temperatures increase, the rate of embryo malformations also increases, as well as the susceptibility to fungus and bacterial infestations. The length of development for Chinook salmon embryos is dependent on the ambient water temperature to which the eggs are exposed. Colder water necessitates longer development times as metabolic processes are slowed. Within the appropriate water temperature range for embryo incubation, embryos hatch in 40 to 60 days, and the alevins (yolk-sac fry) remain in the gravel for an additional 4 to 6 weeks before emerging from the gravel.

During the 4 to 6 week period when alevins remain in the gravel, they utilize their yolk-sac to nourish their bodies. As their yolk-sac is depleted, fry begin to emerge from the gravel to begin exogenous feeding in their natal stream. Fry typically range from 25 mm to 40 mm in length at this stage. Upon emergence, fry swim or are displaced downstream (Healey 1991). The post-emergent fry disperse to the margins of their natal stream, seeking out shallow waters with slower currents, finer sediments, and bank cover such as overhanging and submerged vegetation, root wads, and fallen woody debris, and begin feeding on zooplankton, small insects, and other micro-crustaceans. During the day they may move down into the gravel for cover. Some fry may take up residence in their natal stream for several weeks to a year or more, while others are displaced downstream by the stream's current. Once started downstream, fry may continue downstream to the estuary and rear, or may take up residence in river reaches farther downstream for a period of time ranging from weeks to a year (Healey 1991).

Fry then seek riparian edge habitats containing riparian vegetation and associated substrates important for providing aquatic and terrestrial invertebrates, predator avoidance, and slower velocities for resting (NMFS 1996a). The benefits of shallow water habitats for salmonid rearing 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).

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

As fish begin their emigration, they are displaced by the river's current downstream of their natal reaches. Similar to adult movement, juvenile salmonid downstream movement is crepuscular. The daily migration of juveniles passing Red Bluff Diversion Dam (RBDD) is highest in the 4-hour period prior to sunrise (Martin *et al.* 2001). Juvenile Chinook salmon migration rates vary considerably presumably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al.* (1982) found Chinook salmon fry to travel as fast as 30 km per day in the Sacramento River, and Sommer *et al.* (2001) found travel rates ranging from approximately 0.5 miles up to more than six miles per day in the Yolo Bypass. As Chinook salmon begin the smoltification stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healey 1980, Levy and Northcote 1981).

Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, the Delta, and their tributaries (Maslin *et al.* 1997, Snider 2001). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels, and sloughs (McDonald 1960, Dunford 1975, Meyer 1979, Healey 1980). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, Sommer *et al.* 2001, MacFarlane and Norton 2002). Shallow water habitats are more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001). Optimal water temperatures for the growth of juvenile Chinook salmon in the Delta are between 54ºF to 57ºF (Brett 1952). In Suisun and San Pablo Bays, water temperatures reach 54ºF by February in a typical year. Other portions of the Delta (*i.e.*, South Delta and Central Delta) can reach 70ºF by February in a dry year. However, cooler temperatures are usually the norm until after the spring runoff has ended.

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levings 1982, Levy and Northcote 1982, Levings *et al.* 1986, Healey 1991). As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tides into shallow water habitats to feed (Allen and Hassler 1986). In Suisun Marsh, Moyle *et al.* (1989) reported that Chinook salmon fry tend to remain close to the banks and vegetation, near protective cover, and in dead-end tidal channels. Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Available data indicate that juvenile Chinook salmon use Suisun Marsh extensively both as a migratory pathway and rearing area as they move downstream to the Pacific Ocean. Juvenile Chinook salmon were found to spend about 40 days migrating through the Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallones (MacFarlane and Norton 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.

Historically, spring-run Chinook salmon occupied the upper and middle reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929).

2. Life History Characteristics Specific to Central Valley Spring-Run Chinook Salmon

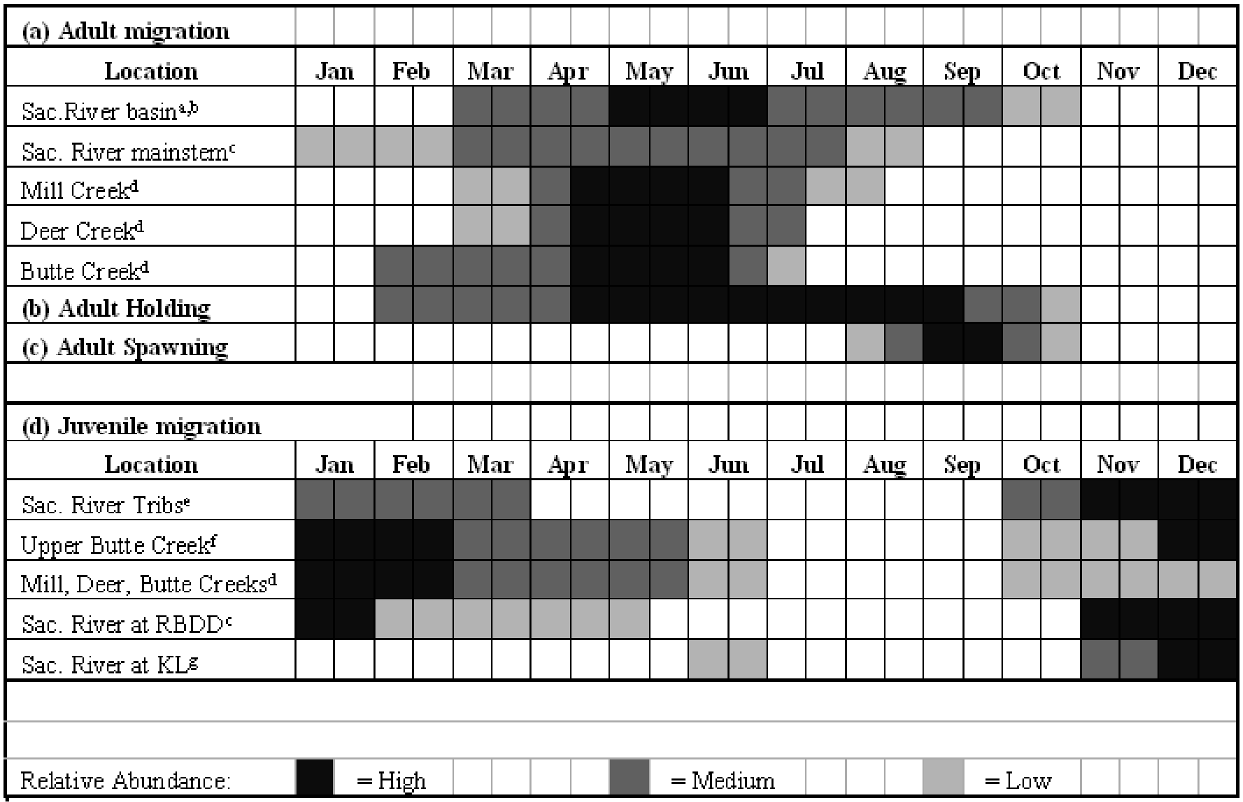
Spring-run Chinook salmon typically exhibit a stream-type life history. Adults enter freshwater in the spring, hold over the summer, spawn in the fall, and the juveniles typically spend a year or more in freshwater before emigrating. Adult spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River between March and September, primarily in May and June (Table IV-a; Yoshiyama *et al*. 1998, Moyle 2002). Lindley *et al*. (2004) indicate that adult spring-run Chinook salmon migrate from the Sacramento River into spawning tributaries 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). Reclamation (2009) reports that spring-run Chinook salmon holding in upper watershed locations prefer water temperatures below 60°F, although salmon can tolerate temperatures up to 65°F before they experience an increased susceptibility to disease.

Spring-run Chinook salmon spawning occurs between September and October depending on water temperatures. Between 56 and 87 percent of adult spring-run Chinook salmon that enter the Sacramento River basin to spawn are 3 years old (Calkins *et al.* 1940, Fisher 1994).

Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year or as juveniles or yearlings. The modal size of fry migrants at approximately 40 mm between December and April in Mill, Butte, and Deer creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al*. 2004). Studies in Butte Creek (Ward *et al*. 2002, 2003; McReynolds *et al*. 2005) found the majority of spring-run Chinook salmon migrants to be fry occurring primarily from December through February, and that these movements appeared to be influenced by flow. Small numbers of spring-run Chinook salmon remained in Butte Creek to rear and migrated as yearlings later in the year, typically the next fall. Juvenile emigration patterns in Mill and Deer creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer creek juveniles typically exhibit a later young-of-the-year migration and an earlier yearling migration (Lindley *et al*. 2004). Spring-run Chinook salmon exposed to environmental stressors have higher rates of parasitism and disease (Bartholomew *et al*. 1989, Bartholomew *et al*. 2006, Hallet and Bartholomew).

Once juveniles emerge from the gravel, they seek areas of shallow water and low velocities while they finish absorbing the yolk sac and transition to exogenous feeding (Moyle 2002). Many also will disperse downstream during high-flow events. As is the case in other salmonids, there is a shift in microhabitat use by juveniles to deeper, faster, water as they grow larger. Microhabitat use can be influenced by the presence of predators, which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002). The emigration period for spring-run Chinook salmon extends from November to early May, with up to 69 percent of the young-of-the-year fish outmigrating through the lower Sacramento River and Delta during this period (CDFG 1998). Spring-run Chinook salmon juveniles have been observed rearing in the lower reaches of non-natal tributaries and intermittent streams in the Sacramento Valley during the winter months (Maslin *et al.* 1997, Snider 2001). Peak movement of juvenile (yearling) spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April for young-of-the-year juveniles. However, juveniles also are observed between November and the end of May (Snider and Titus 2000). Based on the available information, the emigration timing of spring-run Chinook salmon appears highly variable (CDFG 1998). Some fish may begin emigrating soon after emergence from the gravel, whereas others over summer and emigrate as yearlings with the onset of intense fall storms (CDFG 1998).

Table IV-a. The temporal occurrence of migrating adult (a-c) and outmigrating juvenile (d) Central Valley spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance. Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Young of-the-year spring-run Chinook salmon emigrate during the first spring after they hatch.



(a) Adult migration

Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac.River basin[a,b]					▨	▨	▨	▨	■	■	■	■	▨	▨	▨	▨	▨	▨	░	░				
Sac. River mainstem[c]	░	░	░	░	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	░	░								
Mill Creek[d]					░	░	▨	■	■	■	■	▨	▨	░	░									
Deer Creek[d]					░	░	▨	■	■	■	■	▨	▨											
Butte Creek[d]			▨	▨	▨	▨	▨	■	■	■	■	▨	░											
(b) Adult Holding			▨	▨	▨	▨	▨	■	■	■	■	■	■	■	■	■	■	▨	▨	░				
(c) Adult Spawning															░	▨	■	■	▨	░				

(d) Juvenile migration

Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac. River Tribs[e]	▨	▨	▨	▨	▨	▨													▨	▨	■	■	■	■
Upper Butte Creek[f]	■	■	■	■	▨	▨	▨	▨	▨	▨	░	░							░	░	░	░	■	■
Mill, Deer, Butte Creeks[d]	■	■	■	■	▨	▨	▨	▨	▨	▨	░	░							░	░	░	░	░	░
Sac. River at RBDD[c]	■	■	░	░	░	░	░	░	░												■	■	■	■
Sac. River at KL[g]											░	░									▨	▨	■	■

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

Sources: [a]Yoshiyama *et al*. (1998); [b]Moyle (2002); [c]Myers *et al*. (1998); [d]Lindley *et al*. (2004); [e]CDFG (1998); [f]McReynolds *et al*. (2005); Ward *et al*. (2002, 2003); [g]Snider and Titus (2000)

3. Range-Wide (ESU) Status and Trends of Central Valley Spring-Run Chinook Salmon

Historically, spring-run Chinook salmon were the second most abundant salmon run in the Central Valley (CDFG 1998). The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). Before the construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry 1961). Construction of other low elevation dams in the foothills of the Sierras on the American, Mokelumne, Stanislaus, Tuolumne, and Merced rivers extirpated spring-run Chinook salmon from these watersheds. Naturally-spawning populations of spring-run Chinook salmon currently are restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (CDFG 1998). However, only Deer, Mill, and Butte creeks are considered to be independent spring-run Chinook salmon populations. The other tributary populations are considered dependent populations, which rely on the three independent populations for continued existence at this time.

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the FRFH. From 1986 to 2007, the average number of spring-run Chinook salmon returning to the FRFH was 3,992, compared to an average of 12,888 spring-run Chinook salmon returning to the entire Sacramento River Basin (Table IV-b). Coded wire tag information from these hatchery returns indicates substantial introgression has occurred between spring-run Chinook salmon and fall-run Chinook salmon populations within the Feather River system due to hatchery practices. Because Chinook salmon have not always been temporally separated in the hatchery, spring-run Chinook salmon and fall-run Chinook salmon have been spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon 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 two fish in 1978 to 2,908 in 1964. However, the genetic integrity of this population is questionable because of the significant temporal and spatial overlap between spawning populations of spring-run Chinook salmon and fall-run Chinook salmon (Good *et al*. 2005). For the reasons discussed above, and the importance of genetic diversity as one of the VSP parameters, the Feather River spring-run Chinook salmon population numbers are not included in the following discussion of ESU abundance trends.

In addition, monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates some spawning occurs in the river. Here, the potential to physically separate spring-run Chinook salmon from fall-run Chinook salmon is complicated by overlapping migration and spawning periods. Significant hybridization with fall-run Chinook salmon has made identification of a spring-run Chinook salmon in the mainstem very difficult to determine, and there is speculation as to whether a true spring-run Chinook salmon population still exists downstream of Keswick Dam. Although the physical habitat conditions downstream of Keswick Dam is capable of supporting spring-run Chinook salmon, some years have had high water temperatures resulting in substantial levels of egg mortality. Redd surveys conducted in September between 2001 and 2011 have observed an average of 36 salmon redds from Keswick Dam downstream to the Red Bluff Diversion Dam. This is typically when spring-run spawn; however, these redds also could be early-spawning fall-run Chinook salmon. Therefore, even though physical habitat conditions may be suitable, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic integrity and diversity. With the onset of fall-run Chinook salmon spawning occurring in the same time and place as potential spring-run Chinook salmon spawning, it is likely to have caused extensive introgression between the populations (CDFG 1998). For these reasons, Sacramento River mainstem spring-run Chinook salmon are not included in the following discussion of ESU abundance trends.

The Central Valley spring-run Chinook salmon tributary populations have displayed broad fluctuations in adult abundance, ranging from 1,013 in 1993 to 23,788 in 1998 (Table IV-b, figure IV-a). Sacramento River tributary populations in Mill, Deer, and Butte creeks are probably the best trend indicators for the spring-run Chinook salmon ESU as a whole because these streams contain the primary independent populations within the ESU. Until recently, these streams have shown a positive escapement trend since 1991. Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 spring-run Chinook salmon from 1995 to 2006. During this same period, adult returns have averaged 798 spring-run Chinook salmon on Mill Creek, and 1,544 spring-run Chinook salmon on Deer Creek. Even though recent trends are positive, annual abundance estimates displayed a high level of fluctuation, and the overall number of spring-run Chinook salmon remains well below estimates of historic abundance. Fluctuations may be attributable to poor ocean conditions that exist when the returning adults enter the ocean as smolts leading 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 Chinook salmon over-summering in Butte Creek. In 2002, this contributed to the pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek. From 2007 to 2011 most spring-run Chinook salmon population numbers have shown a steady decrease, resulting in the tributary population's five-year average of 3,961, the lowest five-year average since before 1998. Overall escapements have declined over the past 10 years, in particular since 2006.

At the ESU level, the reestablishment of spring-run Chinook salmon into Battle Creek (persisting since around 1995), through a large restoration project that has increased flows, and removed barriers to habitat; and the increasing abundance of spring-run Chinook salmon in Clear Creek due to efforts to enhance oversummering flows in the upper reaches downstream of Whiskeytown Dam, maintain suitable water temperatures in those reaches, enhance spawning habitat through gravel augmentation, and prevent genetic introgression with fall-run Chinook salmon which utilize the same watershed, are improving the status of Central Valley spring-run Chinook salmon. Further efforts will need to involve more than restoration of currently accessible watersheds. The Draft Recovery Plan calls for reestablishing populations into historical habitats currently blocked by large dams, such as those underway to establish spring-run Chinook salmon production in the San Joaquin River downstream of Friant Dam, a population upstream of Shasta Dam, and to facilitate passage of fish upstream of Englebright Dam on the Yuba River will be needed to improve the species viability (NMFS 2009).

The Butte, Deer, and Mill creek populations of spring-run Chinook salmon are in the Northern Sierra Nevada diversity group. Lindley *et al*. (2007) indicated that spring-run Chinook salmon populations in Butte and Deer Creeks had a low risk of extinction, according to their PVA model and the other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence). The Mill Creek population of spring-run Chinook salmon is at moderate extinction risk according to the PVA model, but appears to satisfy the other viability criteria for low-risk status. However, the spring-run Chinook salmon ESU fails to meet the “representation and redundancy rule,” because the Northern Sierra Nevada is the only diversity group in the spring-run Chinook salmon ESU that contains a demonstrably viable population. Independent populations of spring-run Chinook salmon only occur within the Northern Sierra Nevada diversity group. The Northwestern California diversity group contains a few ephemeral populations of spring-run Chinook salmon that are likely currently dependent on the Northern Sierra Nevada populations for their continued existence. The spring-run Chinook salmon populations that historically occurred in the Basalt and Porous Lava, and Southern Sierra Nevada, diversity groups have been extirpated, although a small population in Battle Creek has been reestablished and persisting over the last 15 years. Over the long term, the three remaining independent populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in the Deer, Mill, and Butte Creek watersheds due to their close proximity to each other. One large event could eliminate all three populations.

Table IV-b. Central Valley spring-run Chinook salmon population estimates with corresponding cohort replacement rates (CRR) for years since 1986 (CDFG 2008).

Year	Sacramento River Basin Escapement Run Size[a]	FRFH Population	Tributary Populations	5-Year Moving Average of Trib Population Estimate	Trib CRR[b]	5-Year Moving Average of Trib CRR	5-Year Moving Average of Basin Population Estimate	Basin CRR	5-Year Moving Average of Basin CRR
1986	3,638	1,433	2,205						
1987	1,517	1,213	304						
1988	9,066	6,833	2,233						
1989	7,032	5,078	1,954		0.89			1.93	
1990	3,485	1,893	1,592	1658	5.24		4948	2.30	
1991	5,101	4,303	798	1376	0.36		5240	0.56	
1992	2,673	1,497	1,176	1551	0.60		5471	0.38	
1993	5,685	4,672	1,013	1307	0.64	1.54	4795	1.63	1.36
1994	5,325	3,641	1,684	1253	2.11	1.79	4454	1.04	1.18
1995	14,812	5,414	9,398	2814	7.99	2.34	6719	5.54	1.83
1996	8,705	6,381	2,324	3119	2.29	2.73	7440	1.53	2.03
1997	5,065	3,653	1,412	3166	0.84	2.77	7918	0.95	2.14
1998	30,534	6,746	23,788	7721	2.53	3.15	12888	2.06	2.23
1999	9,838	3,731	6,107	8606	2.63	3.26	13791	1.13	2.24
2000	9,201	3,657	5,544	7835	3.93	2.44	12669	1.82	1.50
2001	16,869	4,135	12,734	9917	0.54	2.09	14301	0.55	1.30
2002	17,224	4,189	13,035	12242	2.13	2.35	16733	1.75	1.46
2003	17,691	8,662	9,029	9290	1.63	2.17	14165	1.92	1.43
2004	13,612	4,212	9,400	9948	0.74	1.79	14919	0.81	1.37
2005	16,096	1,774	14,322	11704	1.10	1.23	16298	0.93	1.19
2006	10,948	2,181	8,767	10911	0.97	1.31	15114	0.62	1.21
2007	9,726	2,674	7,052	9714	0.75	1.04	13615	0.71	1.00
2008	6,368	1,624	4,744	8857	0.33	0.78	11350	0.40	0.69
2009	3,801	989	2,812	7539	0.32	0.69	9388	0.35	0.60
2010	3,792	1,661	2,131	5101	0.30	0.54	6927	0.39	0.49
2011	4,967	1,900	3,067	3961	0.65	0.47	5731	0.78	0.53
Median	7,869	3,655	2,940	7,630	0.89	1.79	10,369	0.95	1.36

[a] NMFS is only including the escapement numbers from the Feather River Fish Hatchery (FRFH) and the Sacramento River tributaries in this table. Sacramento River Basin run size is the sum of the escapement numbers from the FRFH and the tributaries.

[b] Abbreviations: CRR = Cohort Replacement Rate, Trib = tributary

[c] The majority of spring-run spawners are 3 years old. Therefore, NMFS calculated the CRR using the spawning population of a given year, divided by the spawning population 3 years prior.

the last 15 years. Over the long term, the three remaining independent populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in the Deer, Mill, and Butte Creek watersheds due to their close proximity to each other. One large event could eliminate all three populations.

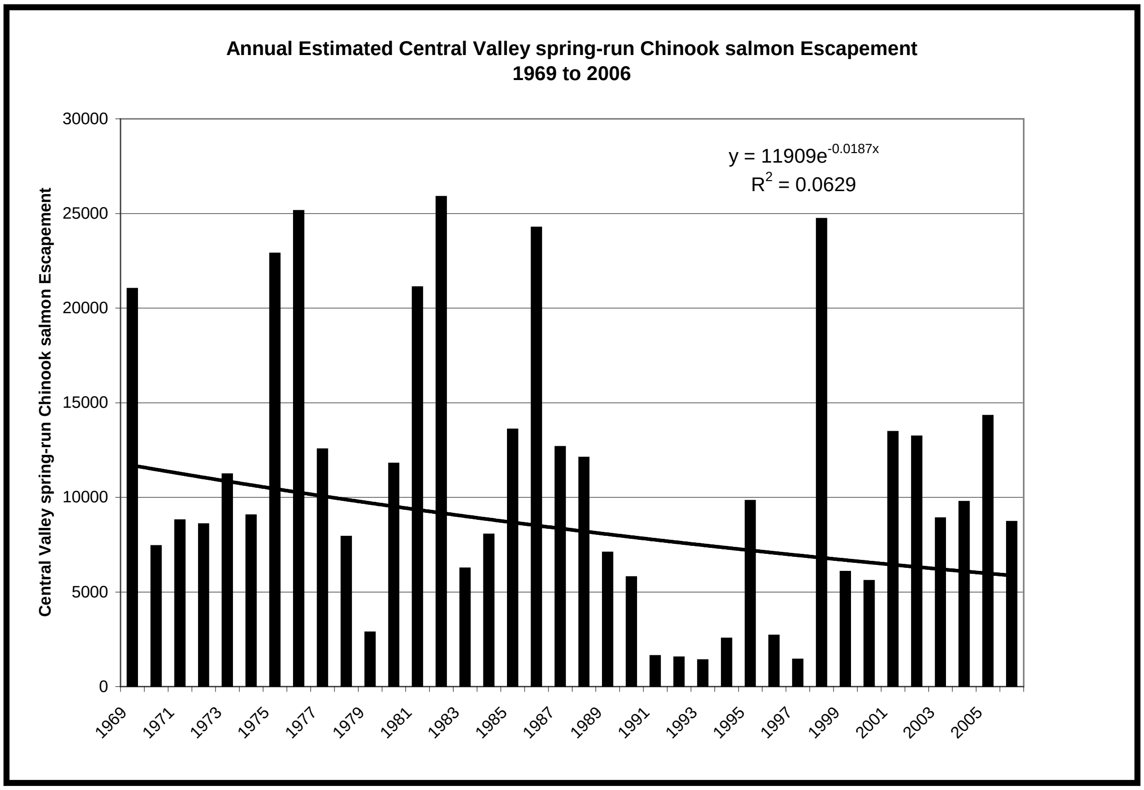


Figure IV-a. Annual estimated Central Valley spring-run Chinook salmon escapement population for the Sacramento River watershed for years 1969 through 2006 (PFMC 2002, 2004, CDFG 2004b, Yoshiyama 1998, GrandTab 2006).

4. Viability of Central Valley Spring-Run Chinook Salmon ESU

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

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

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

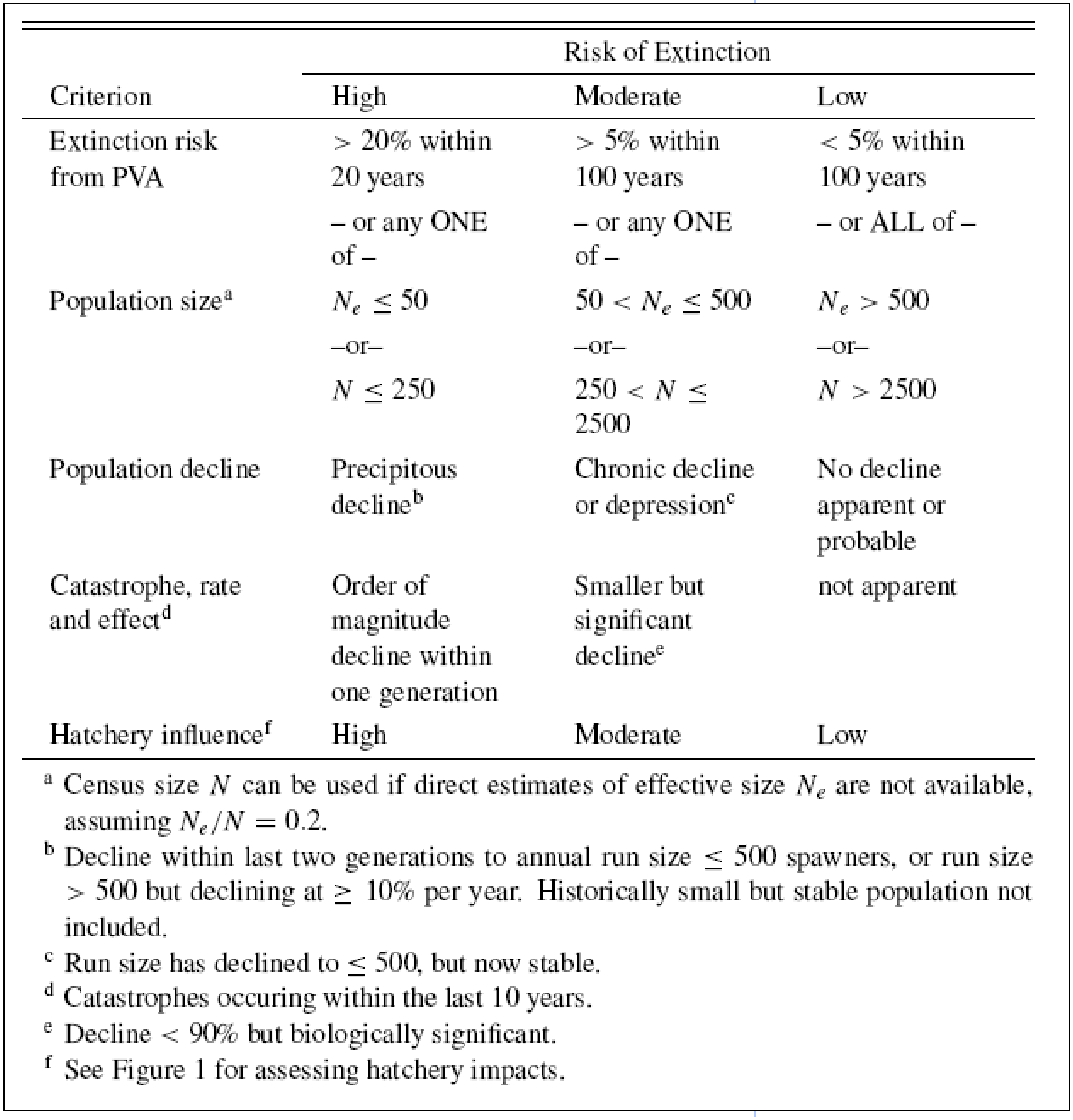
Although Lindley *et al*. (2007) did not provide numerical goals for each population of Pacific salmonid to be categorized at low risk for extinction, they did provide various quantitative criteria to evaluate the risk of extinction (Table IV-c). A population must meet all the low-risk thresholds to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

a. Population Size

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

As provided in Table IV-b, Central Valley spring-run Chinook salmon declined drastically in the mid to late 1980s before stabilizing at very low levels in the early to mid-1990s. From 1995 through 2006 the tributary populations showed a positive escapement trend with an average of 9,655. Abundance is generally dominated by the Butte Creek population. Other independent and dependent populations are smaller. Until recently, the five-year moving average cohort replacement rate of the tributary populations remained above 1.0 from 1995 to 2007. In the most recent years we have seen another decline, with the five-year moving average of the tributary populations reaching a low of 3,961 (the lowest since 1997).

Table IV-c. Criteria for assessing the level of risk of extinction for populations of Pacific salmonids (reproduced from Lindley *et al*. 2007).



	Risk of Extinction		
Criterion	High	Moderate	Low
Extinction risk from PVA	> 20% within 20 years	> 5% within 100 years	< 5% within 100 years
	– or any ONE of –	– or any ONE of –	– or ALL of –
Population size[a]	$N_e \leq 50$	$50 < N_e \leq 500$	$N_e > 500$
	–or–	–or–	–or–
	$N \leq 250$	$250 < N \leq 2500$	$N > 2500$
Population decline	Precipitous decline[b]	Chronic decline or depression[c]	No decline apparent or probable
Catastrophe, rate and effect[d]	Order of magnitude decline within one generation	Smaller but significant decline[e]	not apparent
Hatchery influence[f]	High	Moderate	Low

[a] Census size N can be used if direct estimates of effective size N_e are not available, assuming $N_e/N = 0.2$.

[b] Decline within last two generations to annual run size $\leq$ 500 spawners, or run size > 500 but declining at $\geq$ 10% per year. Historically small but stable population not included.

[c] Run size has declined to $\leq$ 500, but now stable.

[d] Catastrophes occuring within the last 10 years.

[e] Decline < 90% but biologically significant.

[f] See Figure 1 for assessing hatchery impacts.

b. Population Growth Rate

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

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

c.   Spatial Structure

In general, there is less information available on how spatial processes relate to salmonid viability than there is for the other VSP parameters (McElhany *et al.* 2000). Understanding the spatial structure of a population is important because the population structure can affect evolutionary processes and, therefore, alter the ability of a population to adapt to spatial or temporal changes in the species' environment (McElhany *et al*. 2000).

Lindley *et al*. (2007) indicated that of the 19 independent populations of spring-run Chinook salmon that occurred historically, only three (Butte, Mill, and Deer creeks) remain, and their current distribution makes the spring-run Chinook salmon ESU vulnerable to catastrophic disturbance. Butte, Mill, and Deer Creeks all occur in the same biogeographic region (diversity group), whereas historically, independent spring-run Chinook salmon populations were distributed throughout the Central Valley among at least three diversity groups (*i.e.*, basalt and porous lava, northern Sierra Nevada, and southern Sierra Nevada). In addition, dependent spring-run Chinook salmon populations historically persisted in the Northwestern California diversity group (Lindley *et al*. 2004). Currently, there are dependent populations of spring-run Chinook salmon in the Big Chico, Antelope, Clear, Thomes, Battle, and Beegum creeks, and in the Sacramento, Feather, and Yuba rivers (Lindley *et al*. 2007).

d.   Diversity

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

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

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

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

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

The most recent viability assessment of Central Valley spring-run Chinook salmon was conducted during NMFS' 2011 status review (NMFS 2011a). This review found that the biological status of the ESU has worsened since the last status review recommend that its status be reassessed in two to three years as opposed to waiting another five years, if it does not respond positively to improvements in environmental conditions and management actions.

C. Central Valley Steehead

1. General Life History

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

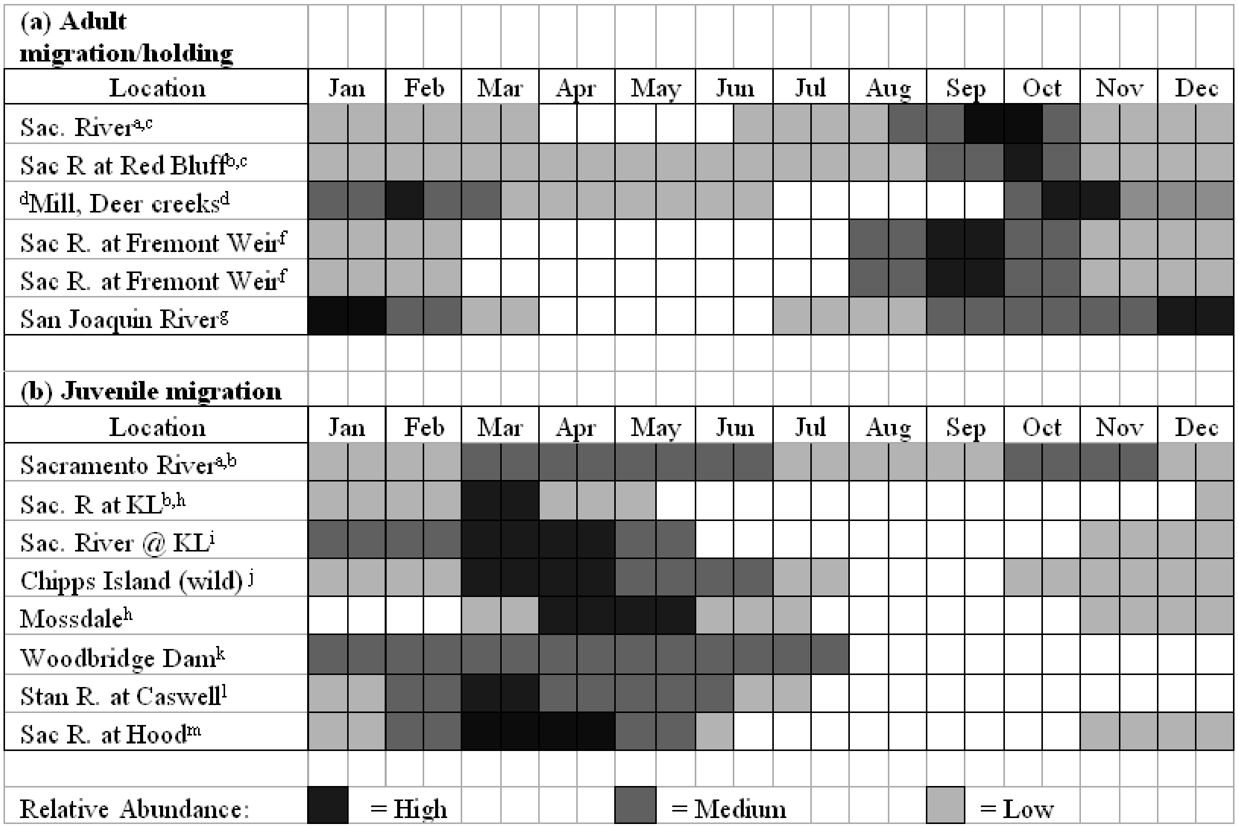
Central Valley steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April, with peaks from January though March, in small streams and tributaries where cool, well oxygenated water is available year-round (Table IV-d; Hallock *et al.* 1961, McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches at river mouths, and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Barnhart 1986, Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams.

Spawning occurs during winter and spring months. The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of steelhead eggs in hatcheries takes about 30 days at 51°F. Fry emerge from the gravel usually about 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can affect emergence timing (Shapovalov and Taft 1954). Newly emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

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

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

Table IV-d. The temporal occurrence of (a) migrating/holding adult and (b) outmigrating juvenile Central Valley steelhead in the Central Valley. Darker shades indicate months of greatest relative abundance.



(a) Adult migration/holding																								
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac. River[a,c]	░	░	░	░	░	░						░	░	░	░	▨	▨	■	■	▨	░	░	░	░
Sac R at Red Bluff[b,c]	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	▨	▨	■	▨	░	░	░	░
[d]Mill, Deer creeks[d]	▨	▨	■	▨	▨	░	░	░	░	░	░	░							▨	■	■	░	░	░
Sac R. at Fremont Weir[f]	░	░	░	░											▨	▨	■	■	▨	▨	░	░	░	░
Sac R. at Fremont Weir[f]	░	░	░	░											▨	▨	■	■	▨	▨	░	░	░	░
San Joaquin River[g]	■	■	▨	▨	░	░							░	░	░	░	▨	▨	▨	▨	▨	▨	■	■
(b) Juvenile migration																								
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sacramento River[a,b]	░	░	░	░	▨	▨	▨	▨	▨	▨	▨	▨	░	░	░	░	░	░	▨	▨	▨	▨	░	░
Sac. R at KL[b,h]	░	░	░	░	■	■	░	░	░															░
Sac. River @ KL[i]	▨	▨	▨	▨	■	■	■	■	▨	▨											░	░	░	░
Chipps Island (wild)[j]	░	░	░	░	■	■	■	■	▨	▨	▨	▨	░	░					░	░	░	░	░	░
Mossdale[h]					░	░	■	■	■	■	░	░	░								░	░	░	░
Woodbridge Dam[k]	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨										
Stan R. at Caswell[l]	░	░	▨	▨	■	■	▨	▨	▨	▨	▨	░	░											
Sac R. at Hood[m]	░	░	▨	▨	■	■	■	■	▨	▨	░										░	░	░	░
Relative Abundance:	■	= High							▨	= Medium							░	= Low						

Sources: [a]Hallock *et al.* (1961); [b]McEwan (2001); [c]USFWS (unpublished data); [d]CDFG (1995); [e]Hallock *et al.* (1957); [f]Bailey (1954); [g]CDFG Steelhead Report Card Data; [h]CDFG (unpublished data); [i]Snider and Titus (2000); [j]Nobriga and Cadrett (2003); [k]Jones & Stokes Associates, Inc. (2002); [l]S.P. Cramer and Associates, Inc. (2000, 2001); [m]Schaffter (1980, 1997)

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) also have verified these temporal findings based on analysis of captures at Chipps Island, Suisun Bay.

2. Range-Wide (DPS) Status and Trends

Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially (figure IV-b). Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River. Steelhead counts at the RBDD declined from an average of approximately 8,000 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Nobriga and Cadrett (2003) compared coded-wire-tagged and untagged (wild) steelhead smolt catch ratios at Chipps Island trawl from 1998 through 2001 to estimate that about 100,000 to 300,000 steelhead juveniles are produced naturally each year in the Central Valley. Good *et al.* (2005) made the following conclusion based on the Chipps Island data:

> "If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1 percent of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire Central Valley. This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s."

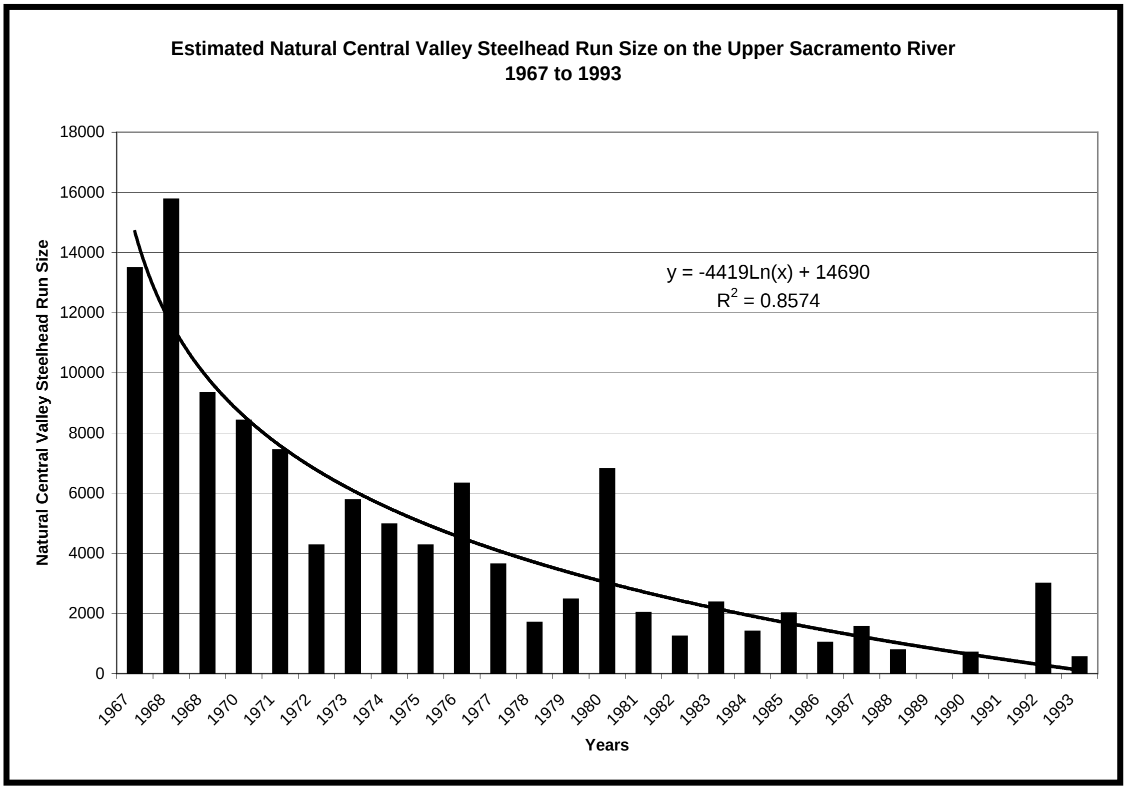


Figure IV-b. Estimated natural Central Valley steelhead escapement in the upper Sacramento River based on RBDD counts. Note: Steelhead escapement surveys at RBDD ended in 1993 (from McEwan and Jackson 1996).

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). Snorkel surveys from 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.

Recent monitoring has detected small, self-sustaining populations (*i.e.*, non-hatchery origin) of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000, 2001). Zimmerman *et al.* (2008) documented Central Valley steelhead in the Stanislaus, Tuolumne and Merced rivers based on otolith microchemistry.

It is possible that naturally-spawning populations exist in many other streams but are undetected due to lack of monitoring programs (Interagency Ecological Program Steelhead Project Work Team 1999). Incidental catches and observations of juvenile steelhead also have occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good *et al*. 2005). CDFG staff has prepared catch summaries for juvenile migrant Central Valley steelhead on the San Joaquin River near Mossdale, which represents migrants from the Stanislaus, Tuolumne, and Merced rivers. Based on trawl recoveries at Mossdale between 1988 and 2002, as well as 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” (figure IV-c). 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 depressed.

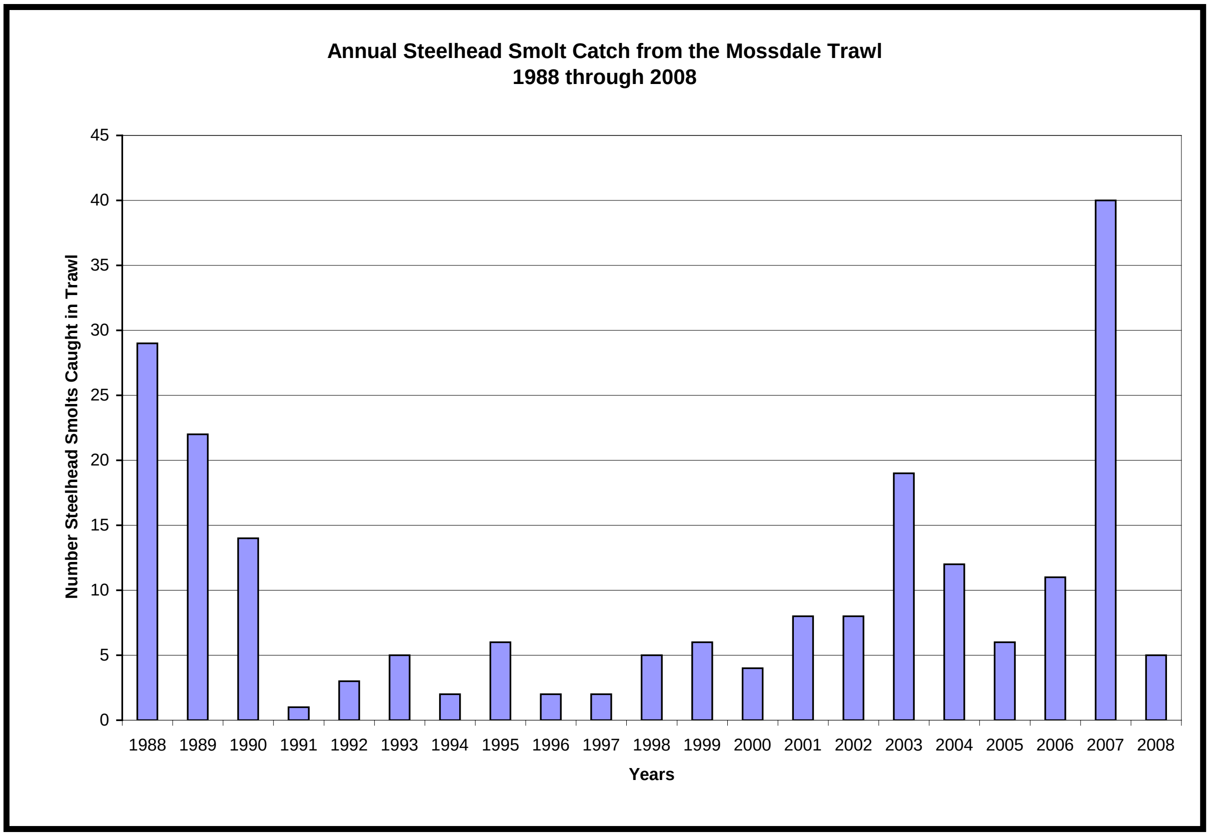


Figure IV-c. Annual number of Central Valley steelhead smolts caught while Kodiak trawling at the Mossdale monitoring location on the San Joaquin River (Marston 2004, SJRGA 2007, Speegle 2008).

3. Viability of the Central Valley Steelhead DPS

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

Table IV-c provides various quantitative criteria to evaluate the risk of extinction. The following provides the evaluation of the likelihood of the threatened Central Valley steelhead DPS becoming viable based on the VSP parameters of population size, population growth rate, spatial structure, and diversity.

a. Population Size

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

b. Population Growth Rate

An estimated 100,000 to 300,000 natural juvenile steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good *et al.* 2005). Concurrently, one million in-DPS hatchery steelhead smolts and another half million out-of-DPS hatchery steelhead smolts are released annually in the Central Valley. The estimated ratio of nonclipped to clipped steelhead has decreased from 0.3 percent to less than 0.1 percent, with a net decrease to one-third of wild female spawners from 1998 to 2000 (Good *et al.* 2005). Recent data from the Chipps Island fish monitoring trawls indicates that in recent years over 90 percent of captured steelhead smolts have been of hatchery origin. In 2010, the data indicated hatchery fish made up 95 percent of the catch.

c. Spatial Structure

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

d. Diversity

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

Analysis of natural and hatchery steelhead stocks in the Central Valley reveal genetic structure remaining in the DPS (Nielsen *et al.* 2003). There appears to be a great amount of gene flow among upper Sacramento River basin stocks, due to the post-dam, lower basin distribution of steelhead and management of stocks. Recent reductions in natural population sizes have created genetic bottlenecks in several Central Valley steelhead stocks (Good *et al.* 2005; Nielsen *et al.* 2003). The out-of-basin steelhead stocks of the Nimbus and Mokelumne river hatcheries are currently not included in the Central Valley steelhead DPS. However, recent work (Garza and Pearse 2008) has identified introgression of stray domestic rainbow trout genes with steelhead, which may be occurring either during egg taking practices in hatcheries or in-river spawning between domesticated strains of rainbow trout and steelhead. Garza and Pearse (2008) also found that all below-dam steelhead populations in the Central Valley were genetically closely related and that these populations had a high level of genetic similarity to populations of steelhead in the Klamath and Eel river basins. This genetic data suggests that the progeny of out-of basin steelhead reared in the Nimbus and Mokelumne river hatcheries have become widely introgressed with natural steelhead populations throughout the anadromous sections of rivers and streams in the Central Valley, including the tail-water sections downstream of impassable dams. This suggests the potential for the loss of local genetic diversity and population structure over time in these waters. Their work also indicates that in contrast to the similarity of the steelhead genetics downstream of dams in the Central Valley, the ancestral genetic structure is still relatively intact upstream of the impassable barriers. This would indicate that extra precautions should be included in restoration plans before above-dam access is provided to the steelhead from the below-dam populations in order to maintain genetic heritage and structure in *O. mykiss* populations upstream of dams.

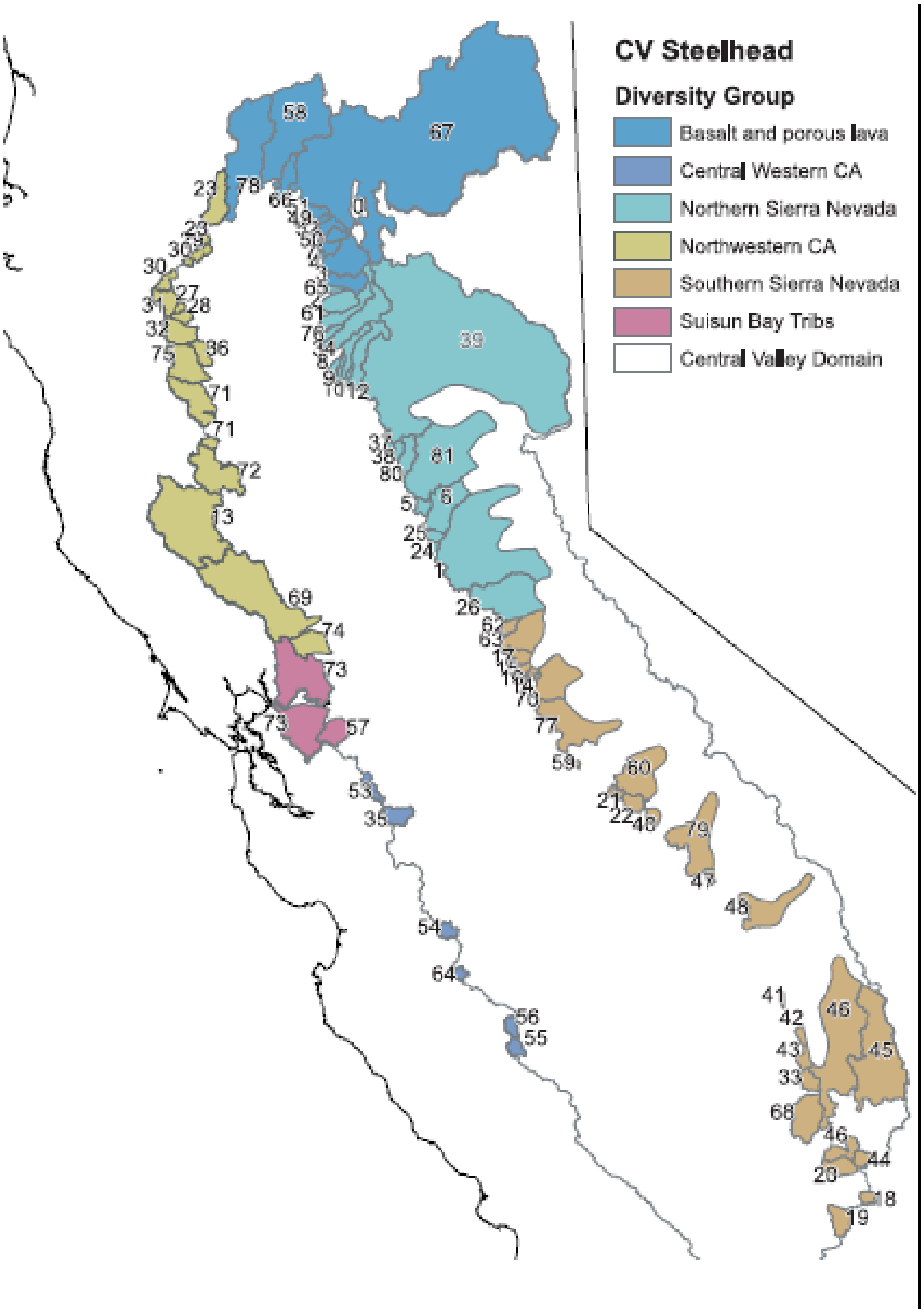


Figure IV-d. Central Valley steelhead[4] **diversity groups (replicated from Lindley *et al*. 2007).**

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[4] Note that the Suisun Bay tributaries identified in the figure (in pink) belong in the CCC steelhead DPS (see section 4.1.1).

4. Summary of Central Valley Steelhead DPS Viability

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

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

D. Green Sturgeon Southern DPS

In North America, spawning populations of green sturgeon are currently found in three river systems: the Sacramento and Klamath rivers in California and the Rogue River in southern Oregon. The green sturgeon Southern DPS includes all green sturgeon populations south of the Eel River, with the main spawning population in the Sacramento River and some of its tributaries, including the Feather and Yuba rivers. Green sturgeon life history can be broken down into four main stages: adult upstream migration and spawning, egg incubation and larval development, juvenile and sub-adult rearing and migration, and ocean residence.

The threats faced by the green sturgeon include loss of historic spawning, lack of population monitoring data, vulnerability of long-term cold water supply for egg incubation and larval survival downstream of dams, loss of juvenile green sturgeon due to entrainment at the fish collection facilities in the South Delta and agricultural diversions within the Sacramento River and Delta systems, alterations of food resources due to changes in the Sacramento River and Delta habitats, and exposure to various sources of contaminants throughout the basin to juvenile, sub-adult, and adult life stages. The long-term viability of the green sturgeon Southern DPS is at risk due to substantial population declines, reduction in spatial distribution and loss of diversity associated with small population size and limited distribution, and degraded habitat conditions, upstream passage impediments and dams and flood control weirs, and entrainment risks throughout their migratory corridors.

1. General Life History

a. Adult Upstream Migrations and Spawning

Adult green sturgeon are are believed to spawn every two to five years (Beamesderfer *et al.* 2007). Upon maturation of their gonadal tissue, but prior to ovulation or spermiation, the adult fish enter freshwater and migrate upriver to their spawning grounds.

Spawning migrations from the ocean into freshwater generally occur from February through June based on observations in the Klamath (Moyle *et al*. 1995, Belchik 2005, Hillemeier 2005), Rogue (Erickson *et al*. 2002, Erickson & Webb 2005), and Sacramento rivers (Brown 2002, CH2M Hill 2002) (Table IV-e). Heublein *et al*. (2006) reported that Sacramento River green sturgeon begin their upstream spawning migrations into the San Francisco Bay in March and reach Knights Landing during April. Green sturgeon are reported to enter the Klamath River beginning in March (Van Eenennaam *et al*. (2006). Freshwater spawning migrations range from up to 100 miles (161 km) in the Klamath and Rogue rivers to 300 miles in the Sacramento River (Brown 2007). Subadults may also migrate upstream into the natal rivers concurrent with the adult spawning migration, but for unknown purposes (73 FR 52084).

Currently spawning appears to occur primarily in the Sacramento River upstream of RBDD, based on the recovery of eggs and larvae at the dam in monitoring studies (Gaines and Martin 2002, Brown 2007). However, successful spawning was documented in spring 2011 in the Feather River by the California Department of Water Resources, and spawning adults were also observed in the Yuba River downstream of Daguerre Point Dam. Sacramento River spawning is estimated to occur from late April through July with a peak in May based on back-calculations from larvae captured in rotary screw traps downstream of Red Bluff Diversion Dam (Gaines and Martin 2002) and development periods determined in the laboratory (Deng *et al*. 2002). In the Klamath River, the primary spawning period is mid-April to June (Van Eenennaam *et al*. 2006).

Female green sturgeon are typically 13 to 27 years old when sexually mature and have a total body length (TL) ranging between 145 and 205 cm at sexual maturity (Nakamoto *et al*. 1995, Van Eenennaam *et al.* 2006). Male green sturgeon become sexually mature at a younger age and smaller size than females. Typically, male green sturgeon reach sexual maturity between 8 and 18 years of age and have a TL ranging between 120 cm to 185 cm (Nakamoto *et al.* 1995, Van Eenennaam *et al.* 2006). The variation in the size and age of fish upon reaching sexual maturity is a reflection of their growth and nutritional history, genetics, and the environmental conditions they were exposed to during their early growth years.

Adult female green sturgeon produce between 60,000 and 140,000 eggs, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al*. 2001). They have the largest egg size of any sturgeon, and the volume of yolk ensures an ample supply of energy for the developing embryo.

Specific spawning behavior, sites and habitat requirements have not been identified for green sturgeon. Attempts to locate and sample specific spawning sites of green sturgeon have been as yet unsuccessful (Brown 2007). Sturgeon are typically broadcast spawners over rocky substrate.

Eggs discharged by each female are fertilized by one to several attending males. Males aggregate in spawning areas where they may remain for days or weeks. Females typically approach male aggregations to initiate spawning which they complete within a relatively short period of hours. Spawning activity is often associated with chasing, splashing, and breaching.

Preferred spawning habitats of green sturgeon are thought to include turbulent areas in close association with deep pools (CDFG 2002; Moyle 2002; Adams *et al*. 2002). Spawning most likely occurs over substrates ranging from clean sand to bedrock, with preferences for cobble substrates (Emmett *et al*. 1991; Moyle *et al*. 1995; Moyle 2002). Eggs adhere to the substrate or settle into crevices (Moyle *et al*. 1995; Deng 2000; Van Eenennaam *et al*. 2001; Deng *et al*. 2002).

Spawning occurs in rivers and months of cool river temperatures. Adult green sturgeon occur in the Sacramento River when temperatures are between 8–14°C (Moyle 2002). Water temperature may vary between 8°C and 21°C during the primary spawning period in the Klamath River. Optimum flow requirements for spawning are unclear, but spawning success in most sturgeons is related to these factors (Detlaff *et al*. 1993, Beamesderfer and Farr 1997). During the spawning months, average daily water flow ranged from 198–306 m^3/s in the Sacramento River (Brown 2007), 58–292 m^3/s in the Rogue River (Erickson and Webb 2007). Spawning may be triggered by small increases in water flow (Schaffter 1997; Brown 2007).

Adults may migrate downstream soon after spawning, or reside near spawning areas over the summer before emigrating in the until late fall or early winter. Adult green sturgeon mortalities downstream of Red Bluff Diversion Dam observed in late May and early June of 2007 were thought to have been killed during downstream passage following spawning. Vogel (2005) observed significant numbers of adult green sturgeon the Sacramento River upstream of Hamilton City (RM 201-205) from July to November. Anglers also regularly report catching adult green sturgeon in the upper and middle reaches of the Sacramento River during summer (Beamesderfer *et al*. 2004). Telemetry studies on the Rogue River found that adult green sturgeon held for as much as six months in deep (>5 m, 16.4 ft), low gradient reaches or off-channel sloughs or coves of the river during summer months when water temperatures were between 59°F and 73°F (Erickson *et al*. 2002). When ambient temperatures in the river dropped in autumn and early winter (<50°F), and flows increased, fish moved downstream and into the ocean. In addition, Erickson *et al*. (2002) found individual green sturgeon adults spend up to six months in freshwater.

Figure IV-e shows the timing of adult upstream migration and spawning and the relation to water temperature and river flow. Table IV-e shows the timing of adult migration and spawning in the Sacramento River system.

b. Egg Incubation and Larval Development

Green sturgeon eggs are the largest of any sturgeon species, ranging from 4.0–4.7 mm in diameter (Cech *et al*. 2000; Van Eenennaam *et al*. 2001; Van Eenennaam *et al*. 2006). Large size indicates that female green sturgeon invest a greater amount of their reproductive resources into maternal yolk for nourishment of the embryo, which results in larger larvae and may confer a survival advantage (Van Eenennaam *et al*. 2001). Larvae are 13–15 mm in length at hatching (Van Eenennaam *et al*. 2001; Deng *et al*. 2002). Compared with other acipenserids, green sturgeon larvae appear more robust and easier to rear in the laboratory (Van Eenennaam *et al*. 2001).

Eggs hatched after an incubation period of 144–216 hours (6–9 days) in laboratory studies at 15.0°C to 15.7°C (Van Eenennaam *et al*. 2001; Deng *et al*. 2002). Incubation period and survival is closely related to temperature. In laboratory studies, the upper limit of the optimal thermal range for green sturgeon development was from 17°F to 18°F, and temperatures ≥23°C were lethal to embryos (Van Eenennaam *et al*. 2005). Successful incubation was observed at temperatures as low as 11°C. Eggs incubated at water temperatures between 17.5°C and 22 °C resulted in elevated mortalities and an increased occurrence of morphological abnormalities in those eggs that did hatch. At incubation temperatures below 14°C, hatching mortality also increased significantly, and morphological abnormalities increased slightly, but not statistically so.

Survival of eggs and larvae requires specific water quality parameters like temperature, DO, and turbidity. These parameters likely constrain the current area available as larval nursery and juvenile foraging areas. Increased water quantity has a positive influence on spawning, and since flow in spawning segments of the Sacramento River is controlled by Shasta Dam, the predictability of flows is high, and project operations can directly influence the successful production of larvae and juveniles. Large flow rates of greater than 14,000 cfs between February 1 and May 31 are similar to what are necessary for producing strong year classes of white sturgeon at spawning sites in the Sacramento River, but not in the Feather or Yuba rivers (Neuman *et al*. 2007).

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

Unlike other acipenserids, newly hatched larvae did not swim up toward the water surface within the first five days post hatch (dph), but remained in clumps near the bottom. By 5–6 dph, larvae exhibited nocturnal behavior, remaining clumped near the bottom during the day and actively swimming at night (Van Eenennaam *et al*. 2001; Deng *et al*. 2002). Green sturgeon embryos have poor swimming ability and exhibit a strong drive to remain in contact with structure, preferring cover and dark habitats to open bottom and illuminated habitats in laboratory experiments (Kynard *et al*. 2005). In experiments, early embryos made no effort to swim, suggesting embryos remain in spawning areas to develop (Kynard *et al*. 2005).

Larvae begin feeding at 10 days post hatch and lengths of 23–25 mm (Deng *et al*. 2002). Larvae are believed to initiate downstream migration from spawning areas, staying close to the bottom and periodically interrupting downstream movement with upstream foraging bouts (Kynard *et al*. 2005). Temperatures of 15°C are believed to be optimal for larval growth, whereas temperatures below 11°C or above 19°C may be detrimental for growth (Cech *et al*. 2000). Substrate may also affect growth and foraging behavior. Larvae reared on flat surfaced substrates (slate-rock and glass) had higher specific growth rates than larvae reared on cobble or sand, most likely due to lower foraging effectiveness and greater activity levels in cobble and sand substrates (Nguyen and Crocker 2007).

Larvae complete metamorphosis to the juvenile stage at 45 dph, when fish range from 62–94 mm in length (Deng *et al*. 2002). Early juveniles exhibit nocturnal behavior in all activities and initiate directed downstream movement in the fall, most likely to migrate to wintering habitats (Kynard *et al*. 2005). Wintering juveniles forage actively at night between dusk and dawn and are inactive during the day, seeking the darkest available habitat (Kynard *et al*. 2005).

Juvenile fish continue to exhibit nocturnal behavioral beyond the metamorphosis from larvae to juvenile stages. Laboratory studies by Kynard *et al*. (2005) indicated that juvenile fish continued to migrate downstream at night for the first 6 months of life. When ambient water temperatures reached 8^{o}C, downstream migrational behavior diminished and holding behavior increased. This data suggests that 9 to 10 month old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds.

Figure IV-e shows the timing of egg incubation and early rearing and the relation to water temperature and river flow. Table IV-e shows the timing of egg incubation and early rearing in the Sacramento River system.

c. Juvenile and Sub-adult Rearing and Migration

Juveniles spend from 1–4 years in fresh and estuarine waters and disperse into salt water at lengths of 300–750 mm (USFWS 1995; Nakamoto *et al*. 1995). Growth is rapid with Klamath River fish reaching 300 mm in one year and over 600 mm within 2–3 years (Nakamoto *et al*. 1995; USFWS 1995). Information on behavior, physiology, and habitat requirements is limited for juveniles in the wild but some insights are provided by laboratory work. Laboratory experiments indicate juveniles may occupy fresh to brackish water at any age, but they are able to completely transition to salt water at around 1.5 years in age (about 533 dph; mean TL of 75.2 plus or minus 0.7 cm) (Allen and Cech 2007). Early juveniles at 100 and 170 dph tolerated prolonged exposure to saltwater, but experienced decreased growth and activity levels and, in some cases, mortality for individuals at 100 dph (Allen and Cech 2007). Juvenile green sturgeon prefer temperatures of 15–16°C with an upper limit of 19°C, beyond which swimming performance may decrease and cellular stress may occur (Mayfield and Cech 2004; Allen *et al*. 2006). Laboratory measurements of oxygen consumption by juveniles ranged from 61.78 plus or minus 4.65 mg O_2 hr^{-1} kg^{-1} to 76.06 plus or minus 7.63 mg O_2 hr^{-1} kg^{-1}, with a trend of increasing oxygen consumption with increasing body mass (Allen and Cech 2006).

Juvenile green sturgeon migrate downstream and feed mainly at night. Studies on juvenile feeding in San Pablo Bay, Suisun Bay, and the Delta identified prey items of shrimp (*Neomysis awatchensis*, *Crangon franciscorum*), amphipods (*Corophium* spp., *Photis californica*), isopods (*Synidotea laticauda*), clams (*Macoma* spp.), annelid worms, and unidentified crabs and fishes (Ganssle 1966; Radtke 1966).

Green sturgeon juveniles tested under laboratory conditions had optimal bioenergetic performance (*i.e.* growth, food conversion, swimming ability) between 15°C and 19°C under either full or reduced rations (Mayfield and Cech 2004). This temperature range overlaps the egg incubation temperature range for peak hatching success previously discussed. Ambient water temperature conditions in the Rogue and Klamath river systems range from 4°C to approximately 24°C. The Sacramento River has similar temperature profiles and, like the previous two rivers, is a regulated system with dams controlling flows on its mainstem (Shasta and Keswick dams), and its tributaries (Whiskeytown, Oroville, Folsom, and Nimbus dams).

Larval and juvenile sturgeon have been caught in traps at two sites in the upper Sacramento River: downstream of RBDD (RM 342) and from the GCID (Glenn-Colusa Irrigation District) pumping plant (RM 205, CDFG 2002). Larvae captured at the RBDD site are typically only a few days to a few weeks old, with lengths ranging from 24 to 31 mm. This body length is equivalent to 15 to 28 days post hatch as determined by Deng *et al.* (2002). Recoveries of larvae at the RBDD rotary screw traps (RSTs) occur between late April/early May and late August with the peak of recoveries occurring in June (1995-1999 and 2003–2008 data). The mean yearly total length of post-larval green sturgeon captured in the GCID RST, approximately 30 miles downstream of RBDD, ranged from 33 mm to 44 mm between 1997 and 2005 (CDFG, 2002) indicating they are approximately 3-4 weeks old (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Taken together, the average length of larvae captured at the two monitoring sites indicate that fish were hatched upriver of the monitoring site and drifted downstream over the course of 2 to 4 weeks of growth. According to the CDFG document commenting on the NMFS proposal to list the green sturgeon Southern DPS (CDFG 2002), some green sturgeon rear to larger sizes upstream of RBDD, or move back to this location after spending time downstream.

Juvenile green sturgeon have been salvaged at the Harvey O. Banks Pumping Plant and the John E. Skinner Fish Collection Facility (Fish Facilities) in the South Delta, and captured in trawling studies by CDFG during all months of the year (CDFG 2002). The majority of these fish were between 200 and 500 mm, indicating they were from 2 to 3 years of age based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates that juveniles of the green sturgeon Southern DPS likely hold in the mainstem Sacramento River, as suggested by Kynard *et al.* (2005).

Figure IV-e shows the timing of juvenile and sub-adult rearing and migration and the relation to water temperature and river flow. Table IV-e shows the timing of juvenile and sub-adult rearing and migration in the Sacramento River system.

d. Ocean Residence and Migrations

Subadult and adult green sturgeon spend most of their time in coastal marine and estuarine waters. Based on their life history, the majority of the green sturgeon population is in the ocean at any given time (Beamesderfer *et al*. 2007). Green sturgeon tagged in the Rogue River and tracked in marine waters ranged widely within the 110 m depth bathymetry but were most often found at depths of 40–70 m (Erickson and Hightower 2007). Fish occasionally made rapid vertical ascents to or near the surface, for reasons yet unknown (Erickson and Hightower 2007).

Most reported locations of green sturgeon in coastal Oregon and Washington bottom-trawl fishery records from 1993 to 2000 also occurred inside of the 110-m depth contour, although most fishing effort occurred in deeper water (Erickson and Hightower 2007). Large concentrations of subadults and adults may be also found during summer in bays and estuaries along the west coast (Emmett *et al*. 1991; Moyle *et al*. 1992; ODFW 2005a; Israel 2006; Moser and Lindley 2007; Lindley *et al*. 2008).

Subadult and adult green sturgeon are omnivorous and a variety of benthic food items have been reported in the diet. Adults captured in the Sacramento-San Joaquin delta feed on invertebrates including shrimp, mollusks, amphipods, and even small fish (Radtke 1966; Houston 1988; Moyle *et al*. 1992). Stomachs of green sturgeon caught in Suisun Bay contained the amphipod *Corophium* spp., bay shrimp *Cragon franciscorum*, opossum shrimp *Neomysis awatchensis* (synonymous with *Neomysis mercedis*), and annelid worms (Ganssle 1966). Stomachs of green sturgeon caught in San Pablo Bay contained bay shrimp, the clam *Macoma* spp., the amphipod *Photis californica*, *Corophium* spp., the isopod *Synidotea laticauda*, and unidentified crab and fish (Ganssle 1966). Stomachs of green sturgeons caught in Delta contained *Corophium* spp. and *N. awatchensis* (Radtke 1966). Stomach samples (n=121) collected in the Columbia River gillnet fishery were found to be empty with the exception of one fish (ODFW 2002).

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

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

Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Upper Sac. River[1,2,3]					▒	▒	▒	■	■	■	■	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒		
Feather River[9]				▒	▒	▒	■	■	■	■	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒			
SF Bay Estuary[4,8]					▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒						

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

Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
RBDD, Sac River[5]									▒	▒	■	■	■	■	▒	▒								
GCID, Sac River[5]									▒	▒	■	■	■	■	▒	▒	░	░	░	░				

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

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

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

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

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

* Fish Facility salvage operations

Sources: [1]USFWS (2002); [2]Moyle *et al*. (1992); [3]Adams *et al*. (2002) and NMFS (2005); [4]Kelly *et al*. (2007); [5]CDFG (2002); [6]Interagency Ecological Program Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [7]Nakamoto *et al*. (1995); [8]Heublein *et al*. (2006); [9]USFWS (1995b)

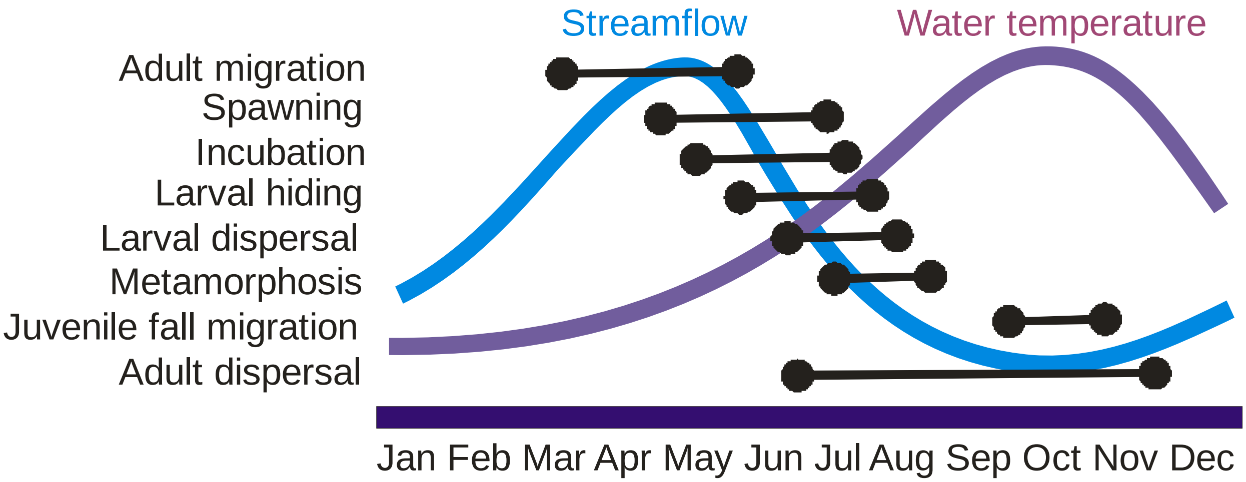

Figure IV-e. Estimated seasonal timing of green sturgeon spawning and early life history stages in the Sacramento River (Beamesderfer 2009).

2. <u>Range-Wide (DPS) Distribution, Status and Trends</u>

In North America, spawning populations of green sturgeon are currently found in only three river systems: the Sacramento and Klamath rivers in California and the Rogue River in southern Oregon. Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. Data from commercial trawl fisheries and tagging studies indicate that the green sturgeon occupy waters within the 110 meter contour (NMFS 2005a). During the late summer and early fall, subadults and nonspawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991, Moser and Lindley 2007). Particularly large concentrations occur in the Columbia River estuary, Willapa Bay, and Grays Harbor, with smaller aggregations in San Francisco and San Pablo Bays (Emmett *et al* 1991, Moyle *et al.* 1992, Beamesderfer *et al.* 2004). Lindley *et al.* (2008) reported that green sturgeon make seasonal migratory movements along the west coast of North America, overwintering north of Vancouver Island and south of Cape Spencer, Alaska. Green sturgon from the Southern DPS have been detected in these seasonal aggregations.

The green sturgeon Southern DPS includes all green sturgeon populations south of the Eel River, with the only known spawning population being in the Sacramento River. The life cycle of Southern DPS of green sturgeon can be broken into four distinct phases based on developmental stage and habitat use: (1) adult females greater than or equal to 13 years of age and males greater than or equal to 9 years of age; (2) larvae and post-larvae less than 10 months of age; (3)

juveniles less than or equal to 3 years of age; and (4) coastal migrant females between 3 and 13 years, and males between 3 and 9 years of age (Nakamoto *et al*. 1995, McLain 2006).

Historically, the green sturgeon southern DPS likely spawned in the Sacramento, Feather, and San Joaquin rivers, judged upon the characteristics of the local habitats (Adams *et al*. 2007). Known current spawning occurs in the Sacramento River (Adams *et al.* 2002, Beamesderfer *et al.* 2004). Mora *et al.* (2009) used river discharge, channel gradient, air temperature and green sturgeon observations to model the historic distribution of Central Valley and concluded that absent large dams and altered hydrographs, green sturgeon would have been present in the main channel Sacramento and San Joaquin rivers and the Feather, Yuba and American rivers. The total amount of habitat blocked includes Keswick Dam: 39 km +/- 14 km, Oroville Dam: 16 km +/- 4 km, Daguerre Point Dam: 4 +/- 2 km, and Friant Dam: 12 +/- 2 km. While dams block only 9 percent of the species habitat, it is likely that the blocked areas contain relatively high amounts of spawning habitat due to their upstream location in the river systems.

Adult green sturgeon currently occupy the lower Feather River downstream from Oroville Dam (RM 72) (Beamesderfer *et al*. 2004), and available evidence suggests that spawning is taking place. Habitat investigations by DWR on the lower Feather River indicate that that there are up to 12 deep holes and over 13 miles of habitat from the Fish Barrier Dam at RM 67 to the downstream end of the Project Boundary at RM 54, with characteristics capable of attracting green sturgeon (Seescholtz 2003). Seven of these holes are greater than 5 meters deep, and 5 of the pools are between 3 and 5 meters. Based on observations of adults, NMFS suspects that spawning may have occurred historically in the lower Feather River and a substantial amount of potential habitat in the Feather River was lost with the construction of Oroville Dam. Significant habitat, while modified, remains accessible downstream from the Thermolito Afterbay Outlet (CDWR 2005a).

Similarly, green sturgeon appear to be utilizing the Yuba river for spawning. Spawning adults were observed and captured on video in the scour pool downstream from Dageurre Point Dam in the winter and spring of 2011.

Spawning in the San Joaquin River system has not been recorded historically or observed recently, but alterations of the San Joaquin River and its tributaries (Stanislaus, Tuolumne, and Merced rivers) occurred early in the European settlement of the region. During the latter half of the 1800s, impassable barriers were built on these tributaries where the water courses left the foothills and entered the valley floor. Therefore, these low elevation dams have blocked potentially suitable spawning habitats located further upstream for approximately a century. Additional destruction of riparian and stream channel habitat by industrialized gold dredging further disturbed any valley floor habitat that was still available for sturgeon spawning. 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 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.

Information regarding the migration and habitat use of the green sturgeon Southern DPS is developing. 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 River 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 Bay estuary between 1954 and 2001. A total of 17 tagged fish were recovered: 3 in the Sacramento-San Joaquin Estuary, 2 in the Pacific Ocean off of California, and 12 from commercial fisheries off of the Oregon and Washington coasts. Eight of the 12 recoveries were in the Columbia River estuary (CDFG 2002).

Kelly *et al.* (2007) indicated that green sturgeon enter the San Francisco Estuary during the spring and remain until autumn. The authors studied the movement of adults in the San Francisco Estuary and found them to make significant long-distance movements with distinct directionality. The movements were not found to be related to salinity, current, or temperature, and Kelly *et al*. (2006) surmised that they are related to resource availability and foraging behavior. Recent acoustical tagging studies on the Rogue River (Erickson *et al*. 2002) have shown that adult green sturgeon will hold for as much as 6 months in deep (> 5m), low gradient reaches or off channel sloughs or coves of the river during summer months when water temperatures were between 15°C and 23°C. When ambient temperatures in the river dropped in autumn and early winter (<10°C) and flows increased, fish moved downstream and into the ocean. Erickson *et al.* (2002) surmised that this holding in deep pools was to conserve energy and utilize abundant food resources. Similar behavior is exhibited by adult green sturgeon on the Sacramento River based on captures of adult green sturgeon in holding pools on the Sacramento River upstream of the 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, indicate spawning occurrence, and it appears adult green sturgeon could utilize a variety of freshwater and brackish habitats for up to nine months of the year (Beamesderfer *et al*. 2007).

Population abundance information concerning the green sturgeon Southern DPS 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 in 1993 to more than 8,421 in 2001, 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, since the population estimates are based on small sample sizes, intermittent reporting, and inferences made from white sturgeon catches. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile Southern DPS green sturgeon of per year (Adams *et al*. 2002).

Green sturgeon larvae and juveniles are routinely observed in rotary screw traps at RBDD and GCID, indicating spawning occurs upstream of both of these sites. Adults have been observed as far down as Hamilton City (RM 200). RST data from RBDD and GCID show a declining trend in juvenile production since the 1990s. Recent data indicate that very little production took place in 2007 and 2008 (13 and 3 larval green sturgeon captured in the RST monitoring sites at RBDD, respectively; Poytress 2008, Poytress *et al*. 2009). Newly hatched larvae in the 30-40 mm range peak at RBDD and GCID in July, indicating they are at least 10 days old. Length data from GCID do not show the same general increase in size over the sampling season as observed at RBDD, which may indicate less favorable growing conditions in the river between RBDD and GCID (CDFG 2002). Juvenile green sturgeon migrate downstream and feed mainly at night. Larvae and young-of-the-year are small enough to be entrained in water diversions. During the day, their benthic behavior likely limits this impact. However, their nocturnal swim up behavior may place them at risk for entrainment by local agricultural diversions in the upper river reaches.

The only existing information regarding changes in the abundance of the green sturgeon Southern DPS includes changes in abundance at the John E. Skinner Fish Collection Facility between 1968 and 2006. The average number of Southern DPS green sturgeon entrained per year at the State Facility prior to 1986 was 732; from 1986 on, the average per year was 47 (April 5, 2005, 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 5, 2005, 70 FR 17386). In light of the increased exports, particularly during the previous 10 years, it is clear that the abundance of the green sturgeon Southern DPS is declining. Additional analysis of North American green and white sturgeon taken at the Fish Facilities indicates that take of both North American green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s (April 5, 2005, 70 FR 17386). Catches of sub-adult and adult Northern and Southern DPS of green sturgeon, primarily in San Pablo Bay, by the Interagency Ecological Program ranged from 1 to 212 green sturgeon per year between 1996 and 2004 (212 occurred in 2001). However, the portion of the green sturgeon Southern DPS is unknown. Recent spawning population estimates using sibling-based genetics by Israel (2006) indicate spawning populations of 32 spawner pairs in 2002, 64 in 2003, 44 in 2004, 92 in 2005, and 124 in 2006 upstream of RBDD (with an average of 71).

As described previously, the majority of spawning by green sturgeon in the Sacramento River system appears to take place upstream of the location of RBDD. This is based on the length and estimated age of larvae captured at RBDD (approximately 2-3 weeks of age) and GCID (downstream, approximately 3-4 weeks of age) indicating that hatching occurred upstream of the sampling location.

3. Current Viability of the Green Sturgeon Southern DPS

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

a. Population Size

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

b. Population Growth Rate

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

c. Spatial Structure

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

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

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

d. Diversity

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

e. Summary of Green Sturgeon Southern DPS Viability

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

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

4. Spring-run Chinook Salmon Critical Habitat Analysis

1. Summary of Designated Critical Habitat

Critical habitat was designated for spring-run Chinook salmon on September 2, 2005, and includes stream reaches such as those of the Feather and Yuba Rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta (70 FR 52488). Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series; Bain and Stevenson 1999; September 2, 2005, 70 FR 52488).

In designating critical habitat, NMFS considers the following requirements of the species: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, generally, (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species [see 50 CFR 424.12(b)]. In addition to these factors, NMFS also focuses on the known physical and biological features (essential features) within the designated area that are essential to the conservation of the species and that may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

Critical habitat for spring-run Chinook salmon is defined as specific areas that contain the primary constituent elements (PCEs) and physical habitat elements essential to the conservation of the species. Within the range of the spring-run Chinook salmon ESU, biological features of the designated critical habitat that are considered vital for spring-run Chinook salmon include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, and nearshore marine areas. The following describe the current conditions of the freshwater PCEs for spring-run Chinook salmon.

a. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Spring-run Chinook salmon spawn in the mainstem Sacramento River between RBDD and Keswick Dam (however, little spawning activity has been recorded in recent years) and in tributaries such as Mill, Deer, and Butte creeks, in addition to smaller populations in the Feather and Yuba rivers, Big Chico, Battle, Antelope, and Clear creeks. Operations of Shasta and Keswick Dams on the mainstem Sacramento River that are focused primarily to ensure an adequate quantity and quality of water for successful adult winter-run Chinook salmon migration, holding, spawning, and incubation may at the same time be limiting the amount of cold water needed to ensure successful incubation of any spring-run Chinook salmon eggs spawned on the mainstem Sacramento River.

b. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging LWM, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. The channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system are much degraded, and typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. However, some complex, productive habitats with floodplains remain in the system [*e.g.*, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa)] and flood bypasses (*i.e.*, Yolo and Sutter bypasses). Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

c. Freshwater Migration Corridors

Adult migration corridors should provide satisfactory water quality, water quantity, water temperature, water velocity, cover/shelter and safe passage conditions in order for adults to reach spawning areas. Adults generally migrate in the fall or winter months to spawning areas. During this time of year, suspended sediment makes respiration for adults difficult. Removal or non-recruitment of woody debris and stream habitat simplification has limits the amount of cover and shelter needed for adults to rest during high flow events. Low flows in streams can physically hinder adult migration, especially if fall rain storms are late or insufficient to raise water levels enough to ensure adequate passage. Poorly designed culverts and other road crossings have truncated adult migration corridors and cut off hundreds of miles of stream habitat throughout the spring-run Chinook salmon ESU. While adult migration corridors are a necessary step in the lifecycle for the species, the condition of this particular essential habitat type in the ESU is probably not as limiting, in terms of recovery of the species, as other essential habitat types, such as juvenile summer and winter rearing areas.

d. Estuarine Areas

Ideal estuarine areas are free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water. Natural cover such as submerged and overhanging LWM, aquatic vegetation, and side channels, are necessary for juvenile and adult foraging. Current estuarine areas are degraded as a result of the operations of the CVP and SWP. Spring-run Chinook salmon smolts are drawn to the Central and South Delta as they outmigrate, and are subjected to the indirect (*e.g.*, predation, contaminants) and direct (*e.g.*, salvage, loss) effects of the Delta and both the Federal and State fish facilities.

The current condition of the estuarine habitat in the project area has been substantially degraded from historic conditions. Over 90 percent of the fringing fresh, brackish, and salt marshes have been lost to human actions. This loss of the fringing marshes reduces the availability of forage species and eliminates the cycling of nutrients from the marsh vegetation into the water column of the adjoining waterways. The channels of the Delta have been modified by the raising of levees and armoring of the levee banks with stone riprap. This reduces habitat complexity by reducing the incorporation of woody debris and vegetative material into the nearshore area, minimizing and reducing local variations in water depth and velocities, and simplifying the community structure of the nearshore environment. Delta hydraulics has been modified as a result of CVP and SWP actions. Within the Central and South Delta, net water movement is towards the pumping facilities, altering the migratory cues for emigrating fish in these regions. Operations of upstream reservoir releases and diversion of water from the southern Delta have been manipulated to maintain a “static” salinity profile in the western Delta near Chipps Island (the X2 location). This area of salinity transition, the low salinity zone, is an area of high productivity. Historically, this zone fluctuated in its location in relation to the outflow of water from the Delta and moved westwards with high Delta inflow (*i.e.*, floods and spring runoff) and eastwards with reduced summer and fall flows. This variability in the salinity transition zone has been substantially reduced by the operations of the projects. The project’s long-term water diversions also have contributed to reductions in the phytoplankton and zooplankton populations in the Delta itself as well as alterations in nutrient cycling within the Delta ecosystem. Heavy urbanization and industrial actions have lowered water quality and introduced persistent contaminants to the sediments surrounding points of discharge (*i.e.*, refineries in Suisun and San Pablo bays, creosote factories in Stockton, *etc*.). Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function to provide predator avoidance, as rearing habitat and as an area of transition to the ocean environment.

2. Current Condition of Critical Habitat

The current condition of spring-run Chinook salmon critical habitat is degraded, and does not provide the conservation value necessary for the recovery of the species. Although there are exceptions, the majority of streams and rivers in the ESU have impaired habitat. Additionally, critical habitat in the ESU often lacks the ability to establish essential features due to ongoing human activities. For example, large dams, such as Englebright Dam on the Yuba River, California, stop the recruitment of spawning gravels, which impacts both an essential habitat type (spawning areas) as well as an essential feature of spawning areas (substrate). Water utilization in many regions throughout the ESU reduces summer base flows, which limits the establishment of several essential features such as water quality and water quantity.

5. Central Valley Steelhead Critical Habitat Analysis

1. Summary of Designated Critical Habitat

Critical habitat was designated for Central Valley steelhead on September 2, 2005 (70 FR 52488). 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; the lower San Joaquin River to the confluence with the Merced River, including its tributaries, and the waterways of the Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series; Bain and Stevenson 1999; September 2, 2005, 70 FR 52488). Critical habitat for Central Valley steelhead is defined as specific areas that contain the PCEs and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for Central Valley steelhead.

a. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for steelhead is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for Central Valley steelhead is similar in nature to the requirements of Chinook salmon, primarily occurring in reaches directly downstream of dams (*i.e.*, upstream of RBDD, but downstream of Keswick Dam, on the Sacramento River) on perennial watersheds throughout the Central Valley. These reaches can be subjected to variations in flows and temperatures, particularly over the summer months, which can have negative effects upon salmonids spawning downstream of them.

b. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging LWM, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system [*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa)] and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment. Steelhead are more susceptible to the negative effects of degraded rearing habitat, as they rear in freshwater longer than most Chinook salmon.

c. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. Currently, RBDD gates are down from May 15 through September 15, and impede the upstream and downstream migration of a portion of each adult and juvenile cohort. Juvenile Central Valley steelhead that try to migrate past RBDD when its gates are down are subjected to disorientation. In addition, although predators of juvenile Central Valley steelhead are prominent throughout the Sacramento River and Delta, they concentrate around structures, and therefore, a higher concentration of striped bass (*Morone saxatilis*), and especially Sacramento pikeminnow (*Ptychocheilus grandis*), reside downstream of RBDD and prey on outmigrating juvenile salmonids.

Juvenile Central Valley steelhead that outmigrate from the San Joaquin River tributaries are exposed to degraded migration corridors, just as they are exposed to degraded water quality in the lower San Joaquin River basin and the Stockton deep water shipping channel. Significant amounts of flow and many juvenile Central Valley steelhead from the Sacramento River enter the Delta Cross Channel (when the gates are open) and Georgiana Slough into the Central Delta. Likewise, some juvenile Central Valley steelhead from the San Joaquin River are diverted into the southern Delta through Old River and Turner and Columbia Cuts. Mortality of juvenile Central Valley steelhead entering the Central Delta is higher than for those continuing downstream in the Sacramento and San Joaquin rivers. This difference in mortality could be caused by a combination of factors: the longer migration route through the Central Delta to the western Delta, exposure to higher water temperatures, higher predation rates, exposure to seasonal agricultural diversions, water quality impairments due to agricultural and municipal discharges, and a more complex channel configuration making it more difficult for Central Valley steelhead to successfully migrate to the western Delta and the ocean. In addition, the State and Federal pumps and associated fish facilities increase mortality of juvenile Central Valley steelhead through various means, including entrainment into the State and Federal facilities, handling, trucking, and release. The current condition of freshwater migration corridors in the Sacramento River, San Joaquin River, and Delta are highly degraded.

d. Estuarine Areas

Ideal estuarine areas are free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water. Natural cover such as submerged and overhanging LWM, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. Current estuarine areas are degraded as a result of the operations of the CVP and SWP. Central Valley steelhead smolts are drawn to the Central and South Delta as they outmigrate, and are subjected to the indirect (*e.g.*, predation, contaminants) and direct (*e.g*., salvage, loss) effects of the Delta and both the Federal and State fish facilities.

The location of X2 has also been modified from natural conditions. Historically, the Delta provided the transitional habitat for Central Valley steelhead to undergo the physiological change to salt water. However, as X2 was modified to control Delta water quality, and competing species' needs [*i.e*., Delta smelt (*Hypomesus transpacificus*), the Delta served more as a migratory corridor for outmigrating anadromous salmonids. The current condition of the estuarine area has been described above for spring-run Chinook salmon critical habitat.

2. Current Condition of Critical Habitat

The current condition of Central Valley steelhead critical habitat is degraded, and does not provide the conservation value necessary for the recovery of the species. Central Valley steelhead critical habitat has suffered similar types of degradation as spring-run Chinook salmon critical habitat. In addition, the Sacramento-San Joaquin River Delta, as part of Central Valley steelhead designated critical habitat, provides very little function necessary for juvenile Central Valley steelhead rearing and physiological transition to salt water.

6. Green Sturgeon Critical Habitat Analysis

1. Summary of Designated Critical Habitat

Critical habitat was designated for the Southern DPS of green sturgeon on October 9, 2009 (74 FR 52300). 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.

The current condition of critical habitat for the Southern DPS of green sturgeon is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the recovery of the species, particularly in the upstream riverine habitat. In particular, passage and water flow PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the Southern DPS of green sturgeon evolved. The habitat values proposed for green sturgeon critical habitat have suffered similar types of degradation as already described for spring-run Chinook salmon critical habitat. In addition, the alterations to the Sacramento-San Joaquin River Delta 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.

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

Critical habitat for the Southern DPS of North American green sturgeon includes the riverine, estuarine, and marine waters containing the following elements:

2. Freshwater Riverine Habitat

a. Freshwater Riverine 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.

b. Freshwater Riverine Type or Size

Suitable critical habitat in the freshwater riverine system should include substrate suitable for egg deposition and development (*e.g.*, cobble, gravel, or bedrock sills and shelves 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, 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 a 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 Keswick Dam and GCID. Ongoing surveys are anticipated to further identify river reaches with suitable substrate characteristics in the upper river and their utilization by green sturgeon.

c. Freshwater Riverine 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°C to19°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. Continued operations of the project are likely to further attenuate these high flow events. Rearrangement of the river channel and the formation of new pools and holes are unlikely to occur given the management of the river's discharge to prevent flooding downstream of the dam.

d. Freshwater Riverine 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 proper functioning of the freshwater habitat. Suitable water temperatures would include: stable water temperatures within spawning reaches (wide fluctuations could increase egg mortality or deformities in developing embryos); temperatures within 11-17°C (optimal range = 14-16°C) in spawning reaches for egg incubation (March-August) (Van Eenennaam *et al.* 2005); temperatures below 20°C for larval development (Werner *et al.* 2007); and temperatures below 24°C for juveniles (Mayfield and Cech 2004, Allen *et al.* 2006). Due to the temperature management of the releases from Keswick Dam for winter-run Chinook salmon 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 parts per thousand) for larvae and early juveniles [about 100 days post hatch (dph)] to brackish water (10 parts per thousand) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech 2007). Salinity levels are suitable for green sturgeon in the Sacramento River and freshwater portions of the Delta for early life history stages. Adequate levels of DO are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1} for juveniles, Allen and Cech 2007). Current mainstem DO levels are suitable to support the growth and migration of green sturgeon in the Sacramento River. Suitable water quality would also include water free of contaminants (*i.e.*, pesticides, organochlorines, elevated levels of heavy metals, *etc*.) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Water free of such contaminants would protect green sturgeon from adverse impacts on growth, reproductive development, and reproductive success (*e.g*., reduced egg size and abnormal gonadal development, abnormal embryo development during early cleavage stages and organogenesis) likely to result from exposure to contaminants (Fairey *et al.* 1997, Foster *et al.* 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.

e. Freshwater Riverine Migratory Corridor

Safe and unobstructed migratory pathways are necessary for passage within riverine habitats and between riverine and estuarine habitats (*e.g*., an unobstructed river or dammed river that still allows for passage). Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning/rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick Dam (RM 302) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242).

Green sturgeon adults that migrate upstream in April, May, and June are completely blocked by the Anderson-Cottonwood Irrigation District's diversion dam. Therefore, five miles of spawning habitat are inaccessible upstream of the diversion dam. It is unknown if spawning is occurring in this area. Adults that pass upstream of Anderson-Cottonwood Irrigation District's diversion dam before April are forced to wait 6 months until the stop logs are pulled before returning downstream to the ocean. Upstream blockage forces sturgeon to spawn in approximately 12 percent less habitat between Keswick Dam and RBDD. Newly emerged green sturgeon larvae that hatch upstream of the Anderson-Cottonwood Irrigation District's diversion dam would be forced to hold for 6 months upstream of the dam or pass over it and be subjected to higher velocities and turbulent flow downstream of the dam, thus rendering the larvae and juvenile green sturgeon more susceptible to predation.

Closure of the gates at RBDD from June 15 through September 15 precludes all access to spawning grounds upstream of 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. A fish screen is under construction at RBDD that will obviate the need for gates at the dam, after which the gates will remain open year around.

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 indicate that some fish are successful in passing the dam when the gates are in the "closed" position. 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 May, 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.

f. Freshwater Riverine Depth

Deep pools of ³ 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 upstream of 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 a 54 pools with adequate depth have been identified in the Sacramento River upstream of the GCID location.

g. Freshwater Riverine Sediment Quality

Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants [*e.g.*, elevated levels of heavy metals (*e.g.*, mercury, copper, zinc, cadmium, and chromium), polycyclic aromatic hydrocarbons, 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 Yuba River watershed.

3. Estuarine Habitat

a. Estuarine Food Resources

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

b. Estuarine Water Flow

Within bays and estuaries adjacent to the Sacramento River (*i.e.*, the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds is required. Sufficient flows are needed to attract adult green sturgeon to the Sacramento River from the bay and to initiate the upstream spawning migration into the upper river. Currently, flows provide the necessary attraction to green sturgeon to enter the Sacramento River. Nevertheless, these flows are substantially less than what would have been available historically to stimulate the spawning migration.

c. Estuarine Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth, and viability of all life stages. Suitable water temperatures for juvenile green sturgeon should be below 24°C (75°F). At temperatures above 24°C, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and

Cech 2004) and increased cellular stress (Allen *et al.* 2006). Suitable salinities in the estuary range from brackish water (10 parts per thousand) to salt water (33 parts per thousand). Juveniles transitioning from brackish to salt water can tolerate prolonged exposure to salt water salinities, but may exhibit decreased growth and activity levels (Allen and Cech 2007), whereas subadults and adults tolerate a wide range of salinities (Kelly *et al.* 2007). Subadult and adult green sturgeon occupy a wide range of DO levels, but may need a minimum DO level of at least 6.54 mg O_2/l (Kelly *et al.* 2007, Moser and Lindley 2007). As described above, adequate levels of DO are also required to support oxygen consumption by juveniles (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1}, Allen and Cech 2007). Suitable water quality also includes water free of contaminants (*e.g.*, pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal development of juvenile life stages, or the growth, survival, or reproduction of subadult or adult stages. In general, water quality in the Delta and estuary meets these criteria, but local areas of the Delta and downstream bays have been identified as having deficiencies. Water quality in the areas such as the Stockton turning basin and Port of Stockton routinely have depletions of DO and episodes of first flush contaminants from the surrounding industrial and urban watershed. Discharges of agricultural drain water have also been implicated in local elevations of pesticides and other related agricultural compounds within the Delta and the tributaries and sloughs feeding into the Delta. Discharges from petroleum refineries in Suisun and San Pablo Bay have been identified as sources of selenium to the local aquatic ecosystem (Linville *et al.* 2002).

d. Estuarine Migratory Corridor

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

e. Estuarine Water Depth

A diversity of depths is necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Subadult and adult green sturgeon occupy deep (≥ 5 m) holding pools within bays and estuaries as well as within freshwater rivers. These deep holding pools may be important for feeding and energy conservation, or may serve as thermal refugia for subadult and adult green sturgeon (Benson *et al*. 2007). Tagged adults and subadults within the San Francisco Bay estuary primarily occupied waters over shallow depths of less than 10 m, either swimming near the surface or foraging along the bottom (Kelly *et al*. 2007). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from three to eight feet deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke 1966). Thus, a diversity of depths is important to support different life stages and habitat uses for green sturgeon within estuarine areas.

Currently, there is a diversity of water depths found throughout the San Francisco Bay estuary and Delta waterways. Most of the deeper waters, however, are comprised of artificially maintained shipping channels, which do not migrate or fluctuate in response to the hydrology in the estuary in a natural manner. The channels are simplified trapezoidal shapes with little topographical variation along the channel alignment. Shallow waters occur throughout the Delta and San Francisco Bay. Extensive "flats" occur in the lower reaches of the Sacramento and San Joaquin River systems as they leave the Delta region and are even more extensive in Suisun and San Pablo bays. In most of the region, variations in water depth in these shallow water areas occur due to natural processes, with only localized navigation channels being dredged (*e.g.*, the Napa River and Petaluma River channels in San Pablo Bay).

f. Estuarine Sediment Quality

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

3. Nearshore Coastal Marine Habitat

a. Nearshore Coastal Marine Migratory Corridor

Safe and unobstructed migratory pathways are necessary for passage within marine coastal zones along the west coast of North America and between estuarine and marine habitats. Subadult and adult green sturgeon spend as much as 13 years out at sea before returning to their natal rivers to spawn. Safe and unobstructed passage within near shore marine waters is critical for subadult and adult green sturgeon to access over-summering habitats within coastal estuaries and over-wintering habitats within coastal estuaries and coastal waters off of Vancouver Island, British Columbia. Passage is also necessary for subadults and adults to migrate back to San Francisco Bay and to the Sacramento River for spawning. Potential conflicts may occur in shipping corridors, areas with commercial bottom trawl fisheries, and coastal discharge of wastewater from sanitation facilities.

b. Nearshore Coastal Marine Water Quality

Nearshore marine waters should have adequate DO levels and be free of contaminants (*e.g.*, pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon. Based on studies of tagged subadult and adult green sturgeon in the San Francisco Bay estuary, California, and Willapa Bay, Washington, subadults and adults may need a minimum DO level of at least 6.54 mg O_2/l (Kelly *et al.* 2007, Moser and Lindley 2007). As described above, exposure to and bioaccumulation of contaminants may negatively affect the growth, reproductive development, and reproductive success of subadult and adult green sturgeon. Thus, waters free of such contaminants would benefit the normal development of green sturgeon for optimal survival and spawning success.

c. Nearshore Coastal Marine Food Resources

Abundant food items for subadults and adults, which may include benthic invertebrates and fish, are important to the growth and viability of subadult and adult green sturgeon. Green sturgeon spend from 3-13 years in marine waters, migrating long distances of up to 100 km per day (NMFS 2005a). Although most tagged individuals swim at speeds too fast for feeding, some individuals swam at slower speeds and resided in areas over several days, indicating that they may be feeding. Abundant food resources are important to support subadults and adults over long-distance migrations, and may be one of the factors attracting green sturgeon to habitats farther to the north (off the coast of Vancouver Island and Alaska) and to the south (Monterey Bay, California, and off the coast of southern California) of their natal habitat. Although direct evidence is lacking, prey species are likely to include benthic invertebrates and fish species similar to those fed upon by green sturgeon in bays and estuaries (*e.g.*, shrimp, clams, crabs, anchovies, sand lances). Concentrations of these species in the near shore environment are likely to attract congregations of adult and sub-adult green sturgeon.

7. Factors Impacting Listed Species

1. <u>Habitat Blockage</u>

Hydropower, flood control, and water supply dams of the CVP, SWP, and other municipal and private entities have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. Clark (1929) estimated that originally there were 6,000 linear miles of salmon habitat in the 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.

As a result of migrational barriers, spring-run Chinook salmon, and steelhead populations have been confined to lower elevation mainstems that historically only were used for migration. Population abundances have declined in these streams due to decreased quantity and quality of spawning and rearing habitat. Higher temperatures at these lower elevations during late-summer and fall are also a major stressor to adult and juvenile salmonids. Of the 18 independent populations of Central Valley spring-run Chinook salmon that occurred historically, only three independent populations remain in Deer, Mill, and Butte creeks. Dependent populations of Central Valley spring-run Chinook salmon continue to occur in Big Chico, Antelope, Clear, Thomes, Beegum, and Stony creeks, but rely on the three extant independent populations for their continued survival. Central Valley steelhead historically had at least 81 independent populations based on Lindley *et al.*'s (2006) analysis of potential habitat in the Central Valley. However, due to dam construction, access to 38 percent of all spawning habitat has been lost as well as access to 80 percent of the historically available habitat. Green sturgeon populations have been similarly affected by these barriers and alterations to the natural hydrology. In particular, RBDD blocked access to a significant portion of the adult green sturgeon spawning run under the pre-OCAP biological opinion operational procedures. Modifications to the operations of the RBDD as required under the 2009 OCAP biological opinion will substantially reduce the impediment to upstream migrations of adult green sturgeon. Post-OCAP biological opinion interim operational procedures require the RBDD gates to remain in the open position from September 1 until June 15. Starting on June 15, 2012, the gates are required to remain open year round.

The Suisun Marsh Salinity Control Gates, located on Montezuma Slough, were installed in 1988, and are operated with gates and flashboards to decrease the salinity levels of managed wetlands in Suisun Marsh. The Suisun Marsh Salinity Control Gates have delayed or blocked passage of adult Chinook salmon migrating upstream (Edwards *et al.* 1996, Tillman *et al.* 1996, DWR 2002). The effects of the Suisun Marsh Salinity Control Gates on sturgeon are unknown at this time.

2. Water Development

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 base their migrations. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower DO levels, and decreased recruitment of gravel and LWM. More uniform flows year round have resulted in diminished natural channel formation, altered food web processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bed load movement (Mount 1995, Ayers 2001), caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat downstream of dams. The storage of unimpeded runoff in these large reservoirs also has altered the normal hydrograph for the Sacramento and San Joaquin River watersheds. Rather than seeing peak flows in these river systems following winter rain events (Sacramento River) or spring snow melt (San Joaquin River), the current hydrology has truncated peaks with a prolonged period of elevated flows (compared to historical levels) continuing into the summer dry season.

Water withdrawals, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al*. 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). Elevated water temperatures in the Sacramento River have limited the survival of young salmon in those waters. Juvenile fall-run Chinook salmon survival in the Sacramento River is also directly related with June streamflow and June and July Delta outflow (Dettman *et al*. 1987).

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

Outmigrant juvenile salmonids in the Delta have been subjected to adverse environmental conditions created by water export operations at the CVP and SWP facilities. Specifically, juvenile salmonid survival has been reduced by the following: (1) water diversion from the main stem Sacramento River into the Central Delta via the Delta Cross Channel; (2) upstream or reverse flows of water in the lower San Joaquin River and southern Delta waterways; (3) entrainment at the CVP/SWP export facilities and associated problems at Clifton Court Forebay; and (4) increased exposure to introduced, non-native predators such as striped bass, largemouth bass, and sunfishes (Centrarchidae). On June 4, 2009, NMFS issued a biological and conference opinion on the long-term operations of the CVP and SWP (NMFS 2009). As a result of the jeopardy and adverse modification determinations, NMFS provided a reasonable and prudent alternative (RPA) that reduces many of the adverse effects of the CVP and SWP resulting from the stressors described above. Several of the actions required by the RPA have been challenged in Federal court and their implementation is uncertain, thus rendering the improvements to the ecosystem tenuous and forestalling benefits to the affected salmonids and green sturgeon populations.

3. Water Conveyance and Flood Control

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of channels and diversions to increase channel elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. As Mount (1995) indicates, there is an “underlying, fundamental conflict inherent in this channelization.” Natural rivers strive to achieve dynamic equilibrium to handle a watersheds supply of discharge and sediment (Mount 1995). The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects.

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

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

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

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

4. Land Use Activities

Land use activities continue to have large impacts on salmonid habitat in the Central Valley watershed. Until about 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation extending outward for four or five 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 two 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 LWD input needed to form and maintain stream habitat that salmon depend on in their various life stages. In addition to this loss of LWD sources, removal of snags and obstructions from the active river channel for navigational safety has further reduced the presence of LWD in the Sacramento and San Joaquin Rivers, as well as the Delta.

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

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

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

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

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

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

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

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

5. Water Quality

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

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

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

Potential factors that contribute to these DO depressions are reduced river flows through the ship channel, released ammonia from the City of Stockton Wastewater Treatment Plant, upstream contributions of organic materials (*e.g.*, algal loads, nutrients, agricultural discharges) and the increased volume of the dredged ship channel. During the winter and early spring emigration period between 2000 and 2005, increased ammonia concentrations in the discharges from the City of Stockton Waste Water Treatment Facility lowered the DO in the adjacent Stockton deep water shipping channel near the West Complex. In addition to the adverse effects of the lowered DO on salmonid physiology, ammonia is in itself toxic to salmonids at low concentrations. Actions have been taken to remedy this source of ammonia by modifying the treatment train at the wastewater facility. Likewise, adult fish migrating upstream will encounter lowered DO in the deep water shipping channel as they move upstream in the fall and early winter due to low flows and excessive algal and nutrient loads coming downstream from the upper San Joaquin River watershed. There is insufficient flow to adequately mix the water mass and maintain the necessary level of DO. Currently, an aerator located at the West Complex is being utilized to help reduce the incidence of low DO concentrations in this reach of the deep water shipping channel when conditions warrant it. Levels of DO below 5 mg/L have been reported as delaying or blocking fall-run Chinook salmon in studies conducted by Hallock *et al.* (1970).

6. Hatchery Operations and Practices

Five hatcheries currently produce Chinook salmon in the Central Valley and four of these also produce steelhead. Releasing large numbers of hatchery fish can pose a threat to wild Chinook salmon and steelhead stocks through genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs in the Central Valley primarily are caused by straying of hatchery fish and the subsequent interbreeding of hatchery fish with wild fish. In the Central Valley, practices such as transferring eggs between hatcheries and trucking smolts to distant sites for release contribute to elevated straying levels (Department of the Interior 1999). For example, the original source of steelhead broodstock at Nimbus Hatchery on the American River came from the Eel River basin and was not from the Central Valley. Thus, the progeny from that initial broodstock served as the basis for the hatchery steelhead reared and released from the Nimbus Fish Hatchery. One of the recommendations in the Joint Hatchery Review Report (NMFS and CDFG 2001) was to identify and designate new sources of steelhead brood stock to replace the current Eel River origin brood stock.

Hatchery practices as well as spatial and temporal overlaps of habitat use and spawning activity between spring-run Chinook salmon and fall-run Chinook salmon fish have led to the hybridization and homogenization of some subpopulations (CDFG 1998). As early as the 1960s, Slater (1963) observed that early fall-run and spring-run Chinook salmon were competing for spawning sites in the Sacramento River downstream of Keswick Dam, and speculated that the two runs may have hybridized. The FRFH spring-run Chinook salmon have been documented as straying throughout the Central Valley for many years (CDFG 1998), and in many cases have been recovered from the spawning grounds of fall-run Chinook salmon, an indication that FRFH spring-run Chinook salmon may exhibit fall-run Chinook salmon life history characteristics. Although the degree of hybridization has not been comprehensively determined, it is clear that the populations of spring-run Chinook salmon spawning in the Feather River and counted at RBDD contain hybridized fish.

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

The increase in Central Valley hatchery production has reversed the composition of the steelhead population, from 88 percent naturally-produced fish in the 1950s (McEwan 2001) to an estimated 23 percent to 37 percent naturally-produced fish by 2000 (Nobriga and Cadrett 2001), and less than 10 percent currently (NMFS 2011b). The increase in hatchery steelhead production proportionate to the wild population has reduced the viability of the wild steelhead populations, increased the use of out-of-basin stocks for hatchery production, and increased straying (NMFS and CDFG 2001). Thus, the ability of natural populations to successfully reproduce and continue their genetic integrity likely has been diminished.

The relatively low number of spawners needed to sustain a hatchery population can result in high harvest-to-escapements ratios in waters where fishing regulations are set according to hatchery population. This can lead to over-exploitation and reduction in the size of wild populations existing in the same system as hatchery populations due to incidental bycatch (McEwan 2001). Currently, hatchery produced fall-run Chinook salmon comprise the majority of fall-run Chinook salmon adults returning to Central Valley streams. Based on a 25 percent constant fractional marking of hatchery produced fall-run Chinook salmon juveniles, adult escapement of fin clipped fish greater than 25 percent in Central Valley tributaries would indicate that hatchery produced fish are the predominate source of fish in the spawning population. Recent surveys (2010) have seen percentages approaching this or exceeding it in area tributaries (Williams 2011). This trend has also been observed with the 2011 returns of fall-run Chinook salmon, in which ad-clipped fish make up more than 25 percent of the observed fish spawning in area rivers.

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

7. <u>Over Utilization</u>

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

Extensive ocean recreational and commercial troll fisheries for Chinook salmon exist along the northern and central California coast, and an inland recreational fishery exists in the Central Valley for Chinook salmon and steelhead. Ocean harvest of Central Valley Chinook salmon is estimated using an abundance index, called the Central Valley Index harvest index. The Central Valley Index is the sum of the ocean fishery Chinook salmon harvested south of Point Arena (where 85 percent of Central Valley Chinook salmon are caught), plus the Central Valley adult Chinook salmon escapement. The Central Valley Index harvest index is the ocean harvest landed south of Point Arena divided by the Central Valley Index. Coded wire tag returns indicate that Sacramento River salmon congregate off the California coast between Point Arena and Morro Bay.

Ocean fisheries have affected the age structure of Central Valley spring-run Chinook salmon through targeting large fish for many years and reducing the numbers of 4- and 5-year-old fish (CDFG 1998). Few, if any 4- and 5-year old fish survive the additional years in the ocean to return as spawners. These fish would be greater than the minimum size limits that would protect younger fish from harvest in the ocean during the regulated fishing season.

As a result of very low returns of fall-run Chinook salmon to the Central Valley in 2007 and 2008, there was a complete closure of commercial and recreational ocean Chinook salmon fishery in 2008 and 2009, respectively. Salmon fisheries were again restricted in 2010 with a limited fishing season due to poor returns of fall-run Chinook salmon in 2009. The Sacramento River winter-run Chinook salmon population increased by approximately 60 percent in 2009, but declined again in 2010 to 1,596 fish. In 2011, the estimated adult escapement of winter-run Chinook salmon fell to 824 fish. A similar trend has been seen in the spring-run Chinook salmon population in the Central Valley following the ocean salmon fishery closures. Contrary to expectations, even with the 2 years of ocean fishery closures, the Central Valley spring-run Chinook salmon population continued to decline in 2010. Adult escapement was up slightly in 2011 by approximately 1000 fish basin wide, but the tributary and basin CRRs were still less than 1, indicating that the cohorts were not replacing themselves. Populations held steady or declined in Deer and Mill creeks, but increased by about 1,000 fish in Butte Creek (GrandTab February 2011, CDFG survey data 2011). Ocean harvest rates of Central Valley spring-run

Chinook salmon are thought to be a function of the Central Valley Index (Good *et al*. 2005). Harvest rates of Central Valley spring-run Chinook salmon ranged from 0.55 to nearly 0.80 between 1970 and 1995 when harvest rates were adjusted for the protection of Sacramento River winter-run Chinook salmon. The drop in the Central Valley Index in 2001 as a result of high fall-run Chinook salmon escapement to 0.27 also reduced harvest of Central Valley spring-run Chinook salmon. The 2011 status review for spring-run Chinook salmon (NMFS 2011a) reported that the fall-run Chinook salmon ocean harvest rate peaked in the late 1980's at 84 percent and then steadily declined over the 1990's to an average level of 51 percent from 2000-2007. The fall-run Chinook salmon harvest index is used as a proxy for the harvest of spring-run Chinook salmon. As mentioned previously, the closure of ocean commercial and sport fisheries in 2008 and 2009, and a reduced season in 2010 sharply reduced the harvest index (6 percent in 2008, 0 percent in 2009, and an estimated 22 percent for 2010). NMFS concluded in its 2011 status review that the ocean fishery did not result in overutilization of this ESU since the last status review in 2005 due to substantially reduced fishing pressure in 2008, 2009, and 2010. There is essentially no ocean harvest of steelhead.

b. Inland Sport Harvest –Chinook Salmon and Steelhead

Historically in California, almost half of the river sport fishing effort was in the Sacramento-San Joaquin River system, particularly upstream from the city of Sacramento (Emmett *et al.* 1991). Since 1987, the Fish and Game Commission has adopted increasingly stringent regulations. In-river recreational fisheries historically have taken Central Valley spring-run Chinook salmon throughout the species' range. During the summer, holding adult Central Valley spring-run Chinook salmon are easily targeted by anglers when they congregate in large pools. Poaching also occurs at fish ladders, and other areas where adults congregate; however, the significance of poaching on the adult population is unknown. Specific regulations for the protection of Central Valley spring-run Chinook salmon in Mill, Deer, Butte, and Big Chico creeks and the Yuba River have been added to the existing CDFG regulations. The current regulations provide some level of protection for spring-run Chinook salmon (CDFG 1998).

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

c. Green Sturgeon

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

Green sturgeon are caught incidentally by sport fisherman targeting the more highly desired white sturgeon within the Delta waterways and the Sacramento River. New regulations which went into effect in March 2007, reduced the slot limit of sturgeon from 72 inches to 66 inches, and limit the retention of white sturgeon to one fish per day with a total of 3 fish retained per year. In addition, a non-transferable sturgeon punch card with tags must be obtained by each angler fishing for sturgeon. All sturgeon caught must be recorded on the card, including those released. All green sturgeon must be released unharmed and recorded on the sturgeon punch card by the angler. In 2010, further restrictions to fishing for sturgeon in the upper Sacramento River were enacted between Keswick Dam and the Highway 162 Bridge over the Sacramento River near the towns of Cordora and Butte City. These regulations are designed to protect green sturgeon in the upper Sacramento River from unnecessary harm due to fishing pressure (CDFG freshwater fishing regulations 2010-2011).

Poaching rates of green sturgeon in the Central Valley are unknown; however, catches of sturgeon occur during all years, especially during wet years. Unfortunately, there is no catch, effort, and stock size data for this fishery which precludes making exploitation estimates (USFWS 1995-volume 1). Areas just downstream of Thermalito Afterbay outlet and Cox's

Spillway, and several barriers impeding migration on the Feather River may be areas of high adult mortality from increased fishing effort and poaching. The small population of sturgeon inhabiting the San Joaquin River (believed to be currently comprised of only white sturgeon) experiences heavy fishing pressure, particularly regarding illegal snagging and it may be more than the population can support (USFWS 1995-volume 1).

8. Disease and Predation

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

Accelerated predation also may be a factor in the decline of Central Valley spring-run Chinook salmon, and to a lesser degree Central Valley steelhead. Human-induced habitat changes such as alteration of natural flow regimes and installation of bank revetment and structures such as dams, bridges, water diversions, piers, and wharves often provide conditions that both disorient juvenile salmonids and attract predators (Stevens 1961, Decato 1978, Vogel *et al.* 1988, Garcia 1989).

On the main stem Sacramento River, high rates of predation are known to occur at the RBDD, Anderson-Cottonwood Irrigation District’s diversion dam, GCID’s diversion facility, areas where rock revetment has replaced natural river bank vegetation, and at South Delta water diversion structures (*e.g*., Clifton Court Forebay, CDFG 1998). In passing these structures, juveniles are subject to conditions which greatly disorient them, making them highly susceptible to predation by fish or birds. Sacramento pikeminnow and striped bass congregate downstream of and around structures and prey on juvenile salmon. The Sacramento pikeminnow is a species native to the Sacramento River basin and has co-evolved with the anadromous salmonids in this system. However, rearing conditions in the Sacramento River today (*e.g.*, warm water, low-irregular flow, standing water, and water diversions) compared to its natural state and function decades ago in the pre-dam era, are more conducive to warm water species such as Sacramento pikeminnow and striped bass than to native salmonids. Tucker *et al.* (1998) reported that predation during the summer months by Sacramento pikeminnow on juvenile salmonids increased to 66 percent of the total weight of stomach contents in the predatory pikeminnow. Striped bass showed a strong preference for juvenile salmonids as prey during this study. This research also indicated that the percent frequency of occurrence for juvenile salmonids nearly equaled other fish species in the stomach contents of the predatory fish. Tucker *et al.* (2003) showed the temporal distribution for these two predators in the RBDD area were directly related to RBDD operations (predators congregated when the dam gates were in, and dispersed when the gates were removed). With the near completion of a new fish screen and pumping facility, the gates at RBDD will remain open year round and predation should be even further reduced. Some predation is still likely to occur due to the physical structure of the dam remaining in the water way, even with the gates in the open position.

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

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

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

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

9. Environmental Variation

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al*. 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal Oscillation. In addition, large-scale climatic regime shifts, such as the El Niño condition, appear to change productivity levels over large expanses of the Pacific Ocean. A further confounding effect is the fluctuation between drought and wet conditions in the basins of the American west. During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years, which reduced inflows to watersheds up and down the west coast. A three year period of reduced precipitation from 2007 to 2009 is thought to have been a contributing factor to reduced salmonid populations in the Central Valley.

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

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

10. Ecosystem Restoration

a. Ecosystem Restoration Program

The Ecosystem Restoration Program (ERP) was created to improve conditions for fish, including listed salmonids, in the Central Valley (CALFED 2000). Restoration actions implemented by the ERP have included the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases.

b. *Central Valley Project Improvement Act*

The CVPIA, implemented in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the CVP. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program. The AFRP is engaged in monitoring, education, and restoration projects geared toward recovery of all anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines Federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the Water Acquisition Program is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the DOI’s ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for spring-run Chinook salmon and steelhead by maintaining or increasing instream flows in Butte and Mill creeks and the San Joaquin River at critical times.

c. *Iron Mountain Mine Remediation*

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

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

The Four Pumps Agreement Program has approved about $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreement inception in 1986. Four Pumps projects that benefit spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer creeks; enhanced law enforcement efforts from San Francisco Bay upstream to the Sacramento and San Joaquin rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and screening of diversions in Suisun Marsh and San Joaquin tributaries. Predator habitat isolation and removal, and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead (see Reclamation 2004 Chapter 15).

11. Non-Native Invasive Species

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

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

12. Summary

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

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

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

V. ENVIRONMENTAL BASELINE

ESA regulations define the environmental baseline as "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). The "effects of the action" include the direct and indirect effects of the proposed action and of interrelated or interdependent activities, "that will be added to the environmental baseline" (50 CFR 402.02); therefore, the environmental baseline provides a reference condition to which we add the effects of conducting the proposed action. Implicit in these definitions is a need to anticipate future effects, including the future component of the environmental baseline. Future effects of Federal projects that have undergone consultation and of contemporaneous State and private actions, as well as future changes due to natural processes, are part of the future baseline, to which effects of the proposed action are added.

The evaluation in the *Environmental Baseline* of the current extinction risk for each listed species within the Yuba River, and the condition of critical habitat for each population, provides a reference condition at the population scale to which NMFS will later add the effects of the proposed action in the *Integration and Synthesis* section of the biological opinion to determine if the action is expected to affect the population's risk of extinction. In addition, the effects of all past and present ongoing activities, other than the effects of the proposed action that will affect individual spring-run Chinook salmon, Central Valley steelhead, or green sturgeon southern DPS or the essential features of critical habitat are carried forward through the period of analysis for this action to form the context or baseline to which we add the expected effects of the proposed action. This future baseline forms the starting point for an assessment of how changes in individual fitness and condition of essential features of critical habitat affect the species and overall critical habitat designation. For this analysis, the action area includes the Yuba River from the mouth of the Feather River to in the upper Yuba River watershed where operational decisions are made that affect flow amounts and timing at Englebright Dam. This area was described in detail on page 8, under "Action Area".

A. Historical Conditions

Yoshiyama *et al*. (2001) reviewed the historical accounts of anadromous fish observations in the upper Yuba River. The text provided below suggests that spring-run Chinook salmon and Central Valley steelhead inhabited several locations in the upper Yuba River watershed:

1. <u>North Yuba River</u>

> "In the North Fork Yuba River, salmon were caught by PG&E workers in the Bullards Bar area during the 1898–1911 period of operation of the Yuba Powerhouse Project; the ditch tenders at the diversion dam "would nail two or three salmon on boards, place them body down in the ice-cold ditch stream, and ten hours later the night's dinner would come floating down" to the powerhouse on the valley floor (Coleman 1952, p 139). In later years, the salmon ascended in "considerable numbers" up to Bullards Bar Dam during its period of construction (1921–1924)—"so many salmon congregated and died below it that they had to be burned" (Sumner and Smith 1940). There are no significant natural barriers upstream of the Bullards Bar Dam site, so salmon presumably had been able to ascend a considerable distance up the North Fork. There is photographic evidence of steelhead (called "salmon-trout" in early writings) occurring farther upstream at Downieville at the mouth of the Downie River (CDFG file records)." (Yoshiyama *et al*. 2001).
>
> "Referring to the salmon runs in 1850 and 1851, the California Fish Commission (CFC 1875) stated that "large quantities were taken by the miners and by Indians… as far up as Downieville on the Yuba," and at other points on the American and Feather rivers. There are no natural obstructions from Downieville upstream to Sierra City, where Salmon Creek enters, so spring-run salmon and steelhead most likely were able to traverse that

> distance. Deep pools are present throughout the North Fork Yuba River from its mouth up to Sierra City (E.R. Gerstung, personal observation) and would have provided prime holding habitat for spring-run salmon. Spring-run salmon and steelhead probably ascended the higher-gradient reaches up to about two miles upstream of the juncture of Salmon Creek and their absolute upstream limit on the North Fork would have been Loves Falls." (Yoshiyama *et al*. 2001).

2. Middle Yuba River

> "In the Middle Fork Yuba River, there are no significant natural obstructions except for a 10-foot falls in the lower reach, and salmon possibly had access to a considerable portion of the Middle Fork. Both salmon and steelhead were observed in the lower part of the Middle Fork, near where the North Fork joins, during a DFG survey in 1938 (DFG unpublished data). Steelhead were found as far upstream as the mouth of Bloody Run Creek (DFG unpublished data). Whether salmon also reached that far remains conjectural, although it is likely that salmon ascended some unknown distance up the Middle Fork because other native fishes such as pikeminnow have been observed as far upstream as Box Canyon, several miles below Milton Reservoir (R. Cutter, personal communication to E.R. Gerstung, see "Notes"). However, direct information is lacking and it is uncertain if many salmon were able to surmount the 10-foot falls on the lower river; therefore, we conservatively consider the falls 1.5 mi upstream of the mouth as the effective upstream limit of salmon in the Middle Fork." (Yoshiyama *et al*. 2001).

3. South Yuba River

> "Similarly, little is known of the original distribution of salmon in the South Fork Yuba River—the salmon population was depressed and access up the stream long since obstructed by dams by the time the DFG surveys were conducted in the 1930s. There are records of salmon occurring within one to two miles upstream of the mouth of the South Fork Yuba River (DFG unpublished data). A substantial cascade with at least a 12-foot drop, located one-half mile below the juncture of Humbug Creek (CRA 1972; Stanley and Holbek 1984), may have posed a significant obstruction to salmon migration, but it was not necessarily a complete barrier. This cascade, or "step-falls," is similar in dimensions and conformation to cascades on other streams, which salmon are known to have surmounted (P. Lickwar, personal communication, see "Notes"). However, we presently take that cascade below Humbug Creek as essentially the historical upstream limit of salmon during most years of natural streamflows. Steelhead are known to have ascended the South Fork as far as the juncture of Poorman Creek near the present town of Washington (DFG unpublished data), and perhaps some spring-run salmon historically also reached that point." (Yoshiyama *et al*. 2001).

B. Past Impacts

1. Hydraulic Mining and Mass Transport of Mining Debris

Historically, the Yuba River supported large numbers of spring-run Chinook salmon, fall-run Chinook salmon, and steelhead. Extensive hydraulic mining in the late 1800s resulted in the massive influx of mining sediments that filled the lower river valleys and profoundly changed the physical character of the lower Yuba River (Moir and Pasternack 2008). The Yuba River suffered perhaps the most significant damage from hydraulic mining of any California river. Approximately 1.5 billion cubic yards of mining debris were washed into the Central Valley from five rivers, with the Yuba River accounting for 40 percent of that total (Mount 1995).

Gilbert (1917) as cited in Yoshiyama *et al*. (2001) estimates that "…*during the period 1849-1909, 684 million cubic yards of gravel and debris due to hydraulic mining were washed into the Yuba River system – more than triple the volume of earth excavated during the construction of the Panama Canal*", and Beak Consultants, Inc. (1989) states "*The debris plain ranged from about 700 feet wide and up to 150 feet thick near the edge of the foothills to nearly 3 miles wide and 26 feet tall near Marysville*" (Beak Consultants, Inc. 1989). In addition to eliminating much of the riparian vegetation corridor along the lower Yuba River (NMFS 2005b), the hydraulic mining debris had devastating impacts on salmonids because the sediments in these debris would have suffocated incubating eggs and pre-emergent fry. Even by the 1870s and 1880s, the Yuba River salmon runs had been greatly diminished by hydraulic mining debris effects (Yoshiyama *et al*. 2001). In addition, because mercury was used to extract gold from mining debris, mercury exists in the Yuba River system, and this mercury can be extremely toxic to salmonids.

Historical gold mining typically involved amalgamation using mercury. This extraction process resulted in elevated levels of mercury in the Yuba River and in Yuba River sediments. As bottom feeders, green sturgeon were likely to have picked up excessive amounts of mercury commonly found in sediments from gold-mining areas. Although historical spawning records do not occur for green sturgeon in the upper Yuba River, they were likely to have been impacted by the mining sediments and habitat inundations.

2. Debris Dams/Migration Barriers

The habitat degradation caused by mining debris was followed by the California Debris Commission construction of a series of impassable debris dams from the early to mid-1900s, leading to major reductions in salmon and steelhead populations in the Yuba River Basin (Yoshiyama *et al.* 2001).

a. Englebright Dam

The vast majority of salmonid spawning and rearing habitat in the Yuba River was first impacted by gold mining activities and then totally cut off by Englebright Dam in 1941. Prior to construction of Englebright Dam, fisheries biologists for CDFG stated that they observed large numbers of steelhead spawning in the uppermost reaches of the Yuba River and its tributaries (CDFG 1998, Yoshiyama *et al*. 1996). By 1969, CDFG estimated a spawning population of only about 200 fish annually. During the 1970s, CDFG annually stocked hatchery steelhead from Coleman National Fish Hatchery into the lower Yuba River, and by 1975 estimated a run size of about 2,000 fish (CDFG 1991). CDFG stopped stocking steelhead into the lower Yuba River in 1979.

Englebright Dam affects the transport of nutrients, fine and course sediments, and woody material from upstream sources to the lower river, and continues to limit habitat complexity and diversity in the lower Yuba River. By preventing upstream passage of salmonids, Englebright Dam also blocks marine-derived nutrients from entering the upper Yuba River watershed. Lack of salmon carcasses in the upper Yuba River watershed eliminates the nutrient and micro-nutrient boost that would have occurred if adult salmon were able to enter the watershed to spawn. A deficiency in marine-derived nutrients reduces the ability of the ecosystem to support large numbers of stream invertebrates and reduces the quantity of available food resources for juvenile salmonids rearing (Bilby *et al.* 1996, Bilby *et al.* 1998, Moore *et al.*2007, Wipfli and Baxter 2010, Zhang 2003).

Loss of access to much of their historic spawning and rearing habitat in the upper basin likely had particularly severe impacts on spring-run Chinook salmon and steelhead populations, which depended on the upper basin for successful summer holding and rearing (Yoshiyama *et al*. 1998; 2001).

Englebright Dam has forced overlapping use of the same spawning areas by spring-run and fall-run Chinook salmon (superimposition). Spring-run Chinook salmon move into spawning streams in the spring, hold over the summer in deep, cold-water pools, and then spawn in the late summer beginning in early to mid-September (Campbell and Moyle, 1992). Under natural conditions spring-run Chinook salmon would take advantage of high spring runoff conditions to migrate into the uppermost reaches of the Yuba watershed where they would spawn in areas spatially separated from the fall-run Chinook salmon. The fall-run Chinook salmon fish enter the river later in the year and are generally unable to reach the upper reaches due to low flow conditions and their need to spawn shortly after entering fresh water. These divergent life history strategies are what have separated the two runs of Chinook salmon creating distinctive genotypic and phenotypic characteristics between the two. The existence of Englebright Dam blocks the migration of spring-run Chinook salmon, forcing them to remain in the lower river while fall-run Chinook salmon arrive in the Yuba River and spawn in the same areas (superimposition). While fall-run Chinook salmon generally begin spawning a little later than spring-run Chinook salmon (starting in early October), there can be some overlap in timing, causing the two races to interbreed and dilute the genetics of the much smaller (in population size) spring-run Chinook salmon. There is also the potential, in areas heavily used by spawning fall-run Chinook salmon, for the later spawning fall-run Chinook salmon to superimpose their redds onto previously laid spring-run Chinook salmon redds (superimposition) thereby disrupting the spring-run Chinook salmon redds and reducing the survival of those eggs.

Although no historical accounts exist for identified green sturgeon spawning occuring upstream of the current dam sites, suitable spawning habitat existed and, based on habitat assessments done for Chinook salmon, the geographic extent of spawning has been reduced due to the impassable barriers constructed on the river. The narrows gorge provides optimal spawning conditions and it is likely that good spawning habitat existed in the upper Yuba River upstream of Englebright Dam. Lack of access to this habitat is likely to have depressed the local population of green sturgeon.

b. Daguerre Point Dam

Daguerre Point Dam was built in 1906. In 1911, crude fish ladders were constructed at each end of Daguerre Point Dam, but they were not very effective (DWR and Corps 2003b). After its construction, Daguerre Point Dam was reported to be a partial or complete barrier to salmon and steelhead for many years because of the lack of functional fish ladders (Mitchell 2010). However, although the dam made it difficult for spawning fish to migrate upstream, salmon reportedly did surmount that dam in occasional years because they were observed in large numbers in the North Yuba River at Bullards Bar during the early 1920s (Yoshiyama *et al.* 2001).

The 1911 fish ladders were destroyed by floods in 1927 and 1928 (CDFG 1991a), and were not replaced until the construction of new ladders in 1938, leaving a 10-year period when upstream fish passage at Daguerre Point Dam was blocked (CDFG 1991). That 10-year period coincided with the droughts of 1928 through 1934, which raised water temperatures below Daguerre Point Dam much higher than those tolerated by Chinook salmon (Mitchell 1992). These conditions probably caused the extirpation of spring-run Chinook salmon from the lower Yuba River (Mitchell 1992). The fish ladders constructed in 1938 consisted of 8- by 10-foot bays arranged in steps with about 1 foot of difference in elevation between steps. The fish ladder installed at Daguerre Point Dam in 1938 was generally ineffective, and functional fish ladders were not installed until 1950 (CDFG 1991). However, passage at the dam was considered to remain impeded, and CDFG (1953) reported that adequate fish ladders only were later provided in about 1950–1952. Fish ladders were reconstructed by the State of California after flood washouts in 1954 and 1964 (Corps 2005).

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In 2001 the Corps 2001 considered poaching of adult salmon at the Daguerre Point Dam fish ladders at the base of the dam to be a persistent problem, because poachers have tampered with fish ladders to block passage and to enhance poaching success. Poaching of adult Chinook salmon at the Daguerre Point Dam fish ladders has been well documented by CDFG. Metal gates were put over all but the lower eight bays of the fish ladders in 2011.

Maintenance of the fish ladders at Daguerre Point Dam has been inconsistent during the past decade. In 2000, the Corps implemented dredging of the sediment in the area immediately upstream of the exit of the north fish ladder as a conservation measure to provide improved fish passage (NMFS 2002). A sediment management plan has been in place since 2003; however, actual sediment removal only followed the 2009 litigation. VAKI Riverwatcher data shows periodic declines in salmonid use of the ladders that are blocked with sediment. These declines were resolved after the 2010 sediment removal.

In August 2009, the Corps removed sediment and gravel from the channel upstream of Daguerre Point Dam. The Corps deposited the material over the face of Daguerre Point Dam, to serve as a source from replenishing gravel/material downstream. This work was performed in coordination with and with the approval of the USFWS and NMFS. In late August 2010, the Corps removed sediment that had accumulated on the north side of the channel upstream of Daguerre Point Dam and the material that was removed was disposed of above the ordinary high water mark. During August 2011, the Corps removed sediment that had accumulated upstream of Daguerre Point Dam and placed that excavated material above the ordinary high water mark.

Corrections have been made to improve ladder efficiency, and in 2003 the Corps installed a log boom to the north ladder exit to divert debris away from the ladder. In June 2010, CDFG installed flashboards in the lower bays of the south fish ladder in an effort to improve attraction flows to the south ladder. Since completing this work, CDFG reported that the number of fish moving through the south ladder increased compared to numbers recorded prior to installation of the flashboards. It is likely that the 2010 sediment removal also helped get fish up the south ladder.

The Interim Remedy Order issued by the Court on July 25, 2011 determined that improved management of the flashboards at Daguerre Point Dam would benefit the listed species by improving the ability of the fish to migrate upstream to spawning and rearing habitats. Measure No. 2 stated that the Corps was to develop a written plan for the systematic use of moveable flashboards on Daguerre Point Dam to manipulate the flows through the north fish ladder within six weeks of issuance of the order. The plan is to specify: (1) how the flashboards can be used to maximize fish passage at Daguerre Point Dam; (2) the lower Yuba River flow conditions that will prompt both the placement or removal of the flashboards; (3) the location where the flashboards will be placed under different river flow scenarios; and (4) any other pertinent criteria related to operating the flashboards in a manner that best facilitates fish passage at Daguerre Point Dam. The plan must also specify that the Corps will: (1) monitor the flashboards at least once per week to make sure that they have not collected debris that might contribute to juvenile fish mortality; and (2) continually adjust the plan for operation and maintenance of flashboards based upon the information generated through monitoring efforts.

Past operational criteria fish ladder gate operations required that the ladders be physically closed during high flows. This gate closure tended to coincide with upstream migration of salmonids.

On October 20, 2010, CDFG advised the Corps that staff from the PSMFC had documented that several fall-run Chinook salmon that had jumped out of the south fish ladder over the previous 4 to 6 weeks. That same day, Corps staff placed plywood boards over the bay as a temporary measure to prevent any more fish from escaping the ladder. In 2011, the Corps installed grating over the fish ladders to reduce ladder mortality.

Figure V-a. Installation of metal grates on the Daguerre Point Dam fish ladder bays during August 2011 (from biological assessment).

3. Water Diversions

The hydrology of the Yuba River has been altered by a series of reservoirs and water conveyance facilities that are operated for water supply, hydropower production, and flood control (Mitchell 2010). Three projects export significant amounts of water from the upper Yuba River watershed: (1) South Feather Water and Power Agency (formerly Oroville-Wyandotte Irrigation District) diverts water from Slate Creek (a tributary to the North Yuba River) to the South Fork Feather River via its South Feather Power Project; (2) PG&E's South Yuba Canal diverts water from the South Yuba River, some of which is consumptively used by the Nevada Irrigation District (NID) and some of which is released into the Bear River watershed; (3) PG&E's Drum-Spaulding Project (supported by the prior two diversions) diverts water from the South Yuba watershed, via the Drum Canal, to the Drum Forebay. Three projects export significant amounts of water from the lower Yuba River: (1) South Yuba/Brophy Diversion on the south side of Daguerre Point Dam; (2) Hallwood-Cordua Diversion on the north side of Daguerre Point Dam, predates construction of Daguerre Point Dam, and (3) the Browns Valley diversion, east of Daguerre

Point Dam. Two reservoirs retain water from entering the lower Yuba River between Englebright and Daguerre Point dams: (1) Lake Wildwood and (2) Merle Collins Reservoir.

a. Upper Yuba River Impoundments and Diversions

Water used at PG&E's Drum Powerhouse is released to the Bear River watershed. If the water is not used there, it is released to Canyon Creek (a tributary of the north fork of the North Fork American River), where it is eventually used for consumptive purposes by Placer County Water Agency and other entities. The amount of water that these projects collectively exported from the upper Yuba River watershed ranges between 589,000 acre-feet (17.3 percent of unimpaired runoff in wet years) and 267,000 acre-feet (31.1 percent of unimpaired runoff) in critical years[5] (SWRI *et al*. 2000). Water from Milton Reservoir is diverted from the Middle Yuba River to Bowman Lake, to Lake Spaulding on the South Yuba River. The impairment of the runoff in the lower Yuba River resulting from these collective diversions is particularly high during the April through September period during snowmelt runoff, reaching an average of 43.2 percent of the runoff in critical years and an estimated 50.7 percent during hydrologic conditions like those that occurred in 1931 (SWRI *et al*. 2000).

The minimum releases from Spaulding Dam result in a thermal barrier to salmonids in the South Yuba River (DWR 2007). Although Spaulding Dam releases changed in 2004, to releasing colder water from the lower outlet on the dam, the data logger was lost (DWR 2007). The warmwater input from Jordan Creek has not been analyzed to determine whether its contribution ameliorates the cold water releases from Lake Spaulding.

b. Lower Yuba River Impoundments and Diversions

The South Yuba-Brophy diversion has been diverting water from the south side of Daguerre Point Dam since 1983. The diversion was fitted with a loose cobble weir which, although intended to protect juvenile fish from becoming entrained into the canal, does not meet California Department of Fish and Game (CDFG) or NMFS screening criteria. In addition to entrainment, the clear deep water at the intake to the diversion is likely to be a predator field where juvenile salmonids are vulnerable to predation.

The interstitial spaces between the rocks making up South Yuba-Brophy diversion weir are much larger than the required 3/32 inches defined in the NMFS Fish Screening Criteria for Anadromous Salmonids. There is a fine meshed fabric buried within the weir which may meet the opening size criteria (if it is still intact) but there is obviously no sweeping flow along the face of this fabric inside of the weir and therefore any fry which encounter this mesh, instead of being swept along the face of the fabric, would be more likely to become impinged on the fabric and perish.

Sweeping flows along the face of the weir are often minimal and occasionally non-existent. By agreement with the CDFG, at least 10 percent of the water diverted from the Yuba River must bypass the weir structure. The stipulated 10 percent bypass flow is not always met (USFWS

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[5] Water year types are defined by the Yuba River Index of SWRCB Decision 1644.

1990) and at times there has been no bypass flow at all with the outlet channel running completely dry.

There have also been several studies which have shown that the South Yuba-Brophy diversion rock weir structure does not exclude juvenile salmonids from being entrained into this diversion. On several occasions, fishery biologists have captured juvenile salmonids that were entrained behind the barrier either by passing through the weir or being washed over the top during high flows (USFWS 1990, Demko and Cramer 1994).

A mark recapture study conducted by CDFG in May of 1988 found that approximately 50 percent of juvenile salmon that were released at the top of the intake channel were subsequently recaptured below the diversion weir in the outflow bypass channel (CDFG 1988). It is possible that some of those fish escaped the diversion without being captured in the two fike nets which spanned the outflow channel; but even so, this data provides a strong indication that fish are being lost at this diversion.

In 2002 NMFS issued a biological opinion to the Corps that required contemporary screening of the diversion point. The Corps considers that compliance rests with the licensee, formerly South Yuba Water District and now YCWA, but no measures were taken to reduce entrainment or predation at the diversion point. In 2007 the Corps offered to coordinate with YCWA, the Brophy Irrigation District, NMFS, CDFG, and the USFWS to conduct a feasibility study to investigate the potential design, location and costs of a screen to replacement the porous rock weir at the South Yuba/Brophy diversion. In 2007 NMFS issued a biological opinion on Corps operations of Engelbright and Daguerre Point Dams, which included a reasonable and prudent measure requiring the Corps to diligently pursue the ongoing effort to fully screen the South Yuba/Brophy diversion to meet all CDFG and NMFS screening criteria.

The Hallwood-Cordua diversion is located on the north side of Daguerre Point Dam with the intake facilities directly connected to the superstructure of the dam. The flood of December 1964, estimated at about 180,000 cfs, also washed out the headworks and retaining walls of the Hallwood-Cordua diversion structure and the upstream portion of the right bank fishway. Temporary repairs of the damage were made in February and March 1965. Permanent repairs were initiated in July 1965 and completed in October 1965 (Corps 1966). There is an interim fish screen on the Hallwood-Cordua Canal approximately 0.25 mile down the canal from the river, which was rebuilt in the spring of 2000 by the Cordua Irrigation District. Although the new screen does not fully meet all CDFG and NMFS criteria, the rehabilitation efforts have greatly improved the effectiveness of the screen by creating favorable hydrological conditions along the face of the screen, allowing continuous operation of the screen throughout the irrigation season and providing direct return of entrained fish back to the river below the dam. The interim fish screen prevented mortality of millions of salmonids annually. The Hallwood-Cordua diversion provides irrigation water to the District 10 - Hallwood area. The Hallwood Irrigation District is entitled to 78,000 acre-feet of Yuba River water annually, and the Cordua District is entitled to 82,000 acre-feet annually. There are two predator fields at the Hallwood-Cordua diversion: the diversion canal and the fish return pipe. The predation level is high in the diversion canal and accounts for much of the mortality at the diversion (Hall 1979). The return flow from the Hallwood-Cordua fish screen enters into the lower Yuba River where a predator field has developed, likely in response presence of abundant juvenile fish in the water column at the outfall (Hall 1979). Although the fish screen was modified in 2000, no predator control has occurred at the Hallwood-Cordua diversion and salmonid loss at this facility is likely to have been a chronic stressor on outmigrating salmonids.

At the Browns Valley diversion facility, a state-of-the-art fish screen was installed at the in 1999 which meets all current NMFS and CDFG screening criteria and is no longer considered to pose a threat of entrainment for juvenile salmonids. Approximately 4,200 feet upstream of Daguerre Point Dam, the Browns Valley Canal diverts water from the north bank of the river at estimated flows of up to 100 cfs. The water enters an excavated side channel and is then pumped up into the canal. Currently, these pumps are screened with a device that meets CDFG and NMFS screening criteria. Although this diversion depends on the elevated head provided by Daguerre Point Dam to draw its water, it is not licensed by the Corps as it has no direct physical link to Corps property. The side channel leading to the pumps is likely to be a predator field, but there is some riparian cover that would reduce predation effects. The side channel is likely to be a chronic stressor in outmigrating salmonids, but less of a stressor than the predator fields in the vicinity of Daguerre Point Dam.

The Browns Valley Diversion serves a 50,000-acre area for irrigation from Englebright Dam to the Browns Valley and Loma Rica areas north to the Butte County line. The Browns Valley Irrigation District is entitled to 25,687 acre-feet annually. The water is drawn primarily from the Merle Collins Reservoir on Dry Creek (tributary to the lower Yuba River) and some from the Yuba River. Reduction of flows into Dry Creek, resulting from impoundment and diversion at the Merle Collins Reservoir has resulted in a baseline reduction of Central Valley steelhead spawning and rearing habitat in Deer Creek and at the confluence of Deer Creek and the lower Yuba River.

Lake Wildwood, a residential community and lake, impounds water for municipal use and hydropower. Hydropower operations at Lake Wildwood have resulted in flows that are markedly different from the natural flow regime. Even small hydropower operations disrupt the natural flow regime of a river. Lake Wildwood operations have changed the quantity, timing, and rate of change of hydrologic conditions in Deer Creek. Lake Wildwood has reduced subsistence flows for salmonids in Deer Creek, and the creek is unlikely to provide the minimum flow needed during critical drought periods to maintain tolerable water-quality conditions and to provide minimal aquatic habitat space for the survival of aquatic species. The winter high-flows and storm flows have been held back at Lake Wildwood, resulting in a long-term suppression of rearing habitat.

4. Hydropower

Hydropower in the Yuba River watershed consists of the Yuba River Project, the dams of which are discussed below, the multi-project, multi-dam Yuba-Bear/Drum-Spaulding Project, which was discussed above, and Lake Wildwood. Our House and Log Cabin diversion dams are included under the discussion of New Bullards Bar.

On March, 2011, NMFS submitted a study request to FERC asking that YCWA: (1) develop three hydrologic data sets to compare Project hydrology with unimpaired hydrology and the effects of other developments within the watershed; (2) conduct a log-Pearson type III flood frequency analysis on all three data sets calculating magnitude return intervals, and duration of pulse flows for each scenario at a list of locations; (3) compute the timing, magnitude, duration, and volume of historical spill events below New Bullards Bar, Our House Diversion, Log Cabin Diversion, and Englebright dams; (4) Analyze the 15-minute data from water years 1970-2010 below the New Colgate and Narrows 2 powerhouses and 1-hour data for water years 1970-2010 below the Log Cabin and Our House diversion dam; (5) calculate the exceedance probability of change in flow and stage in 15 minute and 1 hour intervals for the New Colgate and Narrows 2 powerhouses and 1 hour interval for the Log Cabin and Our House diversion dams for up-ramps and down-ramps as observed during the period of record; (6) develop at two-dimensional model; and (7) examine effects of the powerhouse discharge and ramping rate on the hydraulic characteristics of the reaches below Colgate Powerhouse.

a. New Bullards Bar Dam and Reservoir

New Bullards Bar Reservoir is the largest water storage reservoir in the watershed. This reservoir is operated for flood control, power generation, irrigation, recreation, and protection and enhancement of fish and wildlife. Since 1970, operation of New Bullards Bar Reservoir has modified the seasonal distribution of flows: (1) in the upper Yuba River by releasing only five cfs year-round between New Bullards Bar Dam and the Colgate Powerhouse, and (2) in the reducing spring flows in the Yuba River below Colgate Powerhouse and increasing summer and fall flows. The Colgate Powerhouse releases translate to the same pattern of reduced spring flows and increased summer and fall flows between Englebright Dam and Daguerre Point Dam. New Bullards Bar Reservoir also contributes to cooler water in the lower Yuba River downstream of Englebright.

Although the New Colgate Powerhouse can be used for a combination of peaking and base generation, New Colgate Powerhouse is mostly operated as a peaking facility. Under peaking operations, releases through the powerhouse are concentrated to hours of the day when power is most valuable or when power is needed most (such as weekdays from mid-morning through early evening, largely corresponding to warmer times of the day and/or peak workday and early evening hours). New Colgate Powerhouse ramps up and down typically at least once a day from a few cfs to close to full flow for peaking operations, and can ramp up and down as much as 1,000 cfs or more several times each day for ancillary services. YCWA has been conducting spring-run Chinook salmon and Central Valley steelhead redd dewatering and fry stranding studies since 2002 (YCWA 2010). Although FERC license provisions are in place to reduce stranding, it has occurred as a result of peaking and ramping.

b. Englebright Dam and Reservoir

Following the construction of New Bullards Bar Dam in 1969, the burden of flood control for the Yuba Basin was shifted from Englebright Lake to New Bullards Bar Reservoir, and Englebright Lake has since been kept nearly full most of the time (FERC 1992). As water is released from New Bullards Bar Dam for uses such as hydroelectric power, irrigation, and fisheries, the typical drawdown from July to December in Englebright Lake is about nine feet. Water is released either through the Narrows I powerhouse (capacity of 730 cfs) or through the Narrows II powerhouse (capacity of 3,425 cfs). If Englebright Lake is full, surface water from the lake spills over the dam in excess of what can be handled through the hydroelectric power facilities. The flows into Englebright Lake are managed upstream at New Bullards Bar Reservoir and to a lesser extent, at other upstream reservoirs, which are filled by natural runoff from the North, Middle, and South Yuba River sub-basins.

c. Lake Wildwood Dam and Reservoir

Lake Wildwood operations and resultant Deer Creek flow fluctuations (according to the SWRCB's Revised Decision 1644, Lake Wildwood is operated by the Lake Wildwood Association — a gated community in Penn Valley, California). There is a potential for stranding or isolation events to occur in Deer Creek, near its confluence with the lower Yuba River. Observational evidence suggests that, in the past, adult Chinook salmon entered Deer Creek during relatively high flow periods, presumably for holding or spawning purposes, only to subsequently become stranded in the creek when flows receded due to changes in Lake Wildwood operations. Stranding may delay or prevent adult Chinook salmon from spawning, or cause decreased spawning success due to increased energy expenditure or stress due to delayed spawning (Boggs *et al*., CALFED and YCWA 2005).

5. Hatchery Influence

Spring-run Chinook salmon of hatchery origin have historically spawned in the Yuba River. It is estimated to be between 2.9 and 63.0 percent of the spring-run Chinook salmon spawning upstream of Daguerre Point Dam are of hatchery origin.

The FRFH was built in 1967 as partial mitigation for the construction of Oroville Dam. Brood stock from the Yuba River was used in the early hatchery effort. Spring-run Chinook salmon from the FRFH were planted in the lower Yuba River during 1980 (CDFG 1991). The FRFT has a goal of releasing 2,000,000 spring-run Chinook salmon smolts annually (DWR 2004c). The FRFH spring-run Chinook salmon are substantially introgressed with fall-run Chinook salmon, due to run time overlap at the FRFH. In 2004 FRFH implemented a spring tagging effort, to separate hatchery spawning of the two runs. Hatchery salmonids adversely affect the reproductive fitness of wild salmonids (Araki *et al*. 2007), and competition between hatchery and natural salmonids in the ocean can also lead to density-dependent mechanisms that affect natural salmonid populations, especially during periods of poor ocean conditions (Beamish *et al.* 1997a; Levin *et al.* 2001; Sweeting *et al.* 2003).

In 2003, the Corps granted CDFG a license to install and operate electronic fish counting devices, referred to as a VAKI Riverwatcher infrared and photogrammetric system, in the fish ladders at Daguerre Point Dam. The VAKI Riverwatcher records were variable, during the first few years after installation, due to power issues and camera limitations. These issues were resolved and the VAKI Riverwatcher began to collect robust data on the number of hatchery fish passing at Daguerre Point dam.

Studies of the genetics of *O. mykiss* in California have shown that the lower Yuba River Central Valley steelhead are significantly introgressed with hatchery rainbow trout. The spring-run Chinook salmon from the FRFH introgressed significantly with fall-run Chinook salmon until tagging and separation efforts reduced this introgression. Hatchery influence has historically been a high stressor on both spring-run Chinook salmon and Central Valley steelhead populations.

6. Trout Planting

CDFG stocking records indicate that fish plantings in Englebright Reservoir have taken place from 1965 through 2007. During this period, over 756,000 rainbow trout, 228,320 Kokanee salmon (*O. nerka*), 6,973 lake trout (*Salvelinus namaycush*), nearly 28,000 brown trout (*Salmo trutta*), 4,000 Eagle Lake rainbow trout (*O. mykiss aquilarum*), 2,640 brook trout (*Salvelinus fontinalis*), 45 white crappie (*Pomoxis annularis*), and 80 black crappie (*P. nigro maculatus*) were planted (CDFG 2007). Planted species were primarily from the Shasta and San Joaquin hatcheries. As a result of litigation regarding CDFG's fish stocking program, CDFG did not plant Englebright Reservoir with hatchery trout until October 2011. All CDFG trout releases are triploid and not reproductively viable. However, there is no ban on private fish plants into the same waters where CDFG is barred from doing the same (deVilbiss 2009). PG&E plants diploid fish in Englebright Reservoir as a condition of PG&E's FERC license. These diploid trout are reproductively viable. During 2010, PG&E planted 2,500 pounds of rainbow trout in Englebright Reservoir.

7. Training Walls

In 2007, members of the South Yuba River Citizen's League informed a BLM ranger patrolling the Yuba Goldfields area that motorized vehicles were crossing a tall row of gravel tailings known as the "training wall", and had entered the riverfront parcel over salmon spawning redds (BLM 2008). The vehicle entry points over the training wall were documented by BLM staff during a subsequent site visit to the area (BLM 2008). Although motorized vehicle use has been occurring in the Yuba Goldfields since it was opened to public access in 2003, this occurrence was reportedly the first time that motorized vehicles had gone over the training wall into the river. BLM (2008) further stated that the river in this area is primarily used by spawning fall-run Chinook salmon, although it may also be used by spring-run Chinook salmon and steelhead. To protect anadromous salmonids, the BLM issued an emergency order in January of 2008 to temporarily (up to 6 months) close two parcels of public land to all motorized vehicle use (BLM 2008).

The training walls channelize the lower Yuba River and may have been the primary driver for the river downcutting and separating the Yuba River from its floodplain.

8. Disconnected Floodplain

The Yuba River below Englebright Dam still experiences a dynamic flood regime because uncontrolled winter and spring flows (Moir and Pasternack 2008) in above normal and normal water years, and the flows under the Yuba Accord have improve habitat in recent years, however, the flows in below average water years can be below the optimal depths for spawning and rearing spring-run Chinook salmon, as demonstrated by the flow habitat relationships modeled by Gallagher and Gard (1999). Managed river flows also reduce the amount of rearing habitat available for both spring-run Chinook salmon and Central Valley steelhead. The low flows disconnect the river from the floodplain rearing habitat reducing juvenile survival by decreasing cover and food availability and increasing competition and predation. Downcutting in the Yuba River, by as much as 30 feet, disconnects the river from a dynamic interaction with the floodplain by lowering the water table and reducing the amount of water available for the roots of riparian vegetation.

The biological assessment identified loss of floodplain habitat as a medium risk to spring-run Chinook salmon and Central Valley steelhead; however, floodplain habitat is a primary driver for riparian vegetation, retainment and generation of LWM, and foraging habitat for juvenile fish. Juvenile salmonid growth on floodplains is much greater than in-river (Sommers *et al*. 2001). Consequently, lack of floodplain connectivity is a high stressor to spring-run Chinook salmon and Central Valley steelhead populations.

9. Gravel Injection Below Englebright

In the 2007 NMFS biological opinion on the proposed action, NMFS required the Corps to develop and implement a long-term gravel augmentation program to restore quality spawning habitat below Englebright Dam and to use information from a pilot gravel injection project to develop and commence implementation of a long-term gravel augmentation program within three years (*i.e.*, by November 21, 2010). With the assistance of the University of California, Davis, the Corps completed the pilot injection project on November 30, 2007.

The pilot injection project involved placing 500 tons of gravel approximately 200 yards downstream of Englebright Dam. The Corps anticipated that high flows during winter and spring 2008 would help distribute the gravel in the reaches of the Yuba River below the dam. The Corps contracted University of California at Davis to perform preliminary monitoring of gravel movement from the pilot gravel project. Minimal amounts of gravel moved downstream between 2007 and 2009 due to the lack of high flows during the years since the pilot injection project was completed (Pasternack 2009).

A long-term GAIP was completed on September 30, 2010, and was submitted to NMFS. The Final EA and Finding of No Significant Impact were completed on November 17, 2010. The GAIP included a 2010 recommendation for an injection of 2,000 to 5,000 tons of gravel, and was referred to as a “pilot” measure because of the use of an innovative sluicing method. The Corps began injecting gravel into the reach of the Yuba River below Englebright Dam, just downstream of the PG&E’s Narrows I power plant (referred to as “Area A” in the GAIP), on November 20, 2010. Due to high river flows, the injection was suspended from December 20, 2010 to January 4, 2011, and then was resumed and the injection of 5,000 tons of gravel was completed on January 13, 2011.

10. Removal of bedload at Our House and Log Cabin Diversion Dams

In 2006 80,000 cubic yards of potential spawning gravel were removed from the Middle Yuba River at the Our House Diversion Pool and stockpiled near New Bullards Bar Reservoir (YCWA 2010).

11. Instream Woody Material Management Program

Few pieces of large wood are found within the reach of the lower Yuba River extending from Parks Bar to Hammon Bar, largely due to upstream dams disrupting downstream transport from the upper watershed and the overall lack of supply and available inventory along the riparian corridor of the river downstream of Englebright Dam (cbec *et al*. 2010).

In the 2007 biological opinion on the proposed action, NMFS required the Corps to initiate a study to determine an effective method of replenishing the supply of LWM in the lower Yuba River and to implement that method within four years (*i.e.*, by November 21, 2011). The Corps has not replenished the supply of LWM in the lower Yuba River, but has identified a potential source of LWM and initiated a study to determine a feasible method of woody material management.

LWM was lost to the Yuba River watershed from LWM extraction and burning at New Bullards Bar and Spaulding reservoirs. The removal of this LWM from the aquatic ecosystem reduced the amount of nutrients going into the ecosystem and limited the aquatic macroinvertebrate populations that would have been enhanced by retainment or reapplication of LWM into riverine habitat.

12. Aggregate Mining

The Western Aggregates facility mines and processes sand and gravel deposits within the Yuba Goldfields south of the Yuba River and north of Hammonton-Smartsville Road (Placer County 2007). The mine operates on approximately 2,000 acres, excavating sand and gravel deposits from previous gold dredger tailings. Mined aggregate material is hauled to an onsite processing plant that includes crushers, screeners, and a conveyor. No mine waste enters the Yuba River. The mitigated negative declaration for the mine (adopted March 23, 1977) estimated the mining rate to be about 600,000 tons per year (Placer County 2007).

In 2008, Western Aggregates and SYRCL, along with the Yuba River Preservation Foundation and Yuba Outdoor Adventures signed an Agreement in Principle to establish a conservation easement along three miles of river frontage of the Yuba River downstream of the Parks Bar Bridge (YubaNet 2008). The easement area, consisting of approximately 180 acres of land owned by Western Aggregates, will be used by the four signatories for habitat restoration for salmon, trout, and other native Yuba River species.

13. Suction Dredging

Since the 1960s, suction dredging has been used to extract gold, mercury amalgam, and mercury from Yuba River (CDFG 2010). This modern gold mining technique stirs up the sediments and the smaller particles are released into the river. Suction dredging has led to methylmercury, a toxic form of mercury easily taken up in the food web, to be found at elevated levels in the lower Yuba River (USGS 2011). Suction dredging is likely to cause bioaccumulation of mercury in salmonids

14. Waterway 13

Return flows in Waterway 13, in the Yuba Gold Fields, attract anadromous salmonids into the Yuba Goldfields through Waterway 13 where their migration is delayed. Because the water flowing out of Waterway 13 is natal-origin water, salmonids may persistently search for an upstream path back to the Yuba River and not return downstream and back out to the Yuba River where they can proceed to spawning habitat.

Efforts were undertaken to prevent anadromous salmonids from entering the Goldfields via Waterway 13 during the mid-1980s, 1997, and 2003. Each effort has proven unsuccessful. In May 2005, heavy rains and subsequent flooding breached the structure at the east (upstream facing) end. Subsequently, the earthen “plug” was replaced with a "leaky-dike" barrier intended to serve as an exclusion device for upstream migrating adult salmonids (AFRP 2010). During the spring of 2011, high flows in the lower Yuba River and high flows through the Yuba Goldfields once again caused the “leaky-dike” barrier at the entrance to Waterway 13 to wash out. In response to the recent loss of the “leaky-dike” barrier at Waterway 13, the Corps conducted a real estate investigation and determined that Waterway 13 is located on lands that are under the Corps’ jurisdiction.

15. Recreational Boating

On Englebright Reservoir, privately-owned Skipper’s Cove Marina provides mooring to hundreds of houseboats and pleasure craft at its facility. A small number of slips are on Corps property, and Skippers Cove Marina is situated adjacent to Corps’ recreational facilities. On New Bullards Bar Reservoir, Emerald Cove Marina provides mooring to hundreds of houseboats. Both reservoirs allow access for motorized watercraft. Houseboat effluent is removed via pumping. Both reservoirs have refueling stations for motorized watercraft. NMFS does not currently have access to spill records, but there is considerable algal accumulation at the Colgate Powerhouse outfall, indicating historical nutrient loading at New Bullards Bar. The proximal cause of the nutrient loading is likely to be occasional spills of human waste.

16. Urbanization and Human Population Growth

The population of Yuba County was 72,155 in 2010 and increased by 19.8 percent between 2000 and 2010 (U. S. Census Bureau 2010).

17. Fish Passage Reconnaissance

Fish passage improvement at Daguerre Point Dam has been the subject of various investigations and discussions for the past several years. In 1994, the USFWS prepared a Planning Aid Report (USFWS 1994), which reviewed fish passage issues related to Daguerre Point Dam. In 2000, the

Corps prepared the Hydrology and Hydraulic Design Report (Corps 2000), which compiled preliminary hydrologic information and was used by the Corps to study several hydraulic components associated with potential alternatives to improve fish passage at Daguerre Point Dam. The Corps (2001) prepared a preliminary fish passage improvement study of Daguerre Point Dam which was funded by the AFRP. The Corps also prepared a preliminary environmental baseline report and effects analysis (Corps 2001) which focused on the potential effects resulting from implementing the actions for the three primary alternatives identified and described in the accompanying preliminary planning report addressing fish passage at Daguerre Point Dam.

An analysis of potential benefits to salmon and steelhead from improved fish passage at Daguerre Point Dam was prepared by the Corps and DWR in 2003 (DWR and Corps 2003a). As part of the Daguerre Point Dam Fish Passage Improvement Project, the Corps in cooperation with DWR prepared a report which summarized hydrologic, hydraulic and sediment data for the lower Yuba River (DWR and Corps 2003b). Also associated with the Daguerre Point Dam Fish Passage Improvement Project, the Corps prepared a conceptual report on fish passage alternatives in 2003 (Corps 2003a).

Under authority of Section 216 of the Flood Control Act of 1970, the Corps prepared an Initial Appraisal Report in 2005 to determine if there is a Federal interest in implementing fish passage improvements at Daguerre Point Dam. On February 24, 2006, the South Pacific Division of the Corps determined that improvements at Daguerre Point Dam are in the Federal interest. This determination allowed the Sacramento District to request an initial $100,000 to initiate a study on the feasibility of improvements to fish passage at Daguerre Point Dam. The Sacramento District submitted budget requests for fiscal year 2007 and fiscal year 2008. However, funding associated with those budget requests was not approved by Congress.

The 2007 NMFS biological opinion required the Corps to complete the feasibility study of a fish passage improvement project at Daguerre Point Dam within five years (*i.e.*, November 21, 2012) and to begin implementing the Corps' preferred alternative within ten years (*i.e.*, November 21, 2017). However, the Corps does not have specific authorization to undertake major construction activities addressing the fish ladders at Daguerre Point Dam. To implement a major construction activity associated with fish passage at Daguerre Point Dam, the Corps must have Congressional authorization, a funding appropriation, and a cost share partner. On September 1, 2009, the Corps submitted a legislative proposal to its Headquarters office in Washington, DC seeking legislative authority and funding to conduct a reconnaissance study regarding fish passage in the Yuba River. The President's Budget for fiscal year 2012 for the Corps' Civil Works program included $100,000 for an environmental reconnaissance study regarding fish passage at Englebright and Daguerre Point dams. However, funding for the reconnaissance study was subsequently removed from the 2012 budget that was approved by Congress in 2011.

The NMFS-funded study to research the feasibility of various fish passage alternatives for reintroduction of anadromous fishes above Daguerre Point Dam is not a Corps' reconnaissance study, but it provides information that could be incorporated into a reconnaissance study or adopted as one. The *Yuba River Fish Passage: Conceptual Engineering Project Options* (MWH Americas 2010) addressed both volitional and assisted passage options.

C. Present Conditions and Impacts

Except for hydraulic mining, all of the historical impacts to the Yuba River are extant today. Rather than restate the all of the historical actions that have contributed to environmental baseline in the action area, we are summarizing the effects of the historical actions that continue to contribute environmental, physiological, and reproductive stress on Yuba River spring-run Chinook salmon, Central Valley steelhead, and green sturgeon populations today.

1. Lack of Access to Historical Spawning Habitat

Englebright Dam continues to present an impassable barrier to the upstream migration of anadromous salmonids and may allow limited downstream migration of juvenile *O. mykiss*. Englebright Dam blocks access by listed salmonids to the habitat upstream of the dam, including the many large and small tributaries which make up the upper watershed. It marks the upstream extent of currently accessible spring-run Chinook salmon and Central Valley steelhead habitat in the lower Yuba River. Englebright Dam is a very high stressor on Yuba River spring-run Chinook salmon and Central Valley steelhead populations.

Daguerre Point Dam continues to be an impediment to upstream migration of adult salmon and steelhead under certain conditions. Factors contributing to impeded adult spring-run Chinook salmon upstream passage: (1) periodic obstruction of the ladders by sediment and woody debris; (2) the fish ladder control gate entrance, acting as a submerged orifice, is more passable at low flows (actual flow data are unavailable) during the summer and fall than at high flows during winter and spring; (3) “masking” of the entrances to the ladders when overflow over the spillway occurs; (4) insufficient attraction flows during non-overflow operational conditions; (5) unfavorable fish ladder geometric configurations; (6) wounding and injury of adult salmon jumping into the face of the dam when they are unable to find the ladders; (7) proximity of the ladder exits to the spillway, potentially resulting in adult fish exiting the ladder being immediately swept by flow back over the dam; and (8) sediment accumulation and unfavorable habitat conditions at the upstream exits of the fish ladders, resulting in reduced unimpeded passage from the ladders to the main channel, and the potential for fish to fall-back into the ladders.

Both the north and south fish ladders at Daguerre Point Dam, particularly the north ladder, tend to clog with woody debris and sediment, which can block passage or substantially reduce attraction flows at the ladder entrances. Additionally: (1) the north and south ladders’ exits are close to the spillway, potentially resulting in adult fish exiting the ladder being immediately swept by flow back over the dam; (2) sediment accumulates at the upstream exits of the fish ladders, reducing the unimpeded passage from the ladders to the main channel, and may cause potential fall-back into the ladders; and (3) fish can jump out of the upper bays of the fishway, resulting in direct mortality.

Sheet flow across the dam’s spillway, particularly during high-flow periods, acoustically and physically obscures ladder entrances, making it difficult for immigrating adult salmonids to find the entrances. For example, fall-run Chinook salmon have been observed attempting to leap over the dam, demonstrating that these fish may have difficulty in finding the fish ladder entrances (Corps 2000). This phenomenon may particularly affect spring-run Chinook salmon, because peak spring-run adult Chinook salmon upstream migration occurs primarily during the relatively high-flow periods of spring through early summer. Since 2001, wooden flashboards have been periodically affixed to the crest of the dam during low flow periods to aid in directing the flows towards the fish ladder entrances. Fish passage monitoring data from 2006 indicates that the installation of the flashboards resulted in an immediate and dramatic increase in the passage of salmon up the ladders, and is thought to have improved the ability of salmon to locate and enter the ladders today.

At the two most recent Yuba River Symposiums, held on June 29, 2010, and on July 11, 2011, L. Alber from the PSMFC presented preliminary results of a fish tracking effort conducted by the Yuba Accord RMT (http://www.yubaaccordrmt.com). Recent information demonstrates that phenotypic spring-run Chinook salmon (Chinook salmon that enter the lower Yuba River during spring months) display much more variable upstream migration and holding patterns than previously reported. Phenotypic spring-run Chinook salmon (those entering the lower Yuba River during spring months) may remain in the lower Yuba River in areas downstream (and proximate) to Daguerre Point Dam for extended periods of time during the spring and summer. Now that ladder maintenance is regularly occurring, it is unclear whether, or to what extent, the duration of residency in the large pool located downstream of Daguerre Point Dam is associated with upstream passage impediment and delay, or volitional habitat utilization prior to spawning in upstream areas.

Delays resulting from adult spring-run Chinook salmon adult passage impediments are likely to weaken fish by requiring additional use of fat stores prior to spawning, and could potentially result in reduced spawning success (*i.e.*, production) from reduced resistance to disease, increased prespawning mortality, and reduced egg viability.

Daguerre Point Dam is likely to adversely affect outmigration success of juvenile salmon and steelhead. During downstream migration, juvenile Chinook salmon and steelhead may be disoriented or injured as they plunge over the spillway, increasing their exposure and vulnerability to predators in the large pool at the base of the dam. Daguerre Point Dam is a moderate to high stressor on Yuba River spring-run Chinook salmon and Central Valley steelhead populations.

As described in the Corps' biological assessment for the proposed action, Daguerre Point Dam is a complete barrier to upstream passage for green sturgeon because they are unable to ascend the fish ladders on the dam, or otherwise to pass over or around the structure. Green sturgeon occupy the lower Yuba River up to Daguerre Point Dam, and based on observations of green sturgeon at the dam and spawning behavior of adults during the spawning season, green sturgeon currently use the lower Yuba River for spawning, reproduction, and rearing. Daguerre Point Dam blocks North American green sturgeon from accessing the area between Daguerre Point and Englebright Dams, where deep pools and colder water provide more suitable habitat for spawning and rearing of green sturgeon than the area below the dam. The NMFS Central Valley green sturgeon critical habitat review team (CHRT) identified seven areas upstream from dams that are currently inaccessible to green sturgeon, including reaches upstream of Daguerre Point

Dam on the Yuba River. The CHRT found that conservation of the species cannot be achieved without designating the lower Yuba River as critical habitat based on the importance of the lower Yuba River as potential spawning habitat, its proximity to the Sacramento River and its potential increased value for the species with future habitat improvements (74 FR 52300). The lack of information on green sturgeon utilization of the Yuba River makes it difficult to determine how this blockage might affect green sturgeon abundance, productivity, spatial structure and genetic diversity, but there is the potential that all of these viability factors could be improved if green sturgeon had access to the areas upstream of Daguerre Point Dam. Mora *et al*. (2009) evaluated how impassable dams constrain the distribution of green sturgeon and found that Daguerre Point Dam blocks four plus or minus two kilometers of habitat in the Yuba River.

2. Entrainment and Impingement

Entrainment and impingement of juvenile salmonids remains as a stressor in the lower Yuba River. Entrainment represents a suite of potential negative impacts to juvenile fish that may occur while, or after, the fish encounter a diversion facility during facility operation. For instance, entrainment impacts may include the non-volitional recruitment of juveniles past a diversion facility and/or screening structure, or impingement upon diversion screens and physical damage to fish caused by diversion activities. As juvenile salmonids pass Daguerre Point Dam, physical injury may occur as they pass over the dam or through its fish ladders (SWRI 2002).

Water diversions in the lower Yuba River are year-round, but generally ramp up in the early spring and extend through the fall. During diversion-ramping, increased entrainment and impingement of juvenile salmonids occurs at both the Hallwood-Cordua and South Yuba/Brophy diversions.

Although the fish screen improvements at the Hallwood-Cordua diversion have reduced this stressor on juvenile salmonids, entrainment at Hallwood-Cordua diversion results in a high level of exposure to predation in the diversion canal and at the fish return pipe. At the Hallwood-Cordua diversion, two remaining stressors are likely to have a moderate impact on the population: (1) predation losses of emigrating fry and juvenile fall-run Chinook salmon may remain a limiting factor at this location, and (2) the configuration of the current return pipe and flows through the pipe may also be a limiting factor (CALFED and YCWA 2005).

As previously described, the South Yuba/Brophy system diverts water through an excavated channel from the south bank of the lower Yuba River in the vicinity of Daguerre Point Dam. Diversion at the South Yuba/Brophy diversion has increased 118 percent since 2005. The water is diverted through a porous rock weir that impinges and entrains fish. The current design of this rock structure does not meet NMFS or CDFG juvenile fish screen criteria (SWRI 2002). The diversion is likely to subject salmonids to the high stressors of predation, impingement, and entrainment. Therefore, the South Yuba/Brophy diversion facilities are a high stressor to outmigrant fry and juvenile salmonids, including both spring-run Chinook salmon and Central Valley steelhead.

The Corps has been participating with the Brophy Irrigation District, NMFS, CDFG, and the USFWS to investigate, design, and implement an economical plan to replace the current porous rock weir on the South Yuba/Brophy Diversion with a new positive barrier fish screen that will meet all current CDF and NMFS fish screen criteria for anadromous salmonids. This group is currently in the process of selecting its preferred alternative to conduct a full feasibility and engineering design study on.

In response to concerns over this biological opinion, South Yuba, Brophy, and Wheatland water districts and Dry Creek Mutual Water Company (collectively, the "South County Diverters") wrote a letter to NMFS on February 8, 2012, stating clearly that they cannot afford to replace the rock weir ("gabion") at the South Yuba/Brophy Diversion with a fish screen that meets current CDFG and NMFS screening criteria. The South County Diverters consider the rock weir to be located on private property and outside the Corps' authority.

No predator control program is in place at the South Yuba/Brophy Diversion and salmonid loss at this facility is likely to have been a severe and chronic stressor on outmigrating salmonids.

3. Lack of Instream Cover

The lower Yuba River has an outstanding deficiency of LWM, with only a handful of large pieces of LWM known to occur at Hammond Bar. The rest of the lower Yuba River is devoid of LWM

LWM creates both micro- and macro-habitat heterogeneity by forming pools, back eddies and side channels and by creating channel sinuosity and hydraulic complexity. This habitat complexity provides juvenile salmonids numerous refugia from predators and water velocity, and provides efficient locations from which to feed. Snorkeling observations in the lower Yuba River have indicated that juvenile Chinook salmon had a strong preference for near-shore habitats with instream woody material (JSA 1992).
In consideration of the importance that riparian vegetation and LWM play in the habitat complexity and diversity which potentially limits the productivity of juvenile salmonids, the relatively low abundance of these physical habitat characteristics in the lower Yuba River, and the fact that the loss of riparian habitat and instream cover in the form of LWM is a stressor that is manifested every year, it represents a relatively high stressor to Yuba River juvenile spring-run Chinook salmon and Central Valley steelhead.

Instream woody material provides escape cover and relief from high current velocities for juvenile salmonids and other fishes. LWM also contributes to the contribution of invertebrate food sources, and micro-habitat complexity for juvenile salmonids (NMFS 2007). Snorkeling observations in the lower Yuba River have indicated that juvenile Chinook salmon had a strong preference for near-shore habitats with instream woody material (JSA 1992). However, little instream woody material occurs in the lower Yuba River because upstream dams reduces the downstream transport of woody material, and because of the general paucity of riparian vegetation throughout much of the lower Yuba River.

During uncontrolled spill events, accumulated woody material spills over the Englebright Dam. These are typically small in diameter and pass through the system rapidly, because there is lack of riparian vegetation to capture or anchor woody material and a lack connectivity of the lower Yuba River with its floodplain where woody material can strand or anchor.

4. Lack of Spawning Substrate

The existing condition of salmonid spawning gravel is depleted downstream of Englebright Dam to the Highway 20 reach. The reach immediately downstream of Englebright Dam is devoid of spawning substrate. Downstream of Deer Creek, the channel is actively incising. This lack of spawning substrate limits spawning habitat and fish production. There has been a general coarsening of bed material. Lack of adequate spawning substrate presents a high risk to salmonids.

5. Lack of Riparian Overstory

In the lower Yuba River, mature riparian vegetation is scattered intermittently, leaving much of the banks devoid of LWM and unshaded. This lack of cover affects components that are essential to the health and survival of the freshwater lifestages of salmonids and their prey.

Downstream of the narrows canyon, the lower Yuba River channel enters an alluvial valley plain where massive quantities of hydraulic mining debris remain from past gold mining operations (NFMS 2005). Downstream of the Highway 20 Bridge, blue oak (*Quercus douglasii*) and gray pine (*Pinus sabiniana*) comprise the riparian community at infrequent locations (CALFED and YCWA 2005). For the 4-mile reach extending from the Highway 20 Bridge downstream to the Dry Creek confluence (*i.e.*, Parks Bar to Hammon Bar), a recently conducted field reconnaissance survey indicated that riparian plant cover on surfaces away from the summer baseflow water edge is low, connectivity between older riparian patches and younger patches is low, and that species and structural diversity are low throughout most of the reach (cbec *et al*. 2010). They found that the riparian vegetation along the mainstem is comprised predominantly of shrubs at heights less than 20 feet, and that woody plant species that grow higher than 30 feet are uncommon along the mainstem.

The Yuba Goldfields section near Daguerre Point Dam is largely devoid of streamside vegetation (CALFED and YCWA 2005). Land use surrounding the lower Yuba River from about Simpson Lane downstream to the confluence with the lower Feather River is comprised primarily of agricultural activities (*e.g.*, orchards, grasslands, rice cultivation), and little shading occurs on this portion of the river. In addition, this reach of the river is bordered by levees and is subject to backwater influence of the Feather River, further restricting the establishment of riparian vegetation in this area (CALFED and YCWA 2005).

The deposition of hydraulic mining debris, subsequent dredge mining, and loss/confinement of the active river corridor and floodplain of the lower Yuba River which started in the mid-1800's and continues to a lesser extent today, has eliminated much of the riparian vegetation along the lower Yuba River. In addition, the large quantities of cobble and gravel that remained generally provided poor conditions for re-establishment and growth of riparian vegetation. Englebright Dam continues to inhibit regeneration of riparian vegetation by preventing the transport of any new fine sediment, woody debris, and nutrients from upstream sources to the lower river. Subsequently, mature riparian vegetation is sparse and intermittent along the lower Yuba River, leaving much of the bank areas unshaded and lacking in LWM. This loss of riparian cover has greatly diminished the value of the habitat in this area.

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6. Lack of Natural River Morphology and Function

Other important components of habitat structure at the micro-scale include large boulders, coarse substrate, undercut banks and overhanging vegetation. These habitat elements offer juvenile salmonids concealment from predators, shelter from fast current, feeding stations and nutrient inputs. At the macro-scale, streams and rivers with high channel sinuosity, multiple channels and sloughs, beaver impoundments or backwaters typically provide high-quality rearing and refugia habitats (Spence *et al*. 1996). The lower Yuba River can be generally characterized as lacking an abundance of such features.

Loss of natural river morphology and function is the result of river channelization and confinement, which leads to a decrease in riverine habitat complexity, and thus, a decrease in the quantity and quality of juvenile rearing habitat. This primary stressor category includes the effect that dams have on the aquatic invertebrate species composition and distribution, which may have an effect on the quality and quantity of food resources available to juvenile salmonids.

Attenuated peak flows and controlled flow regimes have altered the lower Yuba River's geomorphology and have affected the natural meandering of the river downstream of Englebright Dam (NMFS 2009). The channel is incised over 20 feet in some areas on the low Yuba River. Planned and unplanned flow reductions may cause side channels and backwaters of the lower Yuba River to become disconnected from the main channel.

7. Lack of Floodplain Habitat

In the lower Yuba River, controlled flows and decreases in peak flows has reduced the frequency of floodplain inundation resulting in a separation of the river channel from its natural floodplain. Within the Yuba Goldfields area (RM 8–14), confinement of the river by massive deposits of cobble and gravel derived from hydraulic and dredge mining activities resulted in a relatively simple river corridor dominated by a single main channel and large cobble-dominated bars, with little riparian and floodplain habitat (DWR and PG&E 2010).

Loss of off-channel habitats such as floodplains, riparian, and wetland habitats has substantially reduced the productive capacity of the Central Valley for many native fish and wildlife species, and evidence is growing that such habitats were once of major importance for the growth and survival of juvenile salmon (Moyle 2002). Recent observations on the lower Yuba River indicate that remnant side channels and associated riparian vegetation play a similar role by providing flood refugia, protection from predators, and abundant food for young salmonids and other native fishes. These habitats also promote extended rearing and expression of the stream-type rearing characteristic of spring-run Chinook salmon (DWR and PG&E 2010).

The Yuba Accord RMT is implementing studies to evaluate the availability of floodplain habitat for juvenile salmonid rearing (including spring-run Chinook salmon). Some important discharges for the lower Yuba River include modern bankfull discharge (5,620 cfs), the pre-New Bullards Bar bankfull discharge (11,600 cfs), and the floodplain-filling discharge of approximately 20,000 cfs (Pasternack 2008). Above 20,000 cfs the only exposed alluvial surfaces in the river valley are terraces and artificial berms. Thus, mesohabitats will be characterized at the representative winter-flood discharges of 12,000 cfs and 20,000 cfs. It is unlikely that any fish observations will be available for these flows, but a calculation will be conducted to assess the areal extent of mesohabitats that may be suitable for refugia of rearing juveniles during flood events (RMT 2010). It is anticipated that draft reports regarding the floodplain habitat availability evaluations will be completed by the fall of 2012.

8. Water Quality

a. *Temperatures*

Due to the Yuba Accord flows, water temperatures during the summer months are generally colder than they would be under the natural hydrograph due to of cold water releases from New Bullards Bar Reservoir. While the lower Yuba River does have generally cool water temperatures, they are not consistently suitable for salmonids throughout the year.

Upstream from Englebright Dam, the South Yuba River is at thermal barrier to salmonids during the months when water is diverted out-of-basin. The Middle Yuba River, below Our House Dam, and Oregon Creek, below Log Cabin Dam, are thermally impaired due to diversion of water that ends up in New Bullards Bar Reservoir.

9. Water Diversions/Low or Insufficient Flows

a. *Upstream of Englebright Reservoir*

Water diversions of an average of 71,000 acre-feet per year are diverted out of the North Yuba River, and 410,000 acre-feet per year are diverted out of the Middle and South Yuba rivers. These annual exports reduce the ability of the Yuba River and its watershed to support native salmonids and sturgeon. No analysis has been done on the collective contribution this water could have to habitat restoration, if allowed to remain in the Yuba River watershed for recovery of local fish. The Upper Yuba River Study looked at increasing the flows in the South and Middle Yuba rivers from 5 cfs to 50 cfs, which would add 5.6 miles of spawning habitat for spring-run Chinook salmon and Central Valley steelhead (UYRSPST 2007). There is currently no operational provision to provide these restoration flow.

b. *Below Englebright Reservoir*

Water exported from the Brophy/South Yuba Diversion has increased to 75,647 acre-feet annually, a 114 percent increase over the delivery amounts in 2005. These increased exports are likely to have increased entrainment and impingement on the inadequate screens. The

Wheatland Project has been constructed and is beginning to divert water from the lower Yuba River.

Increased water exports lead to a reduction in flows within the mainstem of the river, and reduction in flows exacerbates the impacts of inadequate water depth, lack of access to the floodplain. Flows are generally below optimal conditions for all life-history stages of salmon, and the natural hydrograph is altered by hydropower and water delivery. The Yuba River below Englebright Dam still experiences a dynamic flood regime, because of frequent uncontrolled winter and spring flows (Moir and Pasternack 2008), and this is likely to temporarily diminish the impact of low flows during some years and seasons.

For the reach below Daguerre Point Dam, the Wheatland Project will result in a reduction in flows when flows would otherwise be above the minimum instream flow requirements, either because of power releases or uncontrolled flows. Changes in flow are not expected to occur if flows are already at or near the minimum instream flow requirement. The changes in flow levels associated with implementation of the Wheatland project is expected to be of sufficient magnitude, timing, or duration to adversely affect the survival of juvenile steelhead and spring-run Chinook salmon and the conservation value of certain critical habitat primary constituent elements (*i.e.*, freshwater rearing and migration habitat).

Green sturgeon hold in deep (> 5m), low velocity pools during the summer months (Erickson *et al*. 2002, Benson *et al*. 2007). Because the lower Yuba River is smaller than the Sacramento River or other rivers citing a depth criterion of > 5 meters (16.4 feet), use of that criterion may be overly restrictive and not account for local opportunistic habitat utilization by green sturgeon. Therefore, to provide a more rigorous and inclusive analysis, the Corps' biological assessment included an evaluation of water depth by identifying all pools located downstream of Daguerre Point Dam characterized by water depths of > 10.0 feet. These pools were identified by application of a SRH2D 2-dimensional model. Using the model, all pools located below Daguerre Point Dam greater than 10.0 feet deep at the nominal flow of 530 cfs at the Marysville Gage were identified. A total of 26 pool locations were identified below Daguerre Point Dam with water depths greater than 10.0 feet deep at the nominal flow of 530 cfs at the Marysville Gage. However, green sturgeon adults prefer deep turbulent waters at the mouths of tributary streams. Monitoring of green sturgeon and behavior data in the Rogue River in Oregon suggests spawning occurs in sites at the base of riffles or rapids, where depths immediately increase from shallow to about 5 to 10 meters, water flow consists of moderate to deep turbulent or eddying water, and the bottom type is made up of cobble to boulder substrates (D. Erickson, ODFW, pers. comm. September 3, 2008 in NMFS 2009b). Currently accessible habitat that meets this description is limited to the Daguerre Point Dam plunge pool.

The recent returns of green sturgeon to the lower Yuba River are most likely the result of recent weather events, rather than prescribed management flows on the river. This response of green sturgeon to higher winter flows is an indication of a positive biological response to relief from a habitat stressor.

10. Lack of Synchronicity between Feather River and Yuba River Flows

Flow conditions in the Yuba River are better than the flows in the Feather River for migrating salmonids during some years, causing spring-run Chinook salmon from the Feather River to be preferentially attracted into the Yuba River to spawn. This exacerbates baseline hatchery effects and genetic introgression, because it results in an increase in genetic mixing of Feather River wild and hatchery spring-run Chinook salmon with natal Yuba River spring-run Chinook salmon.

11. False Attraction Flows

Waterway 13 is still open and is likely to attract migrating spring-run Chinook salmon and Central Valley steelhead into the Yuba Goldfield where there is no spawning or rearing habitat for salmonids. Waterway 13, when open to the river, is a chronic low to medium stressor on salmonid reproduction.

12. Hydroelectric Peaking and Ramping Flows

Alteration of streamflow magnitudes has been shown to be the primary predictor of biological integrity for fish and macroinvertebrate communities (Carlisle *et al*. 2010). Changes in the stage of the reach below a powerhouse due to project operations can have numerous effects on anadromous species and the physical habitats they may occupy (Hunter 1992). New Bullard Bar Reservoir peaking and ramping through New Colgate Powerhouse results in flow changes in the north Yuba River that preclude establishment of stable salmonid populations in some stretches of the north Yuba River.

New Bullards Bar Reservoir acts as a forebay to Englebright Reservoir, but Englebright Reservoir dampens the environmental effects of peaking and ramping flows coming from the New Colgate Powerhouse. Power generation at Narrows I and Narrows II powerhouses then exposes spring-run Chinook salmon and Central Valley steelhead to peaking and ramping flows downstream of Englebright Dam. Ramping results in changes in river level that expose spring-run Chinook salmon and Central Valley steelhead redds and juveniles dewatering and to increased predation from terrestrial foragers.

When Englebright Dam is spilling, the extreme ramping that occurs at New Colgate rapidly changes flow levels in the lower Yuba, potentially stranding fish. Ramping restrictions under the FERC license on the Yuba River Development Project and under the Yuba Accord are intended to minimize ramping effects on salmonids, making this a low to moderate stressor on spring-run Chinook salmon and Central Valley steelhead, unless there are exceedances; however stranding still occurs (Mitchel *in litt*). The compliance history on the FERC license shows that ramping exceedances occur below Englebright Dam (LoVullo *in litt*.). Ramping exceedances increase the risk of stranding as a stressor on spring-run Chinook salmon and Central Valley steelhead.

Low flows in Deer Creek, from water withdrawal at Lake Wildwood, continue to limit amount of spawning and rearing habitat for spring-run Chinook salmon in both Deer Creek and the lower Yuba River near the confluence with Deer Creek. Changes in quantity, timing, and rate of change of hydrologic conditions continue to be likely to result in stranding, low food availably, and unsuitable riverine temperatures during critical developmental periods for Central Valley steelhead and during summer holding.

Lake Wildwood captures storm and winter high-flows and minimizes Deer Creek's capacity to provide high-flow pulses and overbank flows that are necessary to interface the creek with the riparian edge and provide food and rearing habitat for juvenile salmonids. Peak flows from Lake Wildwood hydropower operation may cause redd scour and reduce successful reproduction of salmonids. Stranding continues to be a population stressor for Central Valley steelhead in Deer Creek.

13. <u>Harvest/Angling/Poaching</u>

Fishing for Chinook salmon on the lower Yuba River is regulated by CDFG. Angling regulations on the lower Yuba River are intended to protect sensitive species, in particular spring-run Chinook salmon (and wild steelhead). CDFG angling regulations (2011-2012) state that the lower Yuba River from its confluence with the lower Feather River up to Englebright Dam is closed year-round to salmon fishing, and no take or possession of salmon is allowed.

a. Angling

Fishing for hatchery trout or hatchery steelhead is allowed on the lower Yuba River from its confluence with the lower Feather River up to the Highway 20 Bridge year-round. The lower Yuba River, between the Highway 20 Bridge and Englebright Dam, is closed to fishing from September through November to protect spring-run Chinook salmon spawning activity and egg incubation.

Although these regulations are intended to specifically protect spring-run Chinook salmon, anglers can potentially harass, harm and kill listed species (spring-run Chinook salmon and wild steelhead) through incidental actions while targeting non-listed species. Examples of potential angler impacts may include, but are not necessarily limited to, angler harvest, physical disturbance of salmonid redds, hooking and catch-and-release stress or mortality, and incidental hooking.

Angling regulations on the lower Yuba River are intended to protect sensitive species, in particular spring-run Chinook salmon and Central Valley steelhead. CDFG angling regulations (2011-2012) state that the lower Yuba River from its confluence with the lower Feather River up to Englebright Dam is closed year-round to salmon fishing, and no take or possession of salmon is allowed. Fishing for hatchery steelhead is allowed on the lower Yuba River from its confluence with the lower Feather River up to the Highway 20 Bridge year-round. Capture and release of Central Valley steelhead is allowed. The lower Yuba River, between the Highway 20 Bridge and Englebright Dam, is closed to all fishing from September through November to protect spring-run Chinook salmon spawning activity and egg incubation.

CDFG regulations are intended to specifically protect spring-run Chinook salmon, but anglers can potentially capture, harass, harm and kill spring-run Chinook salmon and Central Valley steelhead through incidental actions while targeting non-listed species. Exposure of spring-run

Chinook salmon and Central Valley steelhead trout to catch-and-release angling can result in death or injury to individual fish from angler harvest, physical disturbance of redds, and catch-and-release stress or mortality from incidental hooking or contact with dry surfaces.

b. Poaching

Although the fish ladders at Daguerre Point Dam have been covered, it is probable that some level of poaching continues to occur today. Ladder modifications in 2011 may have largely ameliorated this stressor for spring-run Chinook salmon.

14. Predation

Predation occurs in all functioning ecosystems; however, increases in predator habitat and predation opportunities for piscivorous species are created by major structures and diversions. Juvenile spring-run Chinook salmon, Central Valley steelhead, and green sturgeon are more vulnerable to predation in the lower Yuba River due to limited amounts of prey escape cover. High-density predator fields are likely to occur at the South Yuba/Brophy Diversion rock weir and return channel, Hallwood-Cordua Diversion canal, Hallwood-Cordua fish return pipe, Daguerre Point Dam face and fish ladders, and the Browns Valley Diversion channel. Although predation is a natural component of salmonid ecology, the rate of predation of salmonids in the lower Yuba River has potentially increased through the introduction of non-native predatory species such as striped bass, largemouth bass and American shad (*Alosa sapidissima*) and through the alteration of natural flow regimes and the development of structures that attract predators (NMFS 2009). In addition, native predators, such as the Sacramento pikeminnow are documented to forage heavily on salmonids approaching the Hallwood-Cordua fish screen.

Predatory fish are known to congregate around structures in the water including dams, diversions and bridges, where their foraging efficiency is improved by shadows, turbulence and boundary edges (CDFG 1998). Thus, juvenile salmonids can also be adversely affected by Daguerre Point Dam on their downstream migration. Daguerre Point Dam creates a large plunge pool at its base, which provides ambush habitat for predatory fish in an area where emigrating juvenile salmonids may be disoriented after plunging over the face of the dam into the deep pool. The introduced predatory striped bass and American shad have been observed in this pool (CALFED and YCWA 2005). In addition to introduced predatory species, several native fish species also prey on juvenile salmonids in the lower Yuba River, including Sacramento pikeminnow, hardhead and large juvenile and adult rainbow trout/steelhead (CALFED and YCWA 2005). The rate of predation of juvenile salmonids passing over dams in general, and Daguerre Point Dam in particular, is expected to far exceed natural predation because dams create enhanced ambush habitat for predators.

In addition to increased rates of predation resulting from disorientation of juveniles passing over Daguerre Point Dam into the downstream plunge pool, unnaturally high predation rates may also occur in the diversion channel associated with the South Yuba/Brophy diversion. Other structure-related predation issues include the potential for increased rates of predation of juvenile salmonids: (1) in the entryway of the Hallwood-Cordua diversion canal upstream of the fish screen; (2) at the point of return of fish from the bypass pipe of the Hallwood-Cordua diversion canal into the lower Yuba River; and (3) the Browns Valley Diversion channel.

15. Off Road Vehicle Use

Motorized land vehicles on spawning beds can have a deleterious effect on successful reproduction. Although BLM has seasonal closures to the affected areas where off-road vehicles enter the water, trespass recreation on public lands can be difficult to control. Loss of spawning beds continues to be a threat to spring-run Chinook salmon and Central Valley steelhead in the Yuba Gold Fields.

D. Future Impacts

1. Hydropower Relicensing

It is unknown what the outcome of relicensing the Narrows I (in 2016) and Narrows II (in 2013) will be; however, based on FERC's current responsiveness to increasing passage and protective flows, it is likely that existing license conditions will remain substantially the same.

2. Water Deliveries

Water deliveries from the Daguerre Point Dam pool are expected to increase in the future. The historical and current conditions of entrainment and impingement are expected to increase. Yuba County Water Agency is proposing to study effects of the fish screen at the existing Hallwood-Cordua diversion, to provide information for license renewal of the Narrows II Powerhouse in 2016. No studies are proposed for the effects of increase water deliveries through the South Yuba/Brophy diversion. If increased water deliveries lead to temperatures downstream of Daguerre Point Dam being over 55 °F from December through March, both successful outmigration of spring-run Chinook salmon and attraction of green sturgeon for spawning will decline.

3. Climate Change

Climate change is an environmental phenomenon that is part of the future baseline and would occur irrespective of operations of the Project. Climate change scenarios show that average fall-run Chinook salmon mortality increases from 15 percent to 25 percent, and average spring-run Chinook salmon mortality increases from 20 percent to 55 percent (NMFS 2009). The mortality model was not run for Central Valley steelhead, but late-fall Chinook salmon can be used as a surrogate for Central Valley steelhead because they spawn at similar times in the winter. Under both warmer-drier and warmer-wetter conditions, spring-run Chinook salmon would experience a loss of spawning habitat, as water temperatures below dams becomes harder to control. Central Valley steelhead are likely to experience less of a loss on the lower Yuba River, because they spawn in the late winter when water temperatures are not as critical to incubation; however, tributary conditions could become unsuitable for spawning, forcing Central Valley steelhead to spawn in the mainstem and exposing them to increased predation and competition. Climate change is likely to put increased demand on water supply for agricultural and urban uses, and the thermal effects of increased water delivery are likely to be exacerbated by warmer air temperatures (Beamish and Bouillion 1993, Beamish and Mahnken 2001, Döll 2002, Gleick and Chalecki 1999).

4. Increased Urbanization and Human Population Growth

If the human population in Yuba County continues to grow at the current rate, it will more than double by 2050. Increases in urbanization and residential development are expected to impact habitat by altering watershed characteristics, changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the section 7 consultation process with NMFS.

E. Population Condition of Species within the Action Area

The biological requirements of spring-run Chinook salmon, steelhead, and sturgeon in the action area vary depending on the life history stage present at any given time (Spence *et al.* 1996; Moyle 2002). In analyzing the status of the species, NMFS considered the ability of the action area to support successful migration, spawning, embryonic incubation and emergence, juvenile rearing, feeding outmigration, and holding.

1. Spring-Run Chinook Salmon

The Yuba River spring-run Chinook salmon population has low productivity and abundance and is at high risk of extinction. The population is limited by complete barriers to migration at Englebright Dam and its related hydropower facilities, impaired passage at Daguerre Point Dam, superimposition with fall-run Chinook salmon, introgression with hatchery stock, lack of suitable habitat for run separation, a deficiency of spawning gravels, high exposure to predation, sub-optimal flow and temperature conditions during critical life-history stages, entrainment and impingement, lack of suitable cover for rearing, unstable food source from fluctuating aquatic macroinvertebrate populations, and low exposure to marine-derived nutrients. The Yuba River spring-run Chinook salmon population is spatially distributed within a fraction of the historical and potential habitat within the Yuba River watershed. As the population becomes increasingly depressed from multiple stressors, it is less able to contribute to the diversity of the ESU.

The abundance information on spring-run Chinook salmon in the lower Yuba River is quantified based on VAKI Riverwatcher data for fish passage and Daguerre Point Dam and spawning and carcass surveys conducted by CDFG and private consultants. The VAKI Riverwatcher infrared and videographic sampling on both ladders at Daguerre Point Dam since 2003 has provided a robust index of spring-run Chinook salmon numbers migrating into the Yuba River. For the years prior to 2009, these estimates should be considered as minimum numbers, because periodic problems with the sampling equipment have caused periods when fish ascending the ladders were not counted. In years when these sorts of gaps in data occurred during the spring-run migration period, it is likely that some migrating adults were not counted, and the true numbers of spring-run Chinook salmon passing at Daguerre Point Dam may be higher than those reported below.

The detection of adipose fin clips on some of these fish was used to quantify the number hatchery strays passing at Daguerre Point Dam. These hatchery strays are most likely from the FRFH, which are attracted into the lower Yuba River when Feather River flows are lower (often significantly lower) than Yuba River flows. Although hatchery strays make up a significant portion of the Yuba River spring-run Chinook salmon population, wild strays from other rivers are also likely to be spawning on the Yuba River.

a. Migration

The complete barrier to Yuba River spring-run Chinook salmon migration, posed by Englebright Dam existing hydroelectric facilities, is the proximal cause for the decline of the population. The partial barrier to migration caused by inconsistent maintenance of the Daguerre Point Dam is an added stressor acting to suppress the population.

Spring-run Chinook salmon historically migrated to elevations above the Central Valley floor to hold and mature during the summer before spawning; migrations occurred to at least 1,500 feet in the Sacramento River drainage and to at least 2,500 to 3,000 feet if spawning occurred early in the fall (Yoshiyama *et al*. 2001). The elevation at the base of Englebright Dam is roughly 500 feet. On the Middle Yuba River, if not for Englebright Dam, the natural upstream limit to anadromous migration is likely to be river mile (RM) 34.5.

Upstream passage conditions at Daguerre Point Dam are also considered inadequate for Chinook salmon and steelhead throughout much of the year (CDFG 1991). Adult salmonid passage is impaired when rain or snowmelt runoff produces high flow conditions at the dam, which coincides with flow conditions under which spring-run Chinook salmon and steelhead generally migrate upstream to their spawning areas. Throughout winter and spring when flows are high, adult salmonids can experience difficulty in finding the entrance to the ladders because of the very small percentage of attraction flows coming out of the ladders compared to the massive sheet-flow coming over the rest of the dam. The angle of the orifices and proximity to the plunge pool also increase the difficulty for fish to find the entrances to the ladders. Other design deficiencies which have been identified include periodic obstruction of the ladders by woody material, operating criteria that require closure of the ladders at high flows, and the proximity and orientation of the ladder entrances to the spillway (CDFG 1991). Large schools of adult salmon have been observed congregating in the plunge pool below the dam and leaping at the face of the dam, indicating that migrating adults may not readily find the entrances to the fish ladders. This lack of free passage may lead to injury, delayed migration, and/or pre-spawning mortality.

Upstream migration at Daguerre Point Dam is adversely impacted when sediment builds up near the upstream exit of the fish ladders. Normal geofluvial action has, in the past, caused gravel to build up on the upstream side of the dam where it can impede flows into the ladders, thereby reducing the ability of fish to climb the ladders and reducing the attraction flow coming out at the base of the ladders. In addition, the gravel bars have built up to the point where they greatly reduce access to the main channel for fish that have exited at the top of the ladders and are attempting to continue their upstream migration. The Corps has initiated a long term sediment management program to address this problem, and it is expected that this issue will be alleviated through continued diligent implementation of this program.

A simple time delay is not the only consequence of Chinook salmon being unable to pass Daguerre Point Dam. When adult Chinook salmon enter fresh water they cease eating and must rely solely on the finite supply of energy which they have stored in their bodies to last them through their entire migration, holding, and spawning activities. In their efforts to pass Daguerre Point Dam, particularly if these efforts continue for several days or even weeks, they consume a greater amount of these energy stores than if there had been no obstacle in their path. This may leave the fish in a weakened state before spawning which may subject them to a greater chance of disease, especially if they have to hold over the summer prior to spawning (*e.g.*, spring-run Chinook salmon). Other biological consequences of blockage or passage delay at Daguerre Point Dam include increased adult pre-spawning mortality (Reclamation 1985), and decreased egg viability (Vogel *et al.* 1988), all of which may result in the reduction in abundance and productivity of this species.

Juvenile salmonids can also be adversely affected by Daguerre Point Dam on their downstream migration. The large plunge pool at the base of the dam creates an area of unnatural advantage for predatory fish which may seasonally congregate below Daguerre Point Dam. The deep pool provides excellent ambush habitat for predators in an area where juvenile salmonids can be disoriented or injured as they plunge over the face of the dam into the turbulent waters at the base, making them highly vulnerable to predation. High levels of predation over long periods of time can reduce juvenile numbers and weaken their contribution to year class strength and recruitment.

b. Spawning

There are five stressors to successful spawning for Yuba River spring-run Chinook salmon: (1) lack of access to historical spawning habitat, (2) limited amounts of spawning gravels in the lower Yuba River, (3) superimposition from fall-run Chinook salmon, (4) redd dewatering, and (5) potential depensation caused by low population numbers.

Historical habitat can be postulated from studies. In the *Upper Yuba River Watershed Chinook Salmon and Steelhead Habitat Assessment* (UYRSPST 2007) it was calculated that 15,002 m² (161,473 ft²) of potential spawning area occurs in the Middle Yuba River, most of it upstream of Our House Dam (RM 12). It was estimated that there was sufficient spawning habitat with suitably-sized gravel and adjacent refuge areas to support approximately 3,718 Chinook salmon redds, if there are flow enhancements of 50 cfs. Under 2004 flow conditions, an estimated 500 (range 100 to 950) adult spring-run Chinook salmon could spawn within the thermally suitable habitat downstream of the natural barrier at RM 34.5.

In the 2012 technical report: *Modeling Habitat Capacity and Population Productivity for Spring-run Chinook Salmon and Steelhead in the Upper River Watershed*, Stillwater Sciences calculated the useable fraction of spawning habitat for each gradient category and habitat type in the South and Middle Yuba rivers, the mainstem Yuba River downstream of New Bullards Bar Dam, and the North Yuba River upstream of New Bullards Bar Dam. They used 2006 spawning gravel data (Nikirk and Mesic 2006) and optimal median grain sizes calculated by Kondolf and Wolman (1993) a parameters to estimate redd carrying capacity (an index of spawning capacity) and found that under current conditions, the Middle Yuba River could support 126 redds and the North Yuba River could support 2,769 redds, and the mainstem reach downstream of New Bullards Bar Dam could support 123 redds.

Yuba River spring-run Chinook salmon showed a rapid and positive response to the spawning gravels that the Corps placed in the river in 2007 and 2010. Spring-run Chinook salmon spawned on these gravels; however, superimposition from fall-run Chinook salmon, and some redd dewatering, may have reduced the reproductive success of this spawning. The chronic, ongoing stressors to spawning success reduce the fitness individuals and reduce the overall numbers of Yuba River spring-run Chinook salmon.

Depensation, or Allee effects (Allee 1931, Dennis 1989), occur when a population loses its positive stock-recruitment relationship. In a declining population an extinction threshold or "Allee threshold" (Berec 2006) may be crossed, and adults in the population either cease to breed or the population is so compromised that breeding does not contribute to population growth. Allee effects typically fall into three broad categories (Courchamp *et al*. 1999): lack of facilitation (including low mate detection and loss of breeding cues), demographic stochasticity, and loss of heterozygosity. Lack of facilitation may be occurring on the Yuba River, where up to 11 percent of adult females do not spawn (Massa 2005). If the sex ratio is 1:1, then a reasonable conclusion is that 11 percent of the adult males fail to spawn as well. If the sex ration of spring-run Chinook salmon in the Yuba River is other than 1:1, the percentage or failed spawning would be increase, because demographic stochasticity leading to a skewed sex ratio effectively reduces the actual number of breeding pairs.

Harvest and environmental stochasticity amplify Allee effects (Dennis 1989). The Allee effects of demographic stochasticity and lack of reproductive facilitation are likely as the Yuba River spring-run Chinook salmon population continues to decline. The combination of low numbers, shortage of mating encounters, harvest, entrainment, predation and chemical stressors (*e.g.*, mercury) could have devastating consequences for the Yuba River spring-run Chinook salmon population as is approaches the Allee threshold.

c. Genetic integrity

The genetic integrity of the Yuba River spring-run Chinook salmon is compromised by introgression with hatchery fish, introgression with fall-run Chinook salmon, and spatial and temporal overlap with fall-run Chinook salmon spawning. This overwhelming genetic trend of genetic swamping may have already reduced the genetic contribution of Yuba River spring-run Chinook salmon to the ESU. Once the genetic contribution of the population is lost, lack of facilitation and demographic stochasticity may prove to be much stronger drivers in population collapse.

During the past eight years, the contribution of hatchery fish to the spawning run has ranged between 2.9 and 63.0 percent (Table V-a). When measured at the simplest measurable level, the population is not viable because of excessive hatchery introgression. On the Yuba River, the 5 percent tolerance threshold for low extinction risk (Lindley *et al*. 2007) is far exceeded in most years and puts the population at high risk of extinction.

Table V-a. Annual number of spring-run Chinook salmon estimated to have passed upstream of Daguerre Point Dam annually, estimated annual percentage spring-run Chinook salmon of hatchery origin, estimated wild spring-run Chinook salmon, estimated spawning adults.

year	2004	2005	2006	2007	2008	2009	2010
VAKI count[1]	738	2,998	803	285	521	723	2,886
Percent hatchery[2]	10.2	22.0	8.3	13.7	2.9	30.0	63.0
Estimated wild escapement[3]	663	2,338	736	246	506	506	1,068
Est. spawning wild adults[4]	**590**	**2,081**	**655**	**219**	**450**	**450**	**951**

[1] The VAKI Riverwatcher collects data on both upstream and downstream movement. Fish that go up the ladder during the spawning migration and down again do not contribute to the total unless they go up the ladder a second time. Downstream spring-run Chinook salmon are not included in the population total, because their contribution to the population is expected to be minimal due to adverse conditions downstream of Daguerre Point Dam.

[2] Not all fin-clipped fish can be detected by the VAKI Riverwatcher, but we applied the percentage of the known hatchery fish to the total as a reasonable estimate of hatchery influence.

[3] Although this is the measured number of non-hatchery spring-run Chinook salmon, we recognize that up to 91 percent of these fish originated from other non-hatchery populations outside of the Yuba River.

[4] Pre-spawn mortality for Chinook salmon has been measured at 11 percent between Englebright and Daguerre Point Dams. We applied an 11 percent reduction to the spring-run Chinook salmon population, from pre-spawn mortality, because those fish do not contribute to the population.

d. Embryonic incubation and emergence

Generally the water temperatures between Englebright Dam and Daguerre Point Dam are generally good and support embryonic incubation.

Redd superimposition shifts embryos away from suitable incubation habitat and can convey embryos into the water column, where they are vulnerable to predation. This is a chronic stressor on the population that varies from year to year based on population abundance of fall- and spring-run Chinook salmon.

e. Juvenile rearing

Snorkeling observations in the lower Yuba River have indicated that juvenile Chinook salmon had a strong preference for near-shore habitats with instream woody material (JSA 1992). The lower Yuba River is deficient in instream woody material, which reduces the amount and extent of juvenile rearing habitat and cover. Lack of cover leaves juvenile Yuba River spring-run Chinook salmon vulnerable to predation.

Lack of adequate habitat for juvenile rearing is a very high stressor for the Yuba River spring-run Chinook population, although suitable rearing habitat exists in the watershed. There are 46. 8 miles of suitable rearing habitat upstream of Englebright Dam [2.3 miles of suitable rearing habitat on the Middle Yuba River, 27.7 miles suitable rearing habitat on the North Yuba River mainstem upstream of New Bullards Bar Reservoir, 13.6 miles suitable rearing habitat on North Yuba River tributaries upstream of New Bullards Bar Reservoir, and 3.2 miles suitable rearing habitat in the New Bullards Bar reach of the Yuba River (Stillwater 2012)].

Table V-b. Estimated annual recruitment and survivorship of Yuba River spring-run Chinook salmon.

Year	2004	2005	2006	2007	2008	2009	2010
VAKI count[1]	738	2,998	803	285	521	723	2,886
Superimposition estimate[2]	12.5	26.4	15.4	20.4	20.6	13.4	44.6
Females[3]	369	1,499	402	143	261	362	1,443
Females minus pre-spawn mortality[4]	328	1,334	357	127	232	322	1,284
Estimate egg production[5]	1,642,050	6,670,550	1,786,675	634,125	1,159,225	1,608,675	6,421,350
Egg to fry survival[6]	492,615	2,001,165	536,003	190,238	347,768	482,603	1,926,405
Egg to smolt survival[7]	246,308	1,000,583	268,001	95,119	173,884	241,301	963,203

[1] The VAKI Riverwatcher collects data on both upstream and downstream movement. Fish that go up the ladder during the spawning migration and down again do not contribute to the total unless they go up the ladder a second time. Downstream spring-run Chinook salmon are not included in the population total, because their contribution to the population is expected to be minimal due to adverse conditions downstream of Daguerre Point Dam. Hatchery fish are included in this total.

[2] The superimposition estimate is based upon the percentage of fall-run Chinook salmon that are likely to be at the spawning sites at the same time as spring-run Chinook salmon.

[3] Females engaged in spawning are estimated to be the 50 percent number of wild spring-run Chinook salmon after deducting the superimposition estimate.

[4] Pre-spawn mortality is estimated to be 11 percent and is deducted from the number of females prior to estimating egg production.

[5] Estimated egg production is 5,000 eggs per female (Bell 1991).

[6] Estimated egg to fry survival is 30 percent.

[7] Estimated egg to smolt survival is 15 percent.

f. Feeding

Several drivers for optimal foraging habitat are impaired: (1) instream woody material, (2) riparian overstory, and (3) substrates that support invertebrate communities.

Marine-derived nutrients and the macronutrient pulse from adult salmon carcasses can be essential drivers of aquatic invertebrate abundance. The nutrient contribution to the system from returning adult Chinook salmon is less than 20 percent of what can supported within the Yuba River watershed.

Instream woody material is both an energy source and a substrate for aquatic invertebrates (Lemly and Hilderbrand 2000, Bisson *et al*. 1987) that juvenile salmonids feed upon (Mundie 1974). The extreme deficiency of both instream woody material and riparian overstory on the lower Yuba River are likely to result in low food availability for spring-run Chinook salmon adults and juveniles.

Food availability is expected to be good in the upper North Fork Yuba River, where spring-run Chinook salmon no longer occur. Food availability in the lower Yuba River is highly variable, making this a high stressor for the population.

g.   Outmigration

Juvenile spring-run Chinook salmon can be adversely affected by Daguerre Point Dam on their downstream migration. The large plunge pool at the base of the dam creates an area of unnatural advantage for predatory fish which may seasonally congregate below Daguerre Point Dam. The plunge pool is deep and provides excellent ambush habitat for predators in an area where juvenile salmonids can be disoriented or injured as they plunge over the face of the dam into the turbulent waters at the base, making them highly vulnerable to predation. High levels of predation over long periods of time can reduce juvenile numbers and weaken their contribution to year class strength and recruitment.

The 1999-2000 entrainment study of the Hallwood-Cordua fish screen (ICF Jones and Stokes 2008) estimated that 36,144 and 91,113 *O. mykiss* were entrained in 1999 and 2000 respectively. Due to the fact that a spring-run Chinook salmon metric was used for the calculations, these estimates provide a suitable index of the number of outmigrating spring-run Chinook salmon that are likely to be lost at the Hallwood-Cordua diversion. The primary mortality factor in this study was estimated to be predation by Sacramento pikeminnow, based on observations of predator foraging behavior during the study. An earlier report (Hall 1979) found that predation at the Hallwood-Cordua diversion was significantly greater at the fish screens than in the canal leading up to the diversion.

Similar entrainment studies in California have found that predation is a primary mortality factor at fish screens (JSA 2004, Vogel 2008). Given that the length of the rock weir at the South Yuba/Brophy Diversion is 2.52 times longer than the Hallwood-Cordua fish screen, and absent any site specific information at South Yuba/Brophy we applied information from the Hallwood-Cordua entrainment study to estimate that between 90,900 and 229,800 outmigrating juvenile spring-run Chinook salmon are entrained, impinged, or preyed upon at the South Yuba/Brophy Diversion annually.

h. Holding

In general, the holding habitat for adult spring-run Chinook salmon is thermally optimal between Englebright Dam and just downstream from Daguerre Point Dam; however it is limited in spatial extent and the Englebright Dam reach is subject to peaking and ramping flows. The cold water conditions that the species depends upon are provided between Englebright Dam and just below Daguerre Point dam by provisions of the Yuba Accord and by cold waters from New Bullards Bar Reservoir that are delivered through the Yuba River Project. Acoustic tagging studies have shown that a significant proportion of the Yuba spring-run Chinook salmon population holds below Daguerre Point Dam. This could be the result of a combination of cool water temperatures and a bubble curtain providing in-water cover. It is unknown what the density limits are for spring-run holding below Daguerre Point Dam, but low and variable food supply may limit the amount of spring-run Chinook salmon that can hold there.

Congregations of adult Chinook salmon (approximately 30 to 100 fish) have been observed in the outlet pool at the base of Narrows II Powerhouse, generally in late August or September when the powerhouse is shut down for maintenance, and the pool becomes clear enough to see the fish. While it is impossible to visually distinguish spring-run from fall-run Chinook salmon in this situation, the fact that these fish are congregated this far up the river at this time of year indicates that some or the majority of them are likely to be spring-run Chinook salmon.

Holding conditions downstream of Daguerre Point Dam degrade rapidly, due to lack of riparian shading and from water diversions upstream of the Daguerre Point Dam pool.

Stillwater Sciences (2012) predicted that the holding capacity of the North Yuba River upstream of New Bullards Bar Reservoir is 17,500 spring-run Chinook salmon. Holding conditions on the mainstem Yuba River upstream of Englebright Dam are impaired between Englebright Dam and New Bullards Bar Dam, because of hydroelectric peaking and ramping, but have a predicted capacity of 4,069; and the Middle Yuba River has a predicted holding capacity of 126 (Stillwater Sciences 2012). The South Yuba River is thermally impaired, due to water exports and extremely low flows during the hot summer months.

Although there are currently no spring-run Chinook salmon upstream of Englebright Dam, studies done in 2004, under slightly warmer conditions than today, the thermally suitable habitat for spring-run Chinook salmon was estimated to extend approximately 5.6 miles downstream of the natural barrier at RM 35.4. Within the 5.6 mile reach considered thermally suitable, 15 pools were identified with suitable holding habitat for adult spring-run Chinook salmon. Based on the size and configuration of the available pools, a minimum of 750 to 1,500 adult spring-run Chinook salmon could hold in the habitat.

2. Central Valley Steelhead

The Yuba River Central Valley steelhead population has low productivity and abundance and is at high risk of extinction. The population is limited by complete barriers to migration at Englebright Dam and its related hydropower facilities, introgression with other Central Valley steelhead populations, a deficiency of spawning gravels, high exposure to predation, sub-optimal flow and temperature conditions during critical life-history stages, entrainment and impingement, lack of suitable cover for rearing, unstable food source from fluctuating aquatic macroinvertebrate populations, and low exposure to marine-derived nutrients. The Yuba River Central Valley steelhead population is spatially isolated from historical and potential habitat within the Yuba River watershed. As the population becomes increasingly depressed from multiple stressors, it is less able to contribute to the diversity of the DPS.

The abundance information on spring-run Chinook salmon in the lower Yuba River is quantified based on VAKI Riverwatcher data for fish passage and Daguerre Point Dam and spawning and carcass surveys conducted by CDFG and private consultants. The VAKI Riverwatcher infrared and videographic sampling on both ladders at Daguerre Point Dam since 2003 has provided an index of Central Valley steelhead numbers returning to the Yuba River from the Pacific Ocean or the Sacramento-San Joaquin Delta. For the years prior to 2009, these estimates should be considered as minimum numbers, because periodic problems with the sampling equipment have caused periods when fish ascending the ladders were not counted. In years when these sorts of gaps in data occurred during the Central Valley steelhead migration period, it is likely that some migrating adults were not counted, and the true numbers of Central Valley steelhead passing at Daguerre Point Dam may be higher than those reported below.

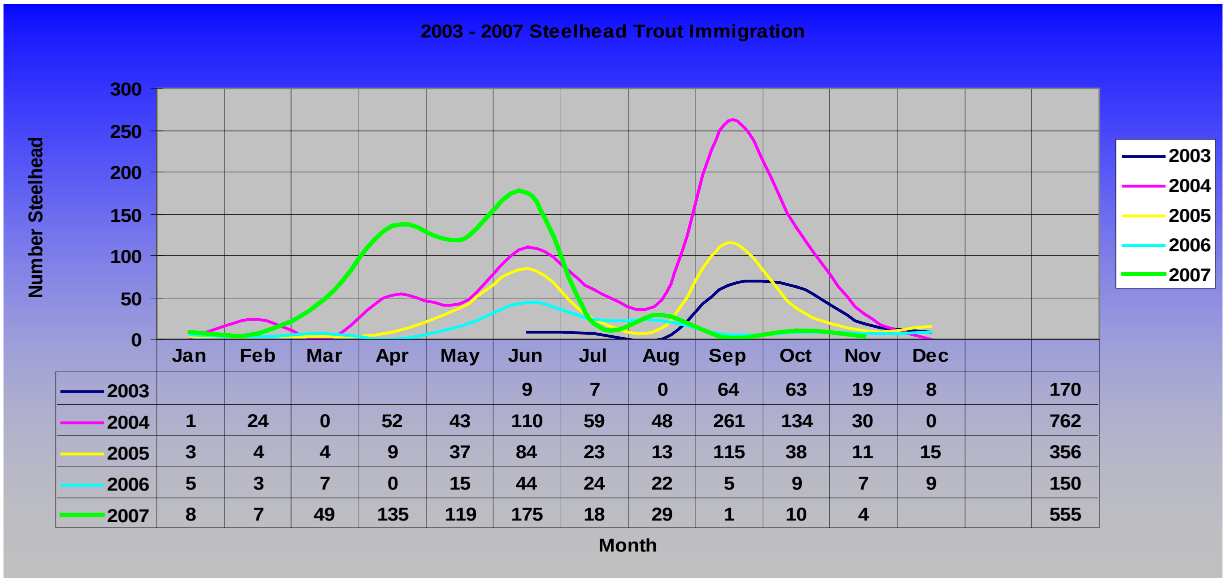
a. Migration

The complete upstream barrier to Yuba River Central Valley steelhead migration, posed by Englebright Dam and existing hydroelectric facilities, is the proximal cause for the decline of the population. Englebright Dam may be only a partial barrier to outmigration.

Upstream migration at Daguerre Point Dam is adversely impacted when sediment builds up near the upstream exit of the fish ladders. Normal geofluvial action has, in the past, caused gravel to build up on the upstream side of the dam where it can impede flows into the ladders, thereby reducing the ability of fish to climb the ladders and reducing the attraction flow coming out at the base of the ladders. In addition, the gravel bars have built up to the point where they greatly reduce access to the main channel for fish that have exited at the top of the ladders and are attempting to continue their upstream migration. The Corps has initiated a long term sediment management program to address this problem, and it is expected that this issue will be alleviated through continued diligent implementation of this program.

Infrared and videographic sampling on both ladders at Daguerre Point Dam since 2003 has provided estimates *O. mykiss* numbers migrating up the Yuba River (figure V-b). However, these estimates should be considered as *minimum* numbers, as periodic problems with the sampling equipment have caused periods when fish ascending the ladders were not counted. Additionally, because steelhead can be similar in size and shape to many other species of fish in the Yuba River, only those inferred images that were backed up by photographic images clearly showing that the fish was a steelhead were included in the counts represented in Figure V-b. It is therefore likely that the true numbers of steelhead passing Daguerre Point Dam are higher than those reported in Figure V-b. It is also important to note that the data collected after February, 2007, has not yet been re-checked for quality and accuracy and should be considered preliminary at this time (CDFG unpublished data).

The preliminary data in Figure V-b indicate that *O. mykiss* passage occurs in many months of the year. As discussed above with spring-run Chinook salmon, the short time period in which this device has been in operation, coupled with the two to four year life cycle of these fish, make it difficult to determine decisive trends in the steelhead population.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
2003						9	7	0	64	63	19	8		170
2004	1	24	0	52	43	110	59	48	261	134	30	0		762
2005	3	4	4	9	37	84	23	13	115	38	11	15		356
2006	5	3	7	0	15	44	24	22	5	9	7	9		150
2007	8	7	49	135	119	175	18	29	1	10	4			555

Figure V-b. *O. mykiss* immigration past Daguerre Point Dam as detected through electronic monitoring in the fish ladders (CDFG unpublished data).

b. Spawning

There are five stressors to successful spawning for Yuba River steelhead: (1) lack of access to historical spawning habitat; (2) limited amounts of spawning gravels in the lower Yuba River; (3) redd scour; (4) redd dewatering; and (5) potential depensation caused by low population numbers.

In the 2012 technical report: *Modeling Habitat Capacity and Population Productivity for Spring-run Chinook Salmon and Steelhead in the Upper River Watershed*, Stillwater Sciences calculated the useable fraction of spawning habitat for each gradient category and habitat type in the South and Middle Yuba rivers, the mainstem Yuba River downstream of New Bullards Bar Dam, and the North Yuba River upstream of New Bullards Bar Dam. They used 2006 spawning gravel data (Nikirk and Mesic 2006) and optimal median grain sizes calculated by Kondolf and Wolman (1993) a parameters to estimate redd carrying capacity (an index of spawning capacity) and found that under current conditions: the South Yuba River could support 3,745 redds; the Middle Yuba River could support 3,284 redds; the North Yuba River could support 16,352 redds; and the mainstem reach downstream of New Bullards Bar Dam could support 121 redds. Central Valley steelhead currently do not have access to this habiat.

c. Genetic integrity

The genetic integrity of the Central Valley steelhead in the lower Yuba River is compromised by introgression with hatchery populations of Central Valley steelhead. Introgression with hatchery steelhead has been shown to reduce wild steelhead reproduction and fitness. Only the lower Stanislaus and Battle Creek populations have more signs of mixing with other Central Valley steelhead populations.

The *O. mykiss* in the North Yuba River, upstream of New Bullards Bar Dam, have a high level of similarity with the postulated, historical, wild genotype of Central Valley steelhead, while *O. mykiss* in the lower Yuba River are genetically mixed (Garza and Pearse 2008). The planting of hatchery fish in Englebright Reservoir may have increased genetic introgression. No specific genetic markers for hatchery fish have been detected in the lower Yuba River, but private hatcheries have not been tested. There may be some successful passage of *O. mykiss* downstream through the Narrows II powerhouse, because an upper Yuba River *O. mykiss* was detected in the lower Yuba River by Garza and Pears (2008).

d. Embryonic incubation and emergence

Generally the water temperatures between Englebright Dam and Daguerre Point Dam are generally good and support embryonic incubation. Redd superimposition shifts embryos away from suitable incubation habitat and can convey embryos into the water column, where they are vulnerable to predation. This is a chronic stressor on the population that varies from year to year based on population abundance of fall- and spring-run Chinook salmon.

e. Juvenile rearing

The lower Yuba River is deficient in instream woody material, gravel, has reduced floodplain availability, high levels of predation, and a lack of access to historic juvenile rearing habitat. These factors reduce the amount and extent of juvenile rearing habitat to fish in the Yuba River.

Lack of adequate habitat for juvenile rearing is a very high stressor for the Yuba River Central Valley steelhead population, although suitable rearing habitat exists in the watershed. There are 143.2 miles of suitable rearing habitat upstream of Englebright Dam (17.6 miles suitable rearing habitat on the mainstem of the South Yuba River, 15.9 miles suitable rearing habitat on the tributaries to the South Yuba River, 17.9 miles of suitable rearing habitat on the Middle Yuba River, 11.5 miles suitable rearing habitat tributaries to the Middle Yuba River, 34.7 miles suitable rearing habitat on the North Yuba River mainstem upstream of New Bullards Bar Reservoir, 51.4 miles suitable rearing habitat on North Yuba River tributaries upstream of New Bullards Bar Reservoir, and 4.2 miles suitable rearing habitat in the New Bullards Bar reach of the Yuba River)(Stillwater 2012). Although Central Valley steelhead do not have access to suitable rearing habitat upstream of Englebright Dam, this is habitat in the action area that has a conservation value for juvenile rearing.

f. Feeding

Four drivers for optimal foraging habitat are missing from the lower Yuba River or are impaired: (1) submerged woody material; (2) riparian habitat; and (3) substrate composition and invertebrate communities.

g. Outmigration

Juvenile Central Valley steelhead can be adversely affected by Daguerre Point Dam on their downstream migration. The large plunge pool at the base of the dam creates an area of unnatural advantage for predatory fish which may seasonally congregate below Daguerre Point Dam. The plunge pool is deep and provides excellent ambush habitat for predators in an area where juvenile salmonids can be disoriented or injured as they plunge over the face of the dam into the turbulent waters at the base, making them highly vulnerable to predation. High levels of predation over long periods of time can reduce juvenile numbers and weaken their contribution to year class strength and recruitment.

The 1999-2000 entrainment study of the Hallwood-Cordua fish screen (IFC Jones and Stokes 2008) estimated that 36,144 and 91,113 *O. mykiss* were entrained in 1999 and 2000 respectively. Although the fish screen has been modified at the Hallwood Cordua diversion and entrainment has been reduced, there have been no actions taken to reduce predation. The primary mortality factor in this study was estimated to be predation by Sacramento pikeminnow, based on observations of predator foraging behavior during the study. An earlier report (Hall 1979) found that predation at the Hallwood-Cordua diversion was significantly greater at the fish screens than in the canal leading up to the diversion.

Similar entrainment studies in California have found that predation is a primary mortality factor at fish screens (JSA 2004, Vogel 2008). Given that the length of the rock weir at the South Yuba/Brophy Diversion is 2.52 times longer than the Hallwood-Cordua fish screen, we estimate that between 90,900 and 229,800 outmigrating juvenile and adult Central Valley steelhead are entrained, impinged, or preyed upon at the South Yuba/Brophy Diversion annually.

h. Holding

CDFG currently manages the river to protect natural steelhead through strict "catch-and release" fishing regulations. Repeated exposure to recreational fishing can reduce survivorship of holding Central Valley steelhead.

Holding conditions downstream of Daguerre Point Dam degrade rapidly, due to lack of riparian shading and from water diversions upstream of the Daguerre Point Dam pool.

Stillwater Sciences (2012) predicted that the summer habitat capacity of the North Yuba River upstream of New Bullards Bar Reservoir is 220,518 Central Valley steelhead. Summer habitat conditions on the mainstem Yuba River upstream of Englebright Dam are impaired between Englebright Dam and New Bullards Bar Dam, because of hydroelectric peaking and ramping, but have a predicted capacity of 21,041; and the Middle Yuba River has a predicted summer capacity of 36,227 (Stillwater Sciences 2012). The South Yuba River is thermally impaired, due to water exports and extremely low flows during the hot summer months.

O. mykiss are found throughout the upper Yuba River watershed, indicating that the habitat would support Central Valley steelhead if there was adequate passage at Englebright Dam.

3. Green Sturgeon

Green sturgeon have been observed in the pool below Daguerre Point Dam in 2006 (Reedy 2006) and 2011. The five individuals observed in 2011 may represent the entire Yuba River population of green sturgeon.

a. Migration

As described in the Corps' biological assessment, Daguerre Point Dam poses a complete barrier to upstream passage for North American green sturgeon. The fish ladders at Daguerre Point Dam were not designed for sturgeon passage, and there has never been any evidence that adult sturgeon are able to ascend the structures. The VAKI Riverwatcher system has not detected any green sturgeon passage since it was installed in 2003.

b. Spawning

The extremely limited information on North American green sturgeon on the lower Yuba River indicates that small numbers of adults occur sporadically below Daguerre Point Dam. Although spawning behavior was observed in 2011, it is not known whether green sturgeon spawning attempts are successful. The spawning conditions are very poor below Daguerre Point Dam, but spawning behavior was observed during the high flows of 2011.

As described in the Corps' biological assessment, Daguerre Point Dam poses a complete barrier to upstream migration for North American green sturgeon. Green sturgeon are unable to ascend the fish ladders on the dam, or otherwise pass over or around the structure and access upstream spawning habitat.

It is possible that the plunge pool below Daguerre Point Dam or other deep holes downstream of the dam provide suitable habitat for green sturgeon spawning and that a small number of sturgeon utilize the lower river for spawning. It is also possible that these fish spawn in the Feather River and are then attracted by the cooler waters of the Yuba to swim up to Daguerre Point Dam and over-summer while waiting for downstream temperatures to cool to the point that they can return to the ocean. A third possibility is that green sturgeon are attracted into the Yuba River to spawn, but do not find suitable habitat below Daguerre Point Dam, and therefore do not spawn, or spawn with a reduced level of success. It is unlikely that any green sturgeon alive today could have been spawned upstream of Daguerre Point Dam, and are attempting to return to their natal spawning habitat upstream of the dam, because the dam has been in place longer than the expected maximum life span (60 to 70 years (Moyle 2002)) of North American green sturgeon.

A large amount of moderate to high quality spawning habitat exists upstream of Daguerre Point Dam. Daguerre Point Dam blocks access to this habitat and forces green sturgeon to spawn at the Daguerre Point Dam plunge pool. Because green sturgeon are long lived, it will take years to determine a trend in the adult population; however, with a the largest observed sub- population of only five fish, and little to no suitable spawning habitat in most years, it is below levels that would be considered viable. Daguerre Point Dam limits the spatial structure and productivity of this population and is a high stressor to green sturgeon on the Yuba River.

c. Genetic integrity

There have been very few green sturgeon observations in the Yuba River. Their genetic composition is unknown.

d. Embryonic incubation and emergence

The temperature conditions in the below Daguerre Point Dam are variable, but thought to be adequate to support incubation and emergence.

Conditions upstream of Daguerre Point Dam are favorable to green sturgeon embryonic incubation and emergence.

e. Juvenile rearing and outmigration

Systematic monitoring with rotary screw traps has not detected the presence of juvenile sturgeon. It is possible that a small number of spawning sturgeon and/or a low reproductive success rate could go undetected by the level of monitoring effort that has occurred on the lower Yuba River.

f. Feeding

Spawning of spring-run and fall-run Chinook salmon, as well as American shad, near the base of Daguerre Point Dam provides a food resource and foraging opportunity for green sturgeon, because sturgeon are bottom feeders and would opportunistically feed on the eggs and young of other fish species.

VI. EFFECTS OF THE ACTION ON LISTED SPECIES

The purpose of the project is to maintain and perpetuate the existence of the Daguerre Point Dam with impaired fish passage (and no passage for green sturgeon) and Englebright Dam without fish passage. These dams are the primary drivers of baseline conditions that have resulted in the Yuba River populations of spring-run Chinook salmon, Central valley steelhead, and green sturgeon to be in the condition they are in today. Migration blockage and impairment, little to no access to refugia, high predation, extraordinarily poor conditions for reproduction, and a depauperate food web are all mortality factors resulting in low viability and high risk of local extinction of these species.

Direct and indirect effects to spring-run Chinook salmon, Central valley steelhead, and green sturgeon are expected to occur from the proposed action and from interrelated and interdependent actions that depend on the Corps' dams and authorizing mechanisms. Effects from interrelated and interdependent actions include the outcome of larger actions that depend upon agreements, permits, license, easements, or contracts that are in place to take advantage of the hydraulic head and open water generated by the dams (or the raised water table resulting from the dams) to generate energy, divert water out of the aquatic ecosystem, or provide for recreation.

A. Approach to the Assessment

Section III "Analytical Approach" of this biological opinion describes our approach to analyzing the effects of the action. The primary information used in this assessment includes information and resources identified in subsection I-C "Key Consultation Considerations", subsection III-D "Application of the Approach to Listed Species Analysis", section IV "Status of the Species and Critical Habitat" and section V "Environmental Baseline" of this biological opinion; studies and accounts of the impacts of water diversions on anadromous species; and documents prepared for analysis of the proposed action.

1. Deconstruct the Action

The primary assumptions are that the Corps will continue to own and operate Englebright and Daguerre Point dams, will continue to maintain the continued existence of the dams, and will renew all easements, permits, and licenses associated with the proposed action and operation and maintenance of the dams, facilities, and properties are considered as integral to understanding and analyzing effects of the proposed action.

In section II "Description of the Proposed Action", the proposed action has been deconstructed into specific actions, or components of the proposed action, related to operation and maintenance of the dams. In the following analysis, the biological effects are parsed out by life history stage. Those components of the proposed action that have an effect on species' life-history stages are addressed within those sections.

2. Assess Species Exposure

Species' exposure is assessed by life-history stage. By conducting the analysis based upon life history stage NMFS is able to define the temporal and spatial co-occurrence of spring-run Chinook salmon, Central Valley steelhead, and green sturgeon life stages and the stressors associated with the proposed action and continuance of the operational baseline. Exposure is spatially and temporally defined by the area and time that the stressor occurs.

3. Assess Species Response

Within each life-history stage, there is an assessment of how spring-run Chinook salmon, Central Valley steelhead, and green sturgeon in the Yuba River are likely to respond to the proposed action and operational baseline stressors. Life stage-specific responses to specific stressors related to the proposed action are summarized in the last two columns of Tables VI-a, VI-b, and VI-c and are described in detail below.

4. Assess Risk to Individuals

Because the proposed action is intended to continue the operational and baseline conditions of the dams, activities and project related baseline conditions that kill, wound, or harm spring-run Chinook salmon, Central Valley steelhead, and green sturgeon are identified to assess risk.

5. Assess Risk to Yuba River Populations

An estimated risk to the Yuba River populations of spring-run Chinook salmon, Central Valley steelhead, and green sturgeon is summarized for each life-history stage.

B. Adult Migration

The proposed action will ensure the continued existence of Englebright and Daguerre Point dams and will perpetuate the baseline conditions that prevent and impair upstream migration of spring-run Chinook salmon, Central Valley steelhead, and green sturgeon. Migration barriers and false attraction flows constitute a very high risk to ability of spring-run Chinook salmon, Central Valley steelhead, and green sturgeon populations to survive in the Yuba River.

1. Spring-run Chinook Salmon and Central Valley Steelhead

a. Englebright Dam

Englebright Dam continues to present an impassable barrier to the upstream migration of anadromous salmonids and is a very high stressor on Yuba River spring-run Chinook salmon and Central Valley steelhead populations. The purpose of the proposed action is to maintain Englebright Dam, and the proposed action does not provide access to suitable, historical habitat upstream of the dam that is important for the survival of the Yuba River populations of spring-run Chinook salmon and Central Valley steelhead.

The interrelated and interdependent Narrows I Project provides attraction flow for migrating adult spring-run Chinook salmon where water from the hydropower plant is delivered to the lower Yuba River. The Narrows I Project depends on an outgrant to PG&E from the Corps for hydropower generation facilities that are used in conjunction with Englebright Dam. The Narrows I Project directly affects migrating spring-run Chinook salmon and Central Valley steelhead that are exposed to attraction flow at the Narrows I Project tailrace. Spring-run Chinook salmon and Central Valley steelhead are likely to respond to attraction flow by attempting to migrate upstream into the flow, where they lose energy reserves while attempting to enter the impassible project works. The expenditure of energy in attempting to pass dams have been shown to have a number of adverse effects on pre-spawning salmonids.

The interrelated and interdependent Narrows II Project creates attraction flows for migrating adult spring-run Chinook salmon where water from the hydropower plant is delivered to the lower Yuba River. The Narrows II Project in has interdependent operation with the Narrows I project and depends on an agreement and contract with YCWA for operation of YCWA hydroelectric generation facilities that are conjunctive uses at Englebright Dam. The Narrows II Project directly affects migrating spring-run Chinook salmon that are exposed to attraction flow at the Narrows II Project tailrace. Spring-run Chinook salmon are likely to respond to attraction flow by attempting to migrate upstream into the flow, where they lose energy reserves while attempting to enter the impassible project works. Congregations of adult Chinook salmon (approximately 30 to 100 fish) have been observed in the outlet pool at the base of the Narrows II Powerhouse, generally during late August or September when the powerhouse is shut down for maintenance. During this time period, the pool becomes clear enough to see the fish. While it is difficult to visually distinguish spring-run from fall-run Chinook salmon in this situation, the fact that these fish are congregated this far up the river at this time of year indicates that some of them are likely to be spring-run Chinook salmon. Delays in passage and the expenditure of excess energy in attempting to pass dams have been shown to have a number of adverse effects on pre-spawning salmonids.

Time spent by spring-run Chinook salmon and Central Valley steelhead attempting to enter project works will delay spawning. Delayed spawning is likely to force spring-run Chinook salmon and Central Valley steelhead to either spawn in suboptimal habitat near Englebright Dam, return downstream where they are not likely to find optimal spawning habitat or suitable mates, or remain in place and fail to spawn. Delayed spawning results in harm to individual spring-run Chinook salmon and Central Valley steelhead and a loss of genetic contribution to the populations. The Narrows I Powerhouse is a chronic, low-level stressor to Yuba River spring-run Chinook salmon and is likely to reduce the reproductive fitness of individual adult salmon that spend time attempting to migrate upstream through the project works. The Narrows II Project has greater attraction flow than the Narrows I Project; therefore, this is a chronic, medium-level stressor to Yuba River spring-run Chinook salmon that is likely to reduce the reproductive fitness of individual adult salmon that spend time attempting to migrate upstream through the project works.

b. Daguerre Point Dam

The purpose and effect of the proposed action is to maintain Daguerre Point Dam into the future, and the proposed action will only partial remediate effects of the dam. Daguerre Point Dam presents stressors from the proposed action and from the continuation of baseline conditions. Migration blockage and impairment during high and low flows, fish ladder operations that cannot overcome design deficiencies, inconsistent fish ladder maintenance, fall-back over the dam after exiting the fish ladder, dam design that leads to spring-run Chinook and Central Valley steelhead jumping into the dam apron all contribute to reduced individual survivorship and fitness of spring-run Chinook salmon and Central Valley steelhead. Flashboard placement, new ladder gate operations, and improved maintenance reduces the structural stressors from the dam, but inconsistent maintenance, directly and indirectly affects individual survival and fitness of spring-run Chinook salmon and Central Valley steelhead.

Upstream passage conditions at Daguerre Point Dam are inadequate, or impaired for spring-run Chinook salmon and Central Valley steelhead throughout much of the year. Adult salmonid passage is impaired when rain or snowmelt runoff produces high flow conditions at the dam, which coincides with flow conditions under which spring-run Chinook salmon and steelhead generally migrate upstream to their spawning areas. Throughout winter and spring when flows are high, adult salmonids can experience difficulty in finding the entrance to the ladders because of the very small percentage of attraction flows coming out of the ladders compared to the massive sheet-flow coming over the rest of the dam. The angle of the orifices and proximity to the plunge pool also increase the difficulty for fish to find the entrances to the ladders. Operating criteria that require closure of the ladders at high flows is expected to change under the proposed action, which will improve passage but not change proximity and orientation of the ladder entrances to the spillway that make the ladders difficult for fish to detect. Large schools of adult salmon have been observed congregating in the plunge pool at the base of the dam and leaping at the face of the dam, indicating that migrating adults are not likely to find the entrances to the fish ladders. This lack of free passage leads to wounding and injury of fish, delayed migration, and pre-spawning mortality.

Daguerre Point Dam continues to present a partial to complete barrier to the upstream migration of spring-run Chinook salmon and Central Valley steelhead when sediment fills the ladders and blocks fish passage. Failure of the Corps to follow through on implementation of their sediment management plan, has contributed to the baseline conditions today. Although there are plans and measures propose to minimize migration impediments at Daguerre Point Dam, the Corps has not shown a pattern of consistent maintenance of the fish ladders. Without better oversight, NMFS has an expectation that the Corps's sediment monitoring and sediment clearing activities could diminish over time. Even with prompt sediment management, the ladders are designed in such a way that blockages are likely to occur during the high-flow events that enhance spring-run Chinook salmon and Central Valley steelhead migration. If only one ladder is blocked, 50 percent of the migration run could be delayed. A 50 percent migration delay, combined with the wounded, injured, and killed spring-run Chinook salmon and Central Valley steelhead that jump into the dam or out of the ladders, or fall-back after ascending the ladder, constitutes a high stressor on the spring-run Chinook salmon and Central Valley steelhead population. Inconsistent sediment management is a moderate to high stressor on the reproductive fitness of Yuba River spring-run Chinook salmon and Central Valley steelhead.

Sediment and woody material (branches and debris, not LWM) in the fish ladders is likely to result in periodic obstruction of the ladders (Figure VI-a) that can block spring-run Chinook salmon passage or substantially reduce attraction flows at the ladder entrances. Each of the bays in the fish ladder could become full of gravel or branches and debris to the extent that spring-run Chinook salmon within the ladders become trapped there. Maintenance-related fish passage impediments can result in delayed migration, direct mortality to migrating fish, changes in spawning distribution, increased adult pre-spawning mortality, or decreased egg viability.

Photo by: Carl Mesick

Figure VI-a. Debris in Daguerre Point Dam South Fish Ladder after the January 1997 Flood. The proposed action does not include a firm commitment to inspect the channel after a "high flow event". High flow events are the times when the river is most likely to mobilize sediment and when impedances in the fish ladders are most likely to occur. Spring-run Chinook salmon that are migrating prior to the June 1 inspection date could be held downstream of Daguerre Point Dam and delayed from migrating upstream for up to three months. Inconsistent or untimely sediment management upstream of the fish ladders is likely to result in sediment accumulation at the upstream exits of the fish ladders, resulting in impeded upstream passage of spring-run Chinook salmon from the ladders to the main channel and in the potential for fish to fall-back into the ladders or over Daguerre Point Dam.

Impaired passage from inadequate or inconsistent fish ladder operations and management will force migrating spring-run Chinook salmon to spawn in sub-optimal habitat downstream of Daguerre Point Dam. This is likely to result in reproductive failure of spawning pairs through increased competition for spawning sites and increased superimposition with fall-run Chinook salmon.

The effect of potential poaching in the fish ladders and for fish jumping out of the upper bays of the fish ladders has recently been reduced by metal grates over the ladders. The lower bays are still uncovered so poaching could still occur in the fish ladders and in the vicinity of Daguerre Point Dam.

The flashboards operated as part of the Hallwood-Cordua license, increase the ability of Hallwood-Cordua to divert water during low flow periods, but also aid in directing the flows towards the fish ladder entrances. Flashboard management has demonstrated an increase in the passage of salmon up the ladders. The effects of flashboard management interact with entrainment effects at the Hallwood-Cordua diversion and consistency of fish ladder maintenance; therefore the flashboard management is likely to increase the success of spring-run Chinook salmon and Central Valley steelhead adult passage at Daguerre Point Dam but not ameliorate effects to spring-run Chinook salmon and Central Valley steelhead from poor ladder maintenance.

The fish ladders periodically experience insufficient attraction flows, for which flashboard management is a remedy. If flashboard management is implemented with the same consistency as baseline fish ladder maintenance, then spring-run Chinook salmon could have difficulty detecting the attraction flow that the flashboards are designed to create. If flashboard management is conducted in a manner that satisfies NMFS and CDFG, then it is likely that flashboard management will enhance spring-run Chinook salmon upstream and downstream passage at Daguerre Point Dam during the summer months.

The proposed operation of slide gates (open at all flows except extreme high flows) is an improvement over baseline conditions. This will improve the baseline spring-run Chinook salmon and Central Valley steelhead passage during high flows, unless ladder and sediment management fail to keep up with incoming woody material and sediment.

With transfer of responsibility of flashboard management to the Hallwood-Cordua license, flashboard management is likely to be more consistent. This is because the flashboards have a dual function of increasing water delivery to the Hallwood-Cordua diversion and enhancing flows at the north ladder at Daguerre Point Dam.

The effects of flashboard management interact with entrainment effects at the Hallwood Cordua diversion and consistency of fish ladder maintenance; therefore the flashboard management is likely to increase the success of spring-run Chinook salmon adult and juvenile passage at Daguerre Point Dam but not ameliorate effects to spring-run Chinook salmon from poor ladder maintenance or from entrainment and increased predation at the diversion.

Ladder gate management is included in the flashboard management plan and constitutes a significant improvement over past operations. Ladder gates are now open during high flows, and the openings constitute an improvement over baseline passage conditions. This advantage to migrating spring-run Chinook salmon and Central Valley steelhead can only be realized if sediment and debris management, and flashboard management, all occur as planned.

Lack of free passage at the Daguerre Point Dam fish ladders leads to injury, delayed migration, and/or pre-spawning mortality. Delays resulting from adult spring-run Chinook salmon adult passage impediments are likely to weaken fish by requiring additional use of fat stores prior to spawning, and could potentially result in reduced spawning success (*i.e.*, production) from reduced resistance to disease, increased pre-spawning mortality, and reduced egg viability. Delayed maintenance actions increase the levels of harm to spring-run Chinook salmon and Central Valley steelhead that are exposed to fish ladders that are blocked at Daguerre Point Dam.

Fish ladder operations and management are a low to medium-level stressor to the Yuba River spring-run Chinook salmon population when maintenance is timely and thorough; however, in years where maintenance is delayed or not conducted, fish ladder operations and maintenance (or lack of it) are a high-level stressor on spring-run Chinook salmon. Funding for maintenance has improved since litigation, but is still dependent upon funding that is not guaranteed. Delayed maintenance reduces fitness of individual spring-run Chinook salmon and represents a high stressor to the population.

c. Waterway 13

Waterway 13 is still open and is likely to expose migrating spring-run Chinook salmon and Central Valley steelhead to attraction flows into the Yuba Goldfield where there is no spawning or rearing habitat for salmonids. During high-flow events, individual spring-run Chinook salmon and Central Valley steelhead exposed to Waterway 13 can enter it and become disoriented as they follow Yuba River flows up into the Yuba Goldfields. Because there is no spawning or rearing habitat in the Yuba Goldfields, spring-run Chinook salmon and Central Valley steelhead are likely to experience pre-spawning mortality or failed spawning attempts if they are not able to return to the mainstem of the Yuba River. If the Yuba river flows are reduced after spring-run Chinook salmon and Central Valley steelhead enter Waterway 13, stranding and thermal stress are likely to result in death of individuals. Spring-run Chinook salmon and Central Valley steelhead that are able to return to the mainstem Yuba River are likely to have reduced reproductive fitness as a result of migration delay. Waterway 13, when open to the Yuba River, is a chronic medium stressor on salmonid reproduction.

2. <u>Green Sturgeon</u>

a. Daguerre Point Dam

Daguerre Point Dam is a complete barrier to upstream migration of green sturgeon and prevents all of the individuals in the population from accessing the deep pools and cold water between Daguerre Point Dam and Englebright Dam. The proposed action is to maintain this barrier, and will result in the green sturgeon being chronically exposed to a migration barrier. Green sturgeon are unable to ascend the fish ladders at Daguerre Point Dam, or otherwise pass over or around the structure.

Green sturgeon are exposed to low flow conditions in the lower Yuba River as a result of water exports that are a conjunctive use at Daguerre Point Dam. Water removed from the aquatic ecosystem, from interrelated and interdependent actions, reduces the flows and water depths in the river and reduces that number of years that the Yuba River could support green sturgeon migration. The suboptimal migration habitat conditions downstream of Daguerre Point Dam can be overcome in years with high, uncontrolled flows; however, increased water diversions associated with the proposed action are likely to further reduce the number of years that green sturgeon can successfully migrate up the Yuba River.

Green sturgeon repeatedly leaping into the concrete apron at Daguerre Point dam are likely to be harmed by loss of energy reserves needed for reproduction or wounded by the dam.

The biological assessment for the proposed action presented an analysis of the number of pools in the lower Yuba River that are greater than 10-feet-deep (3.0 meters), and calculated that there are 26 pools greater than 10-feet-deep at 530 cfs. It is likely that green sturgeon use these pools in their migration up the Yuba River. Green sturgeon are likely to tolerate being exposed to short migration-legs between pools, resulting in energy loss and decreased reproductive fitness. Although these pools can be used by green sturgeon during migration, they are downstream from historic spawning habitats upstream of Daguerre Point Dam.

The recent returns of green sturgeon to the lower Yuba River are most likely the result of recent weather events and climatic conditions resulting in high flows, rather than prescribed management flows on the river. This response of green sturgeon to higher water flows is an indication of a positive biological response to relief from a habitat stressor.

b. Waterway 13

If sufficient flows are coming out of Waterway 13, they may attract green sturgeon into the Yuba Goldfields. There is no spawning or rearing habitat for green sturgeon in the Yuba Goldfields. Individual green sturgeon exposed to Waterway 13 may enter it and become disoriented as they follow Yuba River flows up into the Yuba Goldfields. Because there is no spawning or rearing habitat in the Yuba Goldfields, green sturgeon are likely to have reduced reproductive fitness as a result of migration delay. There is little to no food available to green sturgeon in the Yuba Goldfields, and individual green sturgeon will not find adequate nutrients to enhance or support spawning. If the Yuba river flows are reduced after green sturgeon enter Waterway 13, stranding and thermal stress are likely to result in death of individuals.

The proposed action does not include any immediate corrective measures to close off Waterway 13, only support development of measures to repair the barrier. If only a single green sturgeon entered Waterway 13 and experienced migration delay, stranding, or thermal stress, that would constitute a significant impact on the Yuba River population. Waterway 13, when open to the Yuba River, is likely to be a chronic stressor on green sturgeon reproduction.

C. Adult Holding

1. Spring-run Chinook Salmon and Central Valley Steelhead

a. Temperatures

The proposed action, and interrelated and interdependent actions, perpetuates the water diversions, minimum flow standards, and thermal conditions in the action area below Englebright Dam. Temperatures in the lower Yuba River are largely controlled by the Yuba Accord. These temperatures are driven by river flow and air temperature. During the summer months, temperatures in the lower Yuba River are generally colder than they would be under the natural hydrograph due to cold water releases from New Bullards Bar Reservoir. These colder temperatures provide optimal temperature conditions for spring-run Chinook salmon.

Lack of riparian overstory and instream cover makes the Yuba River downstream of Daguerre Point Dam vulnerable to rapid warming when water diversion reduces flows in the river. Increased temperatures in the Yuba River downstream of Daguerre Point Dam to the mouth of the Feather River are likely to expose spring-run Chinook salmon to thermal stress and result in pre-spawn mortality.

b. Poaching

The location and configuration of the Daguerre Point Dam fish ladders attract poachers. The existing design and configuration of the fish ladders also affects the holding behavior of migrating fish, exposing them to higher rates of poaching. The lower bays on the fish ladders at Daguerre Point Dam have not been covered, per recommendations from CDFG to reduce debris in the ladders during high flows; therefore, some level of poaching is likely to continue to occur. The biological assessment documented the ladder modifications in 2011, which are likely to have reduced this stressor. Poaching is likely to result in death to both Spring-run Chinook salmon and Central Valley steelhead.

2. Green Sturgeon

The proposed action affects green sturgeon by supporting water diversions upstream of Daguerre Point Dam that result in lack of sufficient flows in the lower Yuba River. Interrelated and interdependent actions that include water exports throughout the Yuba River watershed result in insufficient flows to support successful holding of green sturgeon on the lower Yuba River.

The cause of the macroinvertebrate die-offs in the lower Yuba River is unknown, but lack of sufficient food resources, combined with insufficient flows is likely to result in reduced reproductive fitness in the years that green sturgeon hold in the Yuba River.

According to Mora (2009), there are between two and six kilometers of potential holding habitat between Englebright Dam and Daguerre Point Dam. The proposed action perpetuates exclusion of green sturgeon from this habitat by not providing adequate passage. Downstream of Daguerre Point Dam green sturgeon post-spawn holding habitat is limited and probably lacks the prefered diversity of turbulent or converging flows. The exception to this is at the Daguerre Point Dam plunge pool.

a. Poaching

Poaching sturgeon in fish ladders is a common stressor on the Sacramento River, but the fish ladders at Daguerre Point Dam have not been shown to trap sturgeon; however, green sturgeon holding in the plunge pool at Daguerre Point Dam could be gaffed or speared by poachers, resulting in capture, death, wounding, or injury.

c. Invasion by non-native species

Quagga and zebra mussels, and New Zealand mud snails, becoming established in the Yuba River would reduce the invertebrate prey of spring-run Chinook salmon and Central Valley steelhead. The existing prey base is already compromised by lack of LWM and riparian overstory, low-level contribution of marine-derived nutrients, and large population fluctuations. A further reduction in available prey would expose spring-run Chinook salmon and Central Valley steelhead to starvation and reduced reproductive fitness.

D. Spawning

The proposed action will ensure the continuance of baseline spawning conditions for the spring-run Chinook salmon, Central Valley steelhead, and green sturgeon. The proposed action perpetuates lack of fish passage upstream, which reduces the quantity and quality of available spawning habitats and results in: (1) superimposition, spawning gravel deficit, introgression with hatchery stock, lack of suitable habitat for run separation of spring-run Chinook salmon; (2) inadequate flows for spring-run Chinook salmon, Central Valley steelhead, and green sturgeon; and (3) inadequate water depths for Central Valley steelhead, and green sturgeon. Reduced availability of spawning habitat constitutes a very high risk to the ability of spring-run Chinook salmon, Central Valley steelhead, and green sturgeon populations to survive in the Yuba River.

1. Spring-run Chinook Salmon and Central Valley Steelhead

The proposed action will continue to block spring-run Chinook salmon from access to 46.8 miles of suitable spawning habitat upstream of Englebright Dam and block Central Valley steelhead from 143.2 miles of suitable spawning habitat upstream of Englebright Dam, based on habitat availability modeled by Stillwater Sciences (2012). Barnett-Johnson *et al.* (2011) found that only nine percent of Chinook salmon spawning in the Yuba River had natal origins in the Yuba River. The conclusions of Barnett-Johnson *et al.* (2011) conclusions did not include a separate genetic analysis of carcasses, so NMFS is assuming that the nine percent return rate applies to both fall-run Chinook salmon and spring-run Chinook salmon.

The effects of the proposed action downstream of Englebright Dam are as follows:

a. Superimposition

The proposed action perpetuates the impaired passage conditions that promote overlapping use of the same spawning areas by spring-run and fall-run Chinook salmon (superimposition), because available habitat is constrained by lack of fish passage. Superimposition shifts spring-run Chinook salmon eggs and embryos away from suitable incubation habitat and can convey them into the water column where they are exposed to predation and are transported away from suitable rearing conditions. Based upon the fall-run and spring-run Chinook salmon run overlap analyzed in the biological assessment and the associated red superimposition will reduce the reproductive success of spawning individuals.

Central Valley steelhead are not know to experience superimposition from other species. Lack of access to side-channel and stream habitat, due to dam and operationally-induced downcutting and reduced connectivity, forces Central Valley steelhead to spawn on salmon spawning-gravels, which is likely to reduce individual fitness in other life-history stages.

b. Spawning gravel deficit

Englebright Dam was designed to hold back sediment and gravel. The existence of the dam retains spawning gravel, causing the lower Yuba River to be gravel-deficient downstream of Englebright Dam to the Highway 20 reach. This lack of spawning substrate limits spawning habitat and fish production. There has been a general coarsening of bed material. Lack of adequate spawning substrate presents a high risk to salmonids. The proposed action will continue to result in chronic spawning gravel deficiencies downstream from Englebright Dam.

This area has a deficit of 63,000 to 101,000 tons of spawning gravel (Pasternack 2010a). Gravel augmentation under the proposed action has provided a small incremental improvement above the baseline conditions that Englebright Dam is designed to maintain. As of October 6, 2011, PSMFC staff has identified 16 Chinook salmon redds in the Englebright Dam Reach where previously suitable spawning gravels did not exist prior to the Corps' 2010 gravel injection program.

The proposed gravel augmentation would be a short-term increase in the ability of the proposed action to enhance the reproductive fitness of Central spring-run Chinook salmon and Central Valley steelhead, because, as the gravel moves through the system, the level of spawning habitat available will diminish, eventually returning to baseline conditions.

Daguerre Point Dam does not appreciably affect gravel transport, because the pool is full of gravel and dredging is needed to keep the ladders and diversions clear; however, ladder maintenance and dredging that does not return gravel to the Yuba River downstream of Daguerre Point Dam would affect gravel transport. Spawning gravels downstream of Daguerre Point Dam are not a consideration, because the gradient of the river allows for gravel retention.

c. Hybridization

In years when the Feather River has low flows, the flows of the Yuba River attract spring-run Chinook salmon from other populations. Hybridization of Yuba River spring-run Chinook salmon with hatchery origin spring-run Chinook salmon is likely to continue to be between 2.9 and 63.0 percent as a result of the proposed action. Interrelated and interdependent actions will continue to result in flows that attract hatchery fish from the FRFH population. Introgression with all other populations of Chinook salmon has resulted in 91 percent hybridization (Barnett-Johnson *el al*. 2011), which diminishes the independent genetic contribution of the Yuba River population. Lack of fish passage at Englebright Dam results in hatchery fish and other wild spring-run Chinook salmon population fish competing for limited spawning locations and hybridizing. Lack and lack of separation of hatchery fish results in an inability to reduce hatchery fish hybridization.

The interrelated Narrows I powerhouse has trout stocking as a condition of the FERC license. Rainbow trout stocked by PG&E are diploids and can freely interbreed with wild *O. mykiss*. Rainbow trout stocked by CDFG are triploids with very little genetic viability.

Stocking of diploid hatchery trout is expected to have adverse effects on wild *O. mykiss* from disease, genetic introgression, and competition. The switch to stocking of triploid rainbow trout will substantially reduce the genetic influence of hatchery fish wild populations of *O. mykiss*, but stocked fish are still likely to compete with wild fish. Any *O. mykiss* attempting to outmigrate at Englebright Dam would be exposed to competition with hatchery fish that are better suited to survival in a reservoir environment.

The interrelated and interdependent Narrows I powerhouse, operated under an outgrant from the Corps, has an intake in Englebright Reservoir and a small powerhouse approximately one mile downstream from Englebright Dam. The intake in Englebright Reservoir is at a level where outmigrating *O. mykiss* could be entrained in the project works when the reservoir warms and salmonids are found at depths that exposes individual fish to the intake. Although *O. mykiss* on the North Yuba River are not listed, they represent the historical genetic stock of Central Valley steelhead (Garza and Pearse 2008). The Narrows I powerhouse has a Pelton wheel, which is completely impassable to fish. The mortality of *O. mykiss* entrained at the Narrows I intake is expected to be 100 percent, from crushing in the Pelton wheel.

The interrelated and interdependent Narrows II Project, operated under an outgrant and agreement to YCWA from the Corps, has an intake in Englebright Reservoir and a 55 megawatt powerhouse 0.2 downstream from Englebright Dam. The intake in Englebright Reservoir is at a level where outmigrating *O. mykiss* could be entrained in the project works when the reservoir warms and salmonids are found at depths that exposes individual fish to the intake. The Narrows II powerhouse has a Francis turbine, which could successfully pass fish, and upper Yuba River *O. mykiss* are found in the lower Yuba River at low levels (Garza and Pearse 2008). The mortality of *O. mykiss* entrained at the Narrows II intake has not been quantified, but is likely to range between 40 and 60 percent. Lower flows through the Narrows II powerhouse is likely to result in a different mortality rate for outmigrating *O. mykiss*, but the integrated operations of the Narrows I and Narrows II projects call for a switch to Narrows I powerhouse at lower flows.

The interrelated and interdependent Narrows I project FERC license results in trout stocking in Englebright Reservoir. Preventing diploid hatchery *O. mykiss* from entering the lower Yuba River would benefit Central Valley steelhead by reducing the Yuba River population’s exposure to hatchery fish genetics; however, preventing wild *O. mykiss* from entering the lower Yuba River has a chronic, negative effect on Central Valley steelhead by reducing genetic mixing with historical, wild-type genetics.

Now that triploid *O. mykiss* are being planted at Englebright Reservoir by CDFG, there is no genetic benefit to Central Valley steelhead from lack of downstream fish passage, or impaired downstream fish passage, at Englebright Dam.

Introgression with hatchery fish represents a medium to high stressor to the Yuba River Central Valley steelhead population. Preventing or limiting reproduction with the historical genotype of anadromous *O. mykiss* from the Yuba River does nothing to relieve this stressor. The high level of genetic representation from other rivers in California indicates a high level of risk to the Yuba River Central Valley steelhead population.

d. Flows

Reduced flows downstream of Daguerre Point Dam, from water diversions, reduce the amount of available spawning and rearing habitat for spring-run Chinook salmon and Central Valley steelhead that do not pass upstream at the Daguerre Point Dam fish ladders. Although the downstream spawners are an unstudied part of the spring-run Chinook salmon and Central

Valley steelhead populations, in years where there are maintenance problems on the fish ladders, downstream spawners represent a significant portion of the populations. Conditions downstream of Daguerre Point Dam are so inadequate for spring-run Chinook salmon and Central Valley steelhead that these fish are not likely to successfully contribute to the population.

When Englebright Dam is spilling, the extreme ramping that occurs at New Colgate rapidly changes flow levels in the lower Yuba, potentially stranding fish. Ramping restrictions under the FERC license on the Yuba River Development Project and under the Yuba Accord are intended to minimize ramping effects on salmonids, making this a low to moderate stressor on spring-run Chinook salmon and Central Valley steelhead, unless there are exceedances. The compliance history on the FERC license shows that ramping exceedances occur downstream of Englebright Dam (LoVullo *in litt.*). Ramping exceedances increase the risk of stranding as a stressor on spring-run Chinook salmon and Central Valley steelhead.

2. Green Sturgeon

The plunge pool downstream of Daguerre Point Dam provides suitable spawning habitat for green sturgeon spawning in some years, and a small number of green sturgeon are likely to utilize this pool for spawning. Although there are 26 pools that are deeper than 10 feet downstream of Daguerre Point Dam, 25 of these pools lack the features that green sturgeon prefer for spawning (*e.g.*, turbulent or convergent river flows).

It is also possible that green sturgeon spawn in the Feather River and are then attracted by the cooler waters of the Yuba River to swim up to Daguerre Point Dam and over-summer while waiting for downstream temperatures to cool to the point that they can return to the ocean. Another possibility is that green sturgeon are attracted into the Yuba River to spawn, but do not find suitable habitat downstream of Daguerre Point Dam, and therefore do not spawn, or spawn with a reduced level of success.

The Yuba River alluvial fan provides substrate for the majority of pools downstream of Daguerre Point Dam. The lower Yuba River alluvial fan does not provide the substrate conditions or flow conditions of suitable green sturgeon spawning habitat.

E. Egg Incubation and Fry Emergence

1. Spring-run Chinook Salmon and Central Valley Steelhead

The proposed action will ensure the impaired fish passage conditions that will perpetuate the baseline conditions that prevent and impair successful egg incubation and fry emergence of spring-run Chinook salmon and Central Valley steelhead.

During low-flow years, spring-run Chinook salmon eggs downstream of Daguerre Point Dam are likely to be exposed to sub-optimal temperatures and increased disease rates. Downstream spawning will also lead to higher rates of predation on spring-run Chinook salmon eggs, larvae, and juvenile fish, because downstream of Daguerre Point Dam lacks cover from predators and has enhanced predator habitat.

Although spring-run Chinook salmon Central Valley steelhead are not likely to be exposed to the direct effects of recreation, they are likely to be exposed to indirect effects resulting from recreational use of Englebright Reservoir. Recreational boating results in petrochemicals being introduced into the water column. The adverse effect of oil and gas spills from refueling and boat maintenance are likely to have a larger effect on the water column within Englebright Reservoir than downstream at the powerhouse release points, but this small, background stressor is likely to make downstream, larval and juvenile spring-run Chinook salmon more susceptible to disease and less likely to survive the upper levels of thermal tolerance.

Activities under maintenance service contracts are primarily out of reservoir, and consequently have little exposure to the aquatic environment inhabited by spring-run Chinook salmon. The only exception to this is herbicide use at Englebright Reservoir. Herbicide use associated with campground maintenance, and maintenance service contracts at Englebright Dam and Reservoir could adversely affect the aquatic environment if there is a rainfall event within five days of herbicide application.

Application of herbicides, related to treating weeds in and around recreational facilities, can result in herbicides and surfactants entering the water column after rainfall events. Exposure to low levels of herbicides and herbicide surfactants can result in reduced survivorship in eggs and emergent fry. Surfactants associated with herbicide application affect the endocrine systems of larval fish. Without careful timing of application, herbicides are likely to be a low-level stressor to spring-run Chinook salmon and Central Valley steelhead by occasionally reducing egg and larval survivorship. This is a low-intensity, episodic stressor to spring-run Chinook salmon and Central Valley steelhead eggs and fry.

Corrective maintenance actions that could stir up contaminant-laden sediment, or that would result in chemicals being introduced into the water column, could expose sensitive eggs and larvae to toxic sediments at levels that cause death or impairment downstream of the maintenance activity. Sediments released during this sensitive life-history stage could also suffocate eggs and larvae in interstitial substrate.

Sewage spills and accidental releases are commonly known occurrences in association with houseboat communities. Although houseboat communities have measures in place to prevent sewage spills and accidental releases, these measures are not failsafe. Releases can be both effluvia and the chemicals used to treat human waste. Although sewage spills and accidental releases are expected to be episodic, their adverse effect on downstream fish populations cannot be discounted and the magnitude of the event will determine the level of risk to listed fishes.

Motorized land vehicles on spawning beds can have a deleterious effect on successful reproduction. BLM has seasonal closures to the affected areas where off-road vehicles enter the water; however, recreation and trespass on public lands can be difficult to control. Loss of spawning beds continues to be a threat to spring-run Chinook salmon and Central Valley steelhead adjacent to the Yuba Gold Fields.

Stocking of hatchery trout is expected to have adverse effects on spring-run Chinook salmon through exposure to disease. The threat to spring-run Chinook salmon and wild *O. mykiss* from disease is typically addressed by careful hatchery management, but the densities of fish raised in hatcheries makes disease a constant risk. As long as water temperatures remain cold, the threat of disease proliferation remains low; however, warm summer temperatures in Englebright Reservoir could amplify fish populations' response to a disease outbreak. For example, common hatchery diseases are whirling disease, enteric redmouth disease, and protozoan progressive kidney disease. Even though listed salmonids are not currently found in Englebright Reservoir, flows from the reservoir to the river could expose the downstream spring-run Chinook salmon and Central Valley steelhead to disease, resulting in injury or death to eggs, larvae, and juvenile fish.

2. Green Sturgeon

At the one spawning location in the lower Yuba River thermal conditions are probably optimal during spawning and embryo incubation. Water temperatures directly downstream of Daguerre Point dam are controlled by the interrelated and interdependent with water diversions that will continue to be supported by the proposed action.

F. Juvenile Rearing

1. Spring-run Chinook Salmon and Central Valley Steelhead

The proposed action will continue to block spring-run Chinook salmon from access to 46.8 miles of suitable rearing habitat upstream of Englebright Dam and block Central Valley steelhead from 143.2 miles of suitable rearing habitat upstream of Englebright Dam, based on habitat availability modeled by Stillwater Sciences (2012). Englebright Dam, and its continued maintenance without fish passage into the future, reduces the quantity of rearing habitat through bedload depletion (which can affect gravel-dependent macroinvertebrate communities), depletion of instream wood, increased exposure to predation and and lack of access to floodplain habitat from interrelated and interdependent flow management.

Rearing habitat is adversely impacted by water diversions associated with the project and by the training walls disconnecting the Yuba River from its floodplain and disrupting hydrogeomorphic function. The interrelated and interdependent conjunctive uses of water delivery and energy production prevent or reduce the types of releases from Englebright Dam that would stimulate natural hydrogeomorphic processes and reconnect the Yuba River with its the floodplain. River channelization and downcutting exacerbate this problem.

a. Lack of LWM

Englebright Dam reduces the amount of LWM recruited from the upper watershed into the lower Yuba River and thus reduces the amount of instream cover, invertebrate food sources, and micro-habitat complexity that could help support and improve conditions for juvenile rearing of spring-run Chinook salmon and Central Valley steelhead.

Interrelated actions from both the Yuba River Development Project and Yuba-Bear/Drum Spaulding Projects contribute to the loss of LWM entering the Yuba River and contributing to ecosystem function. At both New Bullards Bar Reservoir and Lake Spaulding, LWM is removed from the aquatic ecosystem and burned. These actions directly affect the organic nutrient contribution to the ecosystem and indirectly affect macroinvertebrate abundance and instream cover and prey availability for juvenile salmonids.

Placement of instream LWM is likely to enhance survival of a portion of the spring-run Chinook salmon population by providing cover for juvenile rearing. It will also enhance the macroinvertebrate prey base by providing cover and nutrients for aquatic invertebrates upon which juvenile spring-run Chinook salmon forage.

LWM creates both micro- and macro-habitat heterogeneity by forming pools, back eddies and side channels and by creating channel sinuosity and hydraulic complexity, including retention of spawning gravels. This added habitat complexity provides juvenile salmonids numerous refugia from predators and water velocity, and provides efficient locations from which to feed (Crispin *et al*. 1993, Lemly and Hilderbrand 2000, Merz 2001). Snorkeling observations in the lower Yuba River have indicated that juvenile Chinook salmon had a strong preference for near-shore habitats with instream LWM (JSA 1992).

According to the rehabilitation concepts report prepared by cbec *et al.* (2010), placement of large wood (*e.g.*, ≥16 inch diameter at breast height and ≥15 ft in length, conifers or hardwoods) and root wads within low energy areas of the main channel, side channels and backwaters would provide immediate structural diversity, supplying habitat to aquatic organisms. In some locations, large wood would promote the geomorphic processes of scour and deposition, further enhancing a heterogeneous mosaic of aquatic and riparian habitat types.

In consideration of the importance that riparian vegetation and LWM play in the habitat complexity and diversity which potentially limits the productivity of juvenile salmonids, the relatively low abundance of these physical habitat characteristics in the lower Yuba River, and the fact that the loss of riparian habitat and instream cover in the form of LWM is a stressor that is manifested every year, it represents a relatively high stressor to Yuba River juvenile spring-run Chinook salmon. Placement of LWM under the proposed action is expected to enhance up to 0.5 percent of the riparian edge for juvenile rearing.

b. Lack of Riparian Overstory

The proposed action, and interrelated and interdependent actions, perpetuate the lack of riparian overstory in the lower Yuba River. Englebright Dam continues to inhibit regeneration of riparian vegetation by preventing the transport of any new fine sediment, woody debris, and nutrients from upstream sources to the lower river. This lack of riparian overstory exposes juvenile spring-run Chinook salmon and Central Valley steelhead to sunlight and increased water temperatures.

Due to the lack of riparian overstory, juvenile spring-run Chinook salmon and Central Valley steelhead are likely to be physiologically stressed, harassed, and more susceptible to predation.

c. Stranding

When Englebright Dam is spilling, the extreme ramping that occurs at New Colgate rapidly changes flow levels in the lower Yuba, potentially exposing spring-run Chinooks salmon and Central Valley steelhead to stranding (Mitchell *in litt.*). Individual fish exposed to stranding are likely to be preyed upon by terrestrial and avian foragers, such as raccoons and bald eagles. Desiccation and freezing are other consequences of stranding.

Ramping restrictions under the FERC license on the Yuba River Development Project and under the Yuba Accord are intended to minimize stranding of salmonids; but stranding continues to be a low to moderate stressor on spring-run Chinook salmon and Central Valley steelhead. The compliance history on the FERC license shows that ramping exceedances occur downstream of Englebright Dam (LoVullo *in litt*.). Ramping exceedances increase the risk of stranding as a stressor on spring-run Chinook salmon and Central Valley steelhead.

Stranding results in death and injury of approximately 293 juvenile spring-run Chinook salmon and 184 juvenile Central Valley steelhead annually (Mitchel *in litt*.).

d. Lack of food resources

Englebright Dam continues to inhibit nutrients inputs from upstream sources to the lower Yuba River and continues to suppress anadromous salmonid populations. There are three drivers of food resource utilization in salmonid populations: (1) nutrient input, (2) prey numbers, and (3) access to prey. When conditions are suitable, the nutrient input into the aquatic ecosystem allows for a commensurate increase in prey numbers (Moore *et al*. 2007, Thompson 2007). Marine-derived nutrients and the nutrient input from LWM were discussed earlier.

The nutrient input into the Yuba River ecosystem is low downstream of the regulating dams in the upper watershed and downstream of Englebright dam. Even if the nutrient input was optimal there are likely stressors in the watershed affecting aquatic macroinvertebrate abundance. The macroinvertebrate die-offs in the lower Yuba River have not been studied, and the reasons for recent macroinvertebrate die-offs is unclear; however, *D. reminata,* mercury, herbicides, or sewage treatment chemicals could suppress aquatic macroinvertebrate populations. Aquatic invertebrates can be impacted by any of the above stressors, or from a combination of these and other factors.

Alteration of streamflow magnitudes has been shown to be the primary predictor of biological integrity for fish and macroinvertebrate communities (Carlisle *et al*. 2010). Changes in the river-stage of the reach downstream of a powerhouse, due to project operations, can have crush or desiccate invertebrates or flush them from the reach.

Access to prey is an essential energetic component of juvenile spring-run Chinook and Central Valley steelhead survival. Juvenile salmonids with access to LWM and the floodplain are likely to have greater growth and higher survivorship than individual juvenile salmonids that do not have access to this important foraging habitat.

The proposed action and interrelated and interdependent actions perpetuate the flow conditions that result in lack of connectivity with the floodplain, perpetuate the existence of the training walls that separate the Yuba River from its flood plain and cause further down-cutting of the river, and hold back LWM contributions that would relieve the stressor of lack of food resources.

The training walls upstream of Daguerre Point Dam prevent juvenile spring-run Chinook and Central Valley steelhead from being sheltered from fast currents and is likely to expose them to increased predation. The river confinement caused by the training walls adjacent to the Yuba Goldfields decreases riverine habitat complexity and results in a decrease in the quantity and quality of juvenile rearing habitat. The channel will continue to incise some areas on the lower Yuba River, increasing the severity of this stressor.

Controlled flows and decreases in peak flows will continue to reduce the frequency of floodplain inundation and separation of the river channel from its natural floodplain.

e. Recreational boating

Recreational activities could introduce non-native species into the Yuba River. Recent threats in California are Quagga and zebra mussels, and New Zealand mud snails (CDFG 2008, CDFG 2011). If these non-native species become established in the Yuba River watershed, they would reduce the invertebrate prey of spring-run Chinook salmon and Central Valley steelhead. The existing prey base is already compromised by lack of LWM and riparian overstory, low-level contribution of marine-derived nutrients, and large population fluctuations (including native macroinvertebrate die-offs). Introduced mussels, snails, and algae affect native fish populations by reducing aquatic nutrients available to native invertebrates and thereby reducing prey availability for salmonids. A further reduction in available prey would expose spring-run Chinook salmon and Central Valley steelhead to starvation and reduced reproductive fitness. *D. reminata* appears to have become established in the lower Yuba River. There is a moderate risk of mussels and mud snails entering the watershed, but a high risk to the fitness and reproductive capacity of spring-run Chinook salmon and Central Valley steelhead if these organisms also enter the Yuba River watershed.

2. <u>Green Sturgeon</u>

The lower Yuba River does not provide optimal conditions for juvenile green sturgeon rearing, because of low prey availability and lack of cover. Juvenile green sturgeon exposed to low prey availability and predation in the Yuba River downstream of Daguerre Point Dam are likely to be harmed or killed.

G. Outmigration

1. <u>Spring-run Chinook Salmon and Central Valley Steelhead</u>

Outmigration mortality is estimated to be 55 percent of the annual outmigration of both the spring-run Chinook salmon and Central Valley steelhead at Daguerre Point Dam and the conjunctive use water diversions, based upon mortality calculations done on the RBDD (USFWS 1988). Additional mortality is expected due to perpetuation of lack of cover, lack of prey, predation, and warm winter temperatures that are expected at a result of continuation of operations and maintenance of the dams into the future. Warmer temperatures from global warming and climate change are likely to exacerbate this effect.

a. Daguerre Point Dam plunge pool

The proposed action includes continued maintenance of Daguerre Point Dam and perpetuation of interrelated and interrelated effects associated with the dam. Juvenile spring-run Chinook salmon and Central Valley steelhead can be killed, wounded, or injured at Daguerre Point Dam during their downstream migration. The large plunge pool at the base of the dam creates an area of unnatural advantage for predatory fish which seasonally congregate downstream of Daguerre Point Dam. The deep pool provides excellent ambush habitat for predators in an area where juvenile salmonids can be disoriented or injured as they plunge over the face of the dam into the turbulent waters at the base, making them highly vulnerable to predation. Based on studies at Red Bluff Diversion Dam (Vogel 1988), between 16 and 55 percent of Chinook salmon under the gates are killed. NMFS assumes that mortality at Daguerre Point Dam plunge pool is similar, due to disorientation of downstream migrants and the high predator field below the dam. High levels of predation over long periods of time can reduce juvenile numbers and weaken their contribution to year class strength and recruitment. Daguerre Point Dam is a moderate to high stressor on outmigrating Yuba River spring-run Chinook salmon and Central Valley steelhead.

b. Hallwood-Cordua water diversion

The interrelated and interdependent Hallwood-Cordua water diversion is dependent upon a license from the Corps for conjunctive use of water from the Daguerre Point Dam pool. Although the water diversion pre-dates the dam, the Hallwood-Cordua applicants comply with the terms of the license from the Corps. Water diversions are year-round, but generally ramp up in the early spring and extend through the fall. During diversion-ramping, outmigrating spring-run Chinook salmon and Central Valley steelhead are exposed to increased entrainment, impingement, and predation.

The proposed action perpetuates ongoing entrainment of spring-run Chinook salmon and Central Valley steelhead at the Hallwood-Cordua diversion, by continuing to license the diversion without additional mortality reduction. The 1999-2000 entrainment study by CDFG of the Hallwood-Cordua fish screen (IFC Jones and Stokes 2008) estimated that 36,144 and 91,113 *O. mykiss* were entrained in 1999 and 2000 respectively. To estimate entrainment, the study used spring-run Chinook salmon juveniles from the FRFH to test the screen mortality and make entrainment estimations using a Chinook salmon model from a similar facility in Washington State. Considering that the model used Chinook salmon numbers to calculate *O. mykiss* numbers, it is therefore an excellent model for estimating for both spring-run Chinook salmon and Central Valley steelhead entrainment estimates.

Biological testing of the Glenn-Colusa Irrigation District (GCID) fish screens concluded that predation was the primary cause of mortality to young salmon moving downriver (Vogel, D.

in litt.). The GCID mark/recapture experiments using hatchery juvenile salmon found that ". . . vigorous feeding activity by predators on those fish was evident." They also found that young salmon seeking refugia in the screen's wiper blades were preyed upon (Vogel, D. *in litt.*).

The primary mortality factor in the 1999-2000 Hallwood-Cordua entrainment study was estimated to be predation by Sacramento pike minnow, based on observations of predator foraging behavior during a CDFG study (IFC Jones and Stokes 2008). An earlier report (Hall 1979) found that predation at the Hallwood-Cordua diversion was significantly greater at the fish screens than in the canal leading up to the diversion. Similar entrainment studies in California have found that predation is a primary mortality factor at fish screens (JSA 2004, Vogel 2008). Although the Hallwood-Cordua fish screen modifications in 2000 have very likely reduced entrainment into the diversion canal, the primary mortality factor of predation has not been addressed; therefore, NMFS is considers the overall estimated mortality to spring-run Chinook salmon associated with the diversion as substantially the same as estimated in the 1999-2000 study.

Exposure of outmigrating spring-run Chinook salmon and Central Valley steelhead to the predator fields associated with the Hallwood Cordua diversion canal, fish screen, and fish return pipe results in outmigrating juvenile spring-run Chinook salmon and Central Valley steelhead being killed, injured, or wounded. The estimated loss of between 36,144 and 91,113 juvenile spring-run Chinook salmon and between 36,144 and 91,113 juvenile Central Valley steelhead annually constitutes a long-term, high level stressor for the both the Yuba River spring-run Chinook salmon and Central Valley steelhead populations and measurably contributes to the risk of extinction of the Yuba River population.

c. South Yuba/Brophy water diversion

The interrelated and interdependent South Yuba/Brophy water diversion is dependent upon an easement and license from the Corps for use of Corps' property for conjunctive-use water delivery from the Daguerre Point Dam pool. Water diversion is year-round, but generally ramps up in the early spring and extends through the fall. Increased water deliveries during the winter outmigration period are expected to occur as part of the proposed action, because under the new proposed license to YCWA canal improvements and delivery agreements allow for increased export.

Given that the length of the rock weir at the South Yuba/Brophy Diversion is 2.52 times longer than the Hallwood-Cordua fish screen, we estimate that between 90,900 and 229,800 outmigrating juvenile spring-run Chinook salmon and between 90,900 and 229,800 outmigrating juvenile Central Valley steelhead are likely to be entrained, impinged, or preyed upon at the South Yuba/Brophy Diversion annually. Increased water deliveries during the winter migration period, as a result of the Wheatland Project, exposes more outmigrating juvenile spring-run Chinook salmon to harm or death at the diversion and puts greater pressure on the population due to timing of the exposure. Exposure of outmigrating spring-run Chinook salmon and Central Valley steelhead to the predator field and unscreened diversion at the South Yuba/Brophy Diversion results in outmigrating juvenile spring-run Chinook salmon and Central Valley steelhead being killed, injured, or wounded.

The South Yuba/Brophy rock weir provides the type of cover juvenile Chinook salmon and Central Valley steelhead would normally seek in an ecosystem deficient in LWM and riparian overstory, such as the lower Yuba River. Outmigrating spring-run Chinook salmon and Central Valley steelhead that seek the cover of interstitial spaces along the rock weir are likely to be impinged within the weir and killed. Impingement at the South Yuba/Brophy rock weir is difficult to quantify, because the juvenile fish simply disappear into the gravel, so a metric is needed. Because mortality associated with fish screens has been studied, we used the established Hallwood-Cordua metric in this analysis.

In addition to impingement, flows into the diversion can give a false cue to outmigrating juveniles and attract them into the diversion pool. This pool has all of the features indicating it is a predator field that juvenile spring-run Chinook salmon are not likely to pass successfully. The 300 to 600 cfs flows coming into the diversion pool, with only five cfs returning to the river, does not allow for sweeping flows to let the outmigrating juveniles pass. The diversion pool and return flow channel provides foraging cover for predators and provides predators with easy access to exposed juvenile fish, because they have clear open water, no riparian cover or aquatic LWM, and steeply sloped sides.

Water diversion at the South Yuba/Brophy Diversion removes water from the Yuba River that would otherwise be utilized by spring-run Chinook salmon for basic life history behavior. Water diversions at Daguerre Point Dam reduce the amount of downstream outmigration habitat available for spring-run Chinook salmon and Central Valley steelhead.

The Corps has been participating with the Brophy Irrigation District, NMFS, CDFG, and the USFWS to investigate, design, and implement an economical plan to replace the current porous rock weir on the South Yuba/Brophy Diversion with a new positive barrier fish screen that will meet all current CDF and NMFS fish screen criteria for anadromous salmonids. This group is currently in the process of selecting its preferred alternative to conduct a full feasibility and engineering design study on.

In response to concerns over this biological opinion, South Yuba, Brophy, and Wheatland water districts and Dry Creek Mutual Water Company (collectively, the “South County Diverters”) wrote a letter to NMFS on February 8, 2012, stating clearly that they cannot afford to replace the rock weir (“gabion”) at the South Yuba/Brophy Diversion with a fish screen that meets current CDFG and NMFS screening criteria. The South County Diverters consider the rock weir to be located on private property and outside the Corps’ authority. Dissent from the South County Diverters may result in the June 2018 construction date on South Yuba/Brophy Diversion fish screen to be delayed.

No predator control program is in place at the South Yuba/Brophy Diversion and salmonid loss at this facility is likely to have been a severe and chronic stressor on outmigrating salmonids.

The South Yuba/Brophy Diversion constitutes a chronic, long-term, high level-stressor for the Yuba River spring-run Chinook salmon and Central Valley steelhead populations and measurably contributes to the risk of extinction of these populations.

d. Flashboard Management

The flashboards operated as part of the Hallwood-Cordua license, increase the ability of Hallwood-Cordua to divert water during low flow periods, but also aid in directing the flows towards the fish ladder entrances. Flashboard management has demonstrated an increase in the passage of salmon up the ladders. The effects of flashboard management interact with entrainment effects at the Hallwood-Cordua diversion and consistency of fish ladder maintenance; therefore the flashboard management is likely to increase the success of spring-run Chinook salmon and Central Valley steelhead outmigration, but not ameliorate effects these species from entrainment and increased predation at the diversion.

Although the fish screen improvements at the Hallwood-Cordua diversion have reduced entrainment of juvenile salmonids, the Hallwood-Cordua diversion results in a high level of exposure to predation in the diversion canal and at the fish return pipe. At the Hallwood-Cordua diversion, two remaining stressors are likely to have a moderate impact on the population: (1) predation losses of emigrating fry and juvenile fall-run Chinook salmon remain a limiting factor at this location; and (2) the configuration of the current return pipe and flows through the pipe are also likely to be a limiting factor (CALFED and YCWA 2005).

As previously described, the South Yuba/Brophy system diverts water through an excavated channel from the south bank of the lower Yuba River upstream of Daguerre Point Dam. Diversion of water at the South Yuba/Brophy diversion has increased 118 percent since 2005. The water is diverted through a porous rock weir that impinges and entrains fish. The current design of this rock structure does not meet NMFS or CDFG juvenile fish screen criteria (SWRI 2002). The diversion subjects salmonids to the high stressors of predation, impingement, and entrainment. Therefore, the South Yuba/Brophy diversion facility is a high stressor to spring-run Chinook salmon and Central Valley steelhead outmigrants.

e. Lack of instream cover

The very poor instream cover conditions lower Yuba River will be perpetuated by the proposed action. The LWM supplementation that is being implemented as a conservation action under the proposed action is likely to increase rearing habitat for spring-run Chinook salmon and Central Valley steelhead in approximately 0.5 percent of the riverine edge between Englebright and Daguerre Point dams. The increase is not permanent, and its benefits will decrease as LWM decomposes and is transported out of the system with high flow events and under operational flow conditions. NMFS estimated this increase based on the number of river miles between Englebright and Daguerre Point dams, the potential for either side of the river to support habitat, and the end-to-end distance of the proposed LWM supplementation.

Spring-run Chinook salmon and Central Valley steelhead exposed to lack of instream cover will continue to have reduced fitness from lack of prey, exposure to predation, and exposure to sunlight. Lack of instream cover will continue to be relatively high stressor to Yuba River juvenile spring-run Chinook salmon and Central Valley steelhead.

f. Lack of prey

Lack of marine-derived nutrients, lack of connectivity with floodplain, lack of riparian overstory, and lack of instream LWM all contribute to low prey availability in the lower Yuba River. Outmigrating spring-run Chinook salmon and Central Valley steelhead exposed to this stressor will have reduced growth, reduced survivorship during outmigration, and reduced survivorship through the Delta an in the marine environment. The baseline condition of invertebrate die-offs, combined with the low prey availability from continuing to keep the dams in place, further river channelization caused by the training walls, and regulated flows that keep the river out of the floodplain all contribute to reduced fitness of spring-run Chinook salmon and Central Valley steelhead.

g. Temperatures

A major potential thermal stressor in the lower Yuba River would be temperatures over 55°F during the spring-run Chinook salmon outmigration period. During normal and above normal water years, this thermal stressor is not likely to be of significant concern; however, the lower Yuba River, downstream of Daguerre Point Dam, does not provide cold enough temperatures in January and February for spring-run Chinook salmon smoltification in dry years (C. Mesick, *pers*. *comm*.). Some proportion of outmigrating spring-run Chinook salmon exposed to this stressor will die.

2. <u>Green Sturgeon</u>

The lower Yuba River does not provide optimal conditions for juvenile green sturgeon outmigration, because of low prey availability and lack of cover. Juvenile green sturgeon exposed to low prey availability and predation in the Yuba River downstream of Daguerre Point Dam are likely to be harmed or killed during outmigration.

VII. EFFECTS OF THE ACTION ON CRITICAL HABITAT

The lower Yuba River is critical habitat for spring-run Chinook salmon, Central Valley steelhead, and green sturgeon. Critical habitat provides PCEs, which are physical or biological elements essential for the conservation of the species. Because the PCEs are the same for spring-run Chinook salmon and Central Valley steelhead, critical habitat elements for these two species are analyzed together for both species. Green sturgeon critical habitat is addressed separately. Critical habitat impacted by the proposed action includes the lower Yuba River and the Feather River from the confluence with the Yuba River to the confluence with the Sacramento River.

A. Spring-run Chinook Salmon and Central Valley Steelhead

Critical habitat has been designated downstream of Englebright Dam, to include currently occupied areas. Extension of critical habitat upstream of Englebright Dam was deemed premature until recovery planning determines a need for these areas in the recovery of the spring-run Chinook salmon ESU and Central Valley steelhead DPS (September 2, 2005, 70 FR

52488). The Yuba River below Englebright dam has highly degraded habitat characteristics and substantially different flow, substrate, cover, nutrient availability, and temperature regimes than the upper Yuba River and its headwater streams. Since the 2005 determination of critical habitat for spring-run Chinook salmon and Central Valley steelhead, draft recovery planning has identified habitat upstream of Englebright Dam as essential for the recovery of these species (NMFS 2009). The critical habitat designation has not been revised to reflect the outcome of recovery planning, so upstream habitat is not considered in this analysis.

The Yuba River provides three of the six PCEs essential to support one or more life stages of the spring-run Chinook salmon and Central Valley steelhead. The specific PCEs relevant to the lower Yuba River are: (1) freshwater migration corridors; (2) freshwater spawning sites; and (3) freshwater rearing sites.

1. Freshwater Migration Corridors

Freshwater migration corridors are located downstream of spawning habitat and allow for both the upstream passage of adults and downstream passage of juveniles. Migratory habitat conditions for spring-run Chinook salmon and Central Valley steelhead are impaired by continuance of the proposed action.

Daguerre Point Dam is an intermittent migration barrier, with blockage to adult migration occurring during high and low flows. Successful outmigration is impaired by Daguerre Point Dam and by interrelated and interdependent water diversions, predator fields at manmade structures, impingement and entrainment, lack of instream cover, lack of riparian cover, and lack of access to the floodplain.

The proposed action has measures to enhance adult migration at Daguerre Point Dam, but successful migration of spring-run Chinook salmon and Central Valley steelhead at Daguerre Point Dam can be impacted by delayed maintenance actions and by ladder design features that cannot be corrected. Daguerre Point dam limits the ability of the critical habitat to support spring-run Chinook salmon and Central Valley steelhead, because they can be forced to spawn in unsuitable habitat downstream of Daguerre Point Dam or have reduced reproductive fitness resulting from migration delays while attempting to pass Daguerre Point Dam.

Under the proposed action, the freshwater migration corridors in the Yuba River will continue to be compromised by exposure of juvenile spring-run Chinook salmon and Central Valley steelhead to predator-rich diversion structures and dam features, incised channels that limit channel complexity, and water temperatures that may be physiologically lethal or sublethal.

The winter temperature standard of 63 °F under the Yuba Accord is likely to result in reversal of smoltification of spring-run Chinook salmon and could result in a complete cohort-failure (Mesick *pers. comm.*). Any winter temperature standard above 55 °F does not contribute to the conservation of spring-run Chinook salmon.

Entrainment, impingement, and predation at the South Yuba/Brophy and Hallwood-Cordua diversions reduce the numbers of outmigrating juvenile spring-run Chinook salmon and outmigrating juvenile Central Valley steelhead by up to 229,800 individuals of each species annually. Increased water deliveries during the winter migration period, as a result of the interrelated Wheatland Project, exposes additional outmigrating juvenile spring-run Chinook salmon to entrainment, impingement, and predation. The Wheatland Project could result in the cumulative loss of up to 321,720 outmigrating spring-run Chinook salmon at the South Yuba/ Brophy diversion annually. The Wheatland Project would also result in lower outmigration flows downstream of Daguerre Point Dam.

Interrelated and interdependent water deliver and hydropower actions lead to increases in Yuba River flows during the time period when Feather River flows are low. The “flow disconnect” between the Yuba and Feather rivers causes spring-run Chinook salmon from the Feather River to be preferentially attracted into the Yuba River. This results in migrating Feather River wild and hatchery spring-run Chinook salmon having reduced fitness, by exposing them to the poor reproductive conditions in the Yuba River, and it reduces the contribution of those individuals to the conservation of the ESU.

Waterway 13 and the Narrows I and Narrows II powerhouses provide false attraction flows that disrupt Yuba River spring-run Chinook salmon and Central Valley steelhead migration. Time spent by spring-run Chinook salmon or Central Valley steelhead entering Waterway 13 or attempting to enter project works at the powerhouses is likely to result in reduced reproductive fitness, harm to individual spring-run Chinook salmon and Central Valley steelhead, and a loss of genetic contribution to the conservation of the populations.

Lack of scouring and channel forming flows, in conjunction with training walls, has effectively channelized and simplified the river corridor. The continuance of operational flows and river channelization precludes the critical habitat from supporting the variety of habitats that allow spring-run Chinook salmon and Central Valley steelhead outmigrants to avoid high flows, avoid predators, successfully compete, begin the behavioral and physiological changes needed for life in the ocean, and reach the ocean in a timely manner has been and will continue to be compromised by operational conditions.

The conservation value of migration habitat is negatively affected for both spring-run Chinook salmon and Central Valley steelhead as a result of the proposed action and interrelated and interdependent actions.

2. Freshwater Spawning Habitat

Maintenance of Englebright Dam into the future will continue to degrade spring-run Chinook salmon and Central Valley steelhead spawning habitat in the lower Yuba River. Spawning habitat in the Yuba River is will continue to be negatively affected by lack of natural spawning gravel recruitment, hardening and coarsening of bed materials, and flow and water temperature conditions associated with the proposed action and interrelated and interdependent actions.

The gravel augmentation plan that is being implemented as a conservation action under the proposed action is likely to temporarily increase spawning habitat for spring-run Chinook salmon and Central Valley steelhead. The gravel augmentation is likely to support approximately 23 to

37 redds between Englebright and Daguerre Point dams, but the increase will not be permanent, and the benefit to the conservation of spring-run Chinook salmon and Central Valley steelhead will decrease as the augmentation gravels are moved out of the system during high flow events.

The superimposition caused by continuing to maintain Englebright Dam into the future reduces the conservation value of the spawning habitat for spring-run Chinook salmon in the lower Yuba River. Exposure to hybridization with fall-run Chinook salmon and outbreeding with FRFH and wild Feather River spring-run Chinook further impair the ability of Yuba River spawning habitat to support conservation of spring-run Chinook salmon.

Some level of hybridization with hatchery *O. mykiss* from planted trout at Englebright Reservoir adversely affects spawning conditions of Central Valley steelhead in the lower Yuba River. Planting diploid rainbow trout reduces the value of critical habitat in the lower Yuba River for the conservation of and Central Valley steelhead.

The proposed action has measures to nominally increase Spring-run Chinook salmon and Central Valley steelhead spawning numbers but does not support conservation of the species.

3. Freshwater Rearing Habitat

Englebright and Daguerre Point dams, their continued maintenance into the future, result in a lack of suitable rearing habitat for conservation of spring-run Chinook salmon and Central Valley steelhead. The proposed action and interrelated and interdependent actions perpetuate the high predation, lack of LWM and instream cover, lack of overstory, reduced marine-derived nutrients, reduced invertebrate food sources, risk of disease and non-native species invasions, lack of access to floodplain habitat, and reduced micro-habitat complexity that could help support and improve conditions for juvenile rearing of spring-run Chinook salmon and Central Valley steelhead.

Interrelated and interdependent conjunctive uses further compromise the ability of the critical habitat to provide suitable rearing habitat to conserve spring-run Chinook salmon and Central Valley steelhead. Interrelated and interdependent actions result in high entrainment and impingement, high predation, periodic stranding from peaking and ramping flows, an unstable food source from fluctuating aquatic macroinvertebrate populations, and lack of access to floodplain habitat.

Loss of LWM in the Yuba River directly affects the ability of the river to retain spawning gravels and indirectly affects the ability of the river to establish a riparian overstory. The LWM supplementation that is being implemented as a conservation action under the proposed action will temporarily improve rearing conditions on 0.5 percent of the riverine edge between Englebright and Daguerre Point dams. This will temporarily increase a small amount of rearing habitat for spring-run Chinook salmon and Central Valley steelhead, but cannot overcome the overwhelming deficiency of instream cover perpetuated by removal of LWM from the ecosystem by interrelated and interdependent hydropower and water delivery dams such as New Bullards Bar and Spaulding dams.

Lack of inspections of boats at Englebright Reservoir and no gear inspections at river accesses increases the threat of non-native invertebrates entering critical habitat on the lower Yuba River. Establishment New Zealand snails or quagga or zebra mussels could have catastrophic effects on the ability of the critical habitat to conserve spring-run Chinook salmon and Central Valley steelhead.

As long as Englebright Reservoir is stocked with rainbow trout, there will be the threat of hatchery-originated disease outbreaks in critical habitat on the lower Yuba River.

The changes in flow levels associated with implementation of the interrelated Wheatland project are of sufficient magnitude, timing, or duration to adversely affect freshwater rearing habitat for spring-run Chinook salmon and Central Valley steelhead in the lower Yuba River down to the confluence of the Feather River with the Sacramento River. The changes in flow levels associated with implementation of the Wheatland project is expected to be of sufficient magnitude, timing, or duration to adversely affect the survival of juvenile steelhead and spring-run Chinook salmon.

The proposed action and interrelated and interdependent actions perpetuate the flow conditions that result in lack of connectivity with the floodplain, perpetuate the existence of the training walls that separate the Yuba River from its flood plain and cause further down-cutting of the river, and make LWM contributions that are insufficient to relieve the stressor of lack of food resources.

The conservation value of rearing habitat for both spring-run Chinook salmon and Central Valley steelhead is negatively affected as a result of the proposed action.

B. Green Sturgeon

1. Food Resources

Invertebrate food resources are unstable on the lower Yuba River. This is most likely the result of lack of LWM, lack of riparian overstory, lack of riparian function due to channelization, export of nutrients with water exports, and suppression of salmonid populations which contribute marine-derived nutrients to the ecosystem. Other factors may be affecting invertebrate populations on the lower Yuba River, such as sediment upwelling and re-suspension corresponding with high flows and thermal turnover in reservoirs with mercury-laden sediment, accidental spills associated with recreation or houseboats, or water temperatures above or below suitable ranges for invertebrate development and emergence.

The proposed action and interrelated and interdependent actions are likely to reduce food availability for green sturgeon by perpetuating the conditions that have resulted in unstable invertebrate populations in the lower Yuba River.

2. Substrate Type or Size

Critical habitat in the Yuba River has not been mapped or surveyed for suitable green sturgeon spawning substrate. It is likely that the only suitable spawning substrate downstream of Daguerre Point Dam is the hardened area in and around the plunge pool. The proposed action is not expected to modify the substrate condition.

3. Water Flow

The proposed action and interrelated and interdependent actions will perpetuate the existing, regulated flow conditions on the lower Yuba River. The Yuba River downstream of Daguerre Point Dam does not provide sufficient water flow rates for green sturgeon spawning and rearing under most water-year types. Water diverted out of the river and watershed is the primary reason for the insufficient flows. Only very wet years are likely to provide sufficient flows for spawning and rearing.

Water diversions out of the upper Yuba River watershed contribute to the inadequage flow conditions in the lower Yuba River. These annual exports reduce the ability of the Yuba River and its watershed to support green sturgeon. No analysis has been done on the collective contribution this water could have to habitat restoration, if allowed to remain in the Yuba River watershed for recovery of green sturgeon.

When the lower Yuba River still experiences a dynamic flood regime is when the conditions are likely to be closest to optimal for green sturgeon. Water exports reduce the timing and likelihood of dynamic river flows. Increased exports at the Brophy/South Yuba Diversion are likely to exacerbate poor flow conditions for green sturgeon on the lower Yuba River.

4. Water Quality

The proposed action and interrelated and interdependent actions perpetuate the existing regulatory conditions in the lower Yuba River. The Yuba Accord is the mechanism for managing flows from the interrelated and interdependent actions related to and dependent upon the proposed action. The Yuba Accord does not have temperature requirements that are protective of spawning temperatures for green sturgeon.

5. Migratory Corridor

The migratory corridor in the Yuba River is unimpeded downstream of Daguerre Point Dam, although there are false attraction flows at Waterway 13. The biological assessment modeled the Yuba River downstream of Daguerre Point Dam and found 22 pools greater than 3 meters deep. These are apparently adequate for migration when river flows are sufficient during high flow events.

The recent returns of green sturgeon to the lower Yuba River are most likely the result of recent weather events, rather than prescribed management flows on the river. This response of green sturgeon to higher winter flows is an indication of a positive biological response to relief from a habitat stressor. The ability of the migratory corridor to support conservation of green sturgeon on the lower Yuba River is dependent upon water flow. The migratory corridor is interrupted by the operation of Daguerre Point Dam without fish passage facilities for the species.

6. Water Depth

The only holding pool downstream of Daguerre Point Dam that is close to five meters deep is the plunge pool at the base of the dam. This single holding pool has the associated turbulence needed for spawning and for summer holding, but is such a small area that it may not support more than the five green sturgeon observed there in 2011.

7. Sediment Quality

Englebright Dam retains much of the mercury-laden sediment from the gold mining era, however, summer turnover and high summer flows resuspend this sediment and transport it into green sturgeon critical habitat. It is unclear to what extent sediment release occurs and whether licensed actions can control sediment release.

VIII. CUMULATIVE EFFECTS

Under the ESA cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion (50 CFR 402.02). 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. This section summarizes the impacts of future non-Federal actions reasonably certain to occur within the action area, as required by regulation.

A. Western Aggregates Easement

The Western Aggregates 180-acre conservation easement will prohibit development or mining on the encumbered lands (except for disturbance that may be necessary to re-establish floodplains), and will outline a range of potential prescriptions for habitat restoration (YubaNet 2008). The project also will incorporate pedestrian access to the lower Yuba River through several walk-through gates to be established at locations to be agreed upon at a future date.

The parties plan to implement the project in three phases. Initially, the project will protect and conserve land from vehicular damage to habitat. Concurrently, SYRCL will lead design and feasibility studies for physical habitat restoration. In the second phase, habitat for salmon and riparian wildlife will be restored through a series of projects over the encumbered lands. Finally, the project contemplates implementing long-term enhancement and monitoring of these restored habitats. The timing of the completion of the three phases is unknown at this time because of the funding needs of the project (YubaNet 2008). Western has initiated a Yuba Salmon Enhancement Fund through a "challenge grant" to SYRCL of $50,000, and Western has agreed to match SYRCL's fund-raising of the project dollar for dollar for the first $50,000 raised by SYRCL (YubaNet 2008). The four parties to the Agreement in Principle also must obtain the consent of certain third parties who have varying interests in some of the lands contemplated for the conservation easement (YubaNet 2008).

B. Wheatland Project

YCWA completed an agricultural delivery canal (Wheatland Project) to Wheatland Water District in 2010 (Wheatland Project). The Wheatland Project extended YCWA surface water delivery capabilities to the Wheatland Water District by constructing canal facilities to deliver Yuba River Development Project water to the Wheatland Water District in southern Yuba County.

The total future projected annual agricultural water demand that could be served by the Wheatland Project is about 41,000 acre-feet. Water is diverted from the Yuba River at the South Yuba/Brophy Diversion and is conveyed to the Wheatland Water District through the existing South Main Canal. The diverted water is either provided through the direct diversion of the natural flow of the Yuba River or, during dry periods, through rediversion of stored water released from New Bullards Bar Reservoir, which is located on the North Yuba River.

The Wheatland Project is expected increase water diversions from the Yuba River and to increase the level of impacts to listed salmonids associated with increased exposure to the South Yuba/Brophy diversion. Results of model simulations for changes in flows in the lower Yuba River for the reach from Englebright Dam to Daguerre Point Dam show that during many summer months, flows would be higher with the Wheatland Project due to increased storage releases from Englebright Reservoir for the additional irrigation diversion deliveries downstream. Flows throughout the river during the winter would be somewhat lower with the Wheatland Project during some occasions. This reduction in flows would occur because of delay or reduction in spill amounts caused by lower storage levels, which, in turn, are the result of increased summer releases (YCWA 2002).

Results of model simulations for changes in flows in the lower Yuba River for the reach from Englebright Dam to Daguerre Point Dam show that during many summer months, flows are higher with the Wheatland Project due to increased storage releases from Englebright Reservoir for the additional irrigation diversion deliveries downstream. Flows throughout the river during the winter would be somewhat lower with the Wheatland Project during some occasions. This reduction in flows would occur because of delay or reduction in spill amounts caused by lower storage levels, which, in turn, are the result of increased summer releases (YCWA 2002).

For the reach below Daguerre Point Dam, the Wheatland Project results in a reduction in flows when flows would otherwise be above the minimum instream flow requirements, either because of power releases or uncontrolled flows. The new flow levels associated with the Wheatland project are expected to be of sufficient magnitude, timing, or duration to adversely affect critical habitat and listed salmonids in the lower Yuba River. There are likely to be increased habitat values and reduced water temperatures in the upstream reaches during the summer and fall irrigation season but reduced habitat values and flows in the spawning and rearing period. Although there may be benefits of increased flows in the primary spawning and rearing reaches upstream of Daguerre Point Dam during certain periods, there will be reduced flows in the reaches below Daguerre Point Dam. We therefore expect that the effects of stream flows associated with the Wheatland project lead to increased entrainment at the South Yuba-Brophy diversion that is expected to cause a reduction in survival of juvenile steelhead and spring-run Chinook salmon in the Yuba River.

The increase in diversion rates at the South Yuba-Brophy diversion associated with the proposed Wheatland project is likely to expose juvenile spring-run Chinook salmon to greater rates of predation and entrainment during the critical outmigration period. This potential increase in entrainment could be avoided if a fish screen meeting CDFG and NMFS screening criteria is installed.

C. Agricultural Practices

Agricultural practices may negatively affect riparian and wetland habitats through upland modifications that lead to increased siltation or reductions in water flow in stream channels flowing into the action area, including the Sacramento River and Delta. Grazing activities from livestock operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation, as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into receiving waters. Increased water temperatures can result when agricultural water exposed to warm summer air temperatures is returned to the Yuba River as agricultural return flow. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect salmonid reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

D. Browns Valley Irrigation District Agricultural Return Flow Recapturing Project

Browns Valley Irrigation District (BVID) is planning to construct a pumping plant and a pipeline to recapture and recycle irrigation return flows that the district is discharging into Dry Creek (BVID 2011). BVID will convey recycled flows from a pumping plant on Dry Creek to rice fields presently irrigated exclusively by diversions from the lower Yuba River. The warmer reclaimed water will be delivered into BVID's Pipeline Canal and applied by its customers to rice lands where the elevated water temperature benefits rice production. Application of tailwater recaptured from Dry Creek to the agricultural lands within BVID's service area will reduce the district's demand for water diverted directly from the lower Yuba River, thus balancing the reduction in inflow to the river that results from pumping from Dry Creek with an equivalent reduction in diversion. The agricultural return-flow project is of regional significance because it will reduce diversions from the lower Yuba River (Yuba County 2007).

The agricultural return-flow project proposes to recapture up to a maximum of 10 cfs of irrigation return flow from Dry Creek during the irrigation season, which typically runs from April through October (BVID 2011). It is estimated that the influx of tailwater raises Dry Creek's temperature by an average of 4 ºC to 5 ºC and introduces sediment, nutrients, and other constituents into the Dry Creek approximately 1.8 miles upstream of its confluence with the lower Yuba River (BVID 2009). By pumping water from Dry Creek downstream of the confluence with Little Dry Creek when Dry Creek flows are primarily comprised of tailwater from irrigated lands, the agricultural return-flow is expected to improve water quality by removing some of the thermal and pollutant load from Dry Creek before it reaches the lower Yuba River. BVID will continue to meet existing minimum flow requirements with releases of cool, good quality water from Collins Lake. Use of the recaptured tailwater for the rice fields will reduce BVID diversions of cool surface water from the lower Yuba River, and this substitution will retain cool water in the lower Yuba River, which will benefit fisheries resources and aquatic habitat (BVID 2009).

E. Recreational Boating

Recreational boating represents a significant risk to aquatic ecosystems in California through introduction and dispersal of non-native aquatic invertebrates. In the action area, both zebra (*Dreissena polymorpha*) and quagga (*D. rostriformis*) mussels could enter Englebright or New Bullards Bar reservoirs via contaminated boats, motors, trailers, and recreation equipment coming into contact with the reservoir waters. Zebra and quagga mussels arrived in the U.S. in 1988 and 1989 respectively, and they have spread widely since then. Both mussels can become established in freshwater ecosystems. The larvae are too small to see with the naked eye, making early detection difficult. Adults may release over 40,000 eggs in a reproductive cycle and up to 1 million in a spawning season. In addition to attaching to boats, motors, trailers, and recreation equipment, they can attach to aquatic plants, aquatic substrates, in addition to substrates, docks, piers, anchors, and hydroelectric facilities. These mussels can survive three to five days out of water depending upon temperature and humidity in summer, and up to 30 days in the winter (CDFG 2008). By filtering nutrients out of the water, these bivalve diminish the amount food available for native species.

New Zealand mud snails (*Potamopyrgus antipodarum*) have recently invaded stream and rivers in California. They establish very dense populations and can reduce whole-stream algal production other populations of other macroinvertebrates depend upon (CDFG 2011). Reduction in algal production can rapidly reduce food resources for spring-run Chinook salmon and Central Valley steelhead trout, particularly mayflies, caddisflies, and chironomids. They

Recreational houseboating is likely to continue on both Englebright and New Bullards Bar reservoirs. Because houseboats are not as mobile as fishing boats, their risk of introducing non-native invertebrates is less than that of recreational boating; however, accidental spills of sewage effluent are more likely to occur with houseboats. Both sewage and treatment chemicals can enter the aquatic ecosystem and disrupt the nutrient cycle.

F. Trust for Public Lands Excelsior Project

The Excelsior Project is a collaborative conservation effort on the lower Yuba River, featuring 924 acres of wetlands, oak woodlands, gold-rush archeological remnants, and 2 miles of riparian salmon spawning habitat. The Yuba Narrows Ranch will be managed and permanently protected as open space. Additionally, the Trust for Public Land is presently pursuing efforts to acquire a conservation easement for the historic 157-acre Black Swan Ranch portion of the Excelsior property, which is located near the confluence of Deer Creek and overlooks Englebright Reservoir and the lower Yuba River (Sierra Nevada Conservancy 2010).

IX. INTEGRATION AND SYNTHESIS

The *Integration and Synthesis* section is the final step of NMFS' assessment of the risk posed to species and critical habitat as a result of the proposed action. In this section, NMFS performs two evaluations: whether, given the environmental baseline and status of the species and critical habitat, as well as future cumulative effects, it is reasonable to expect the proposed action is not likely to: (1) reduce the likelihood of both survival and recovery of the species in the wild, and (2) result in the destruction or adverse modification of designated critical habitat (as determined by whether the critical habitat will remain functional to serve the intended conservation role for the listed anadromous species or retain its current ability to establish those features and functions essential to the conservation of the species).

The *Analytical Approach* described the analyses and tools we have used to complete this analysis. This section is based on analyses provided in the *Status of the Species*, the *Environmental Baseline*, and the *Effects of the Proposed Action*.

In our *Status of the Species* section, NMFS summarized the current likelihood of extinction of each of the listed species. We described the factors that have led to the current listing of each species under the ESA across their ranges. These factors include past and present human activities and climatological trends and ocean conditions that have been identified as influential to the survival and recovery of the listed species. Beyond the continuation of the human activities affecting the species, we also expect that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover. The *Environmental Baseline* reviewed the status of the species and the factors that are affecting their survival and recovery in the action area; and most specifically focused on these factors in the Feather River. The *Effects of the Proposed Action* reviewed the exposure of the species and critical habitat to the proposed action and interrelated and interdependent actions, cumulative effects. NMFS then evaluated the likely responses of individuals, populations, and critical habitat. The *Integration and Synthesis* will consider all of these factors to determine the proposed action's influence on the likelihood of both the survival and recovery of the species, and on the conservation value of designated critical habitat.

The criteria recommended for low risk of extinction for Pacific salmonids are intended to represent a species and populations that are able to respond to environmental changes and withstand adverse environmental conditions. Thus, when our assessments indicate that a species or population has a moderate or high likelihood of extinction, we also understand that future adverse environmental changes could have significant consequences on the ability of the species to survive and recover. Also, it is important to note that an assessment of a species having a moderate or high likelihood of extinction does not mean that the species has little or no chance to survive and recover, but that the species faces moderate to high risks from various processes that can drive a species to extinction. With this understanding of both the current likelihood of extinction of the species and the potential future consequences for species survival and recovery, NMFS will analyze whether the effects of the proposed action are likely to in some way increase the extinction risk each of the species faces.

In order to estimate the risk to spring-run Chinook salmon, Central Valley steelhead, and green sturgeon as a result of the proposed action, NMFS uses a hierarchical approach. The condition of the ESU or DPS is reiterated from the *Status of the Species* section of this biological opinion. We then consider how the viability of the population, as described in the *Environmental Baseline*, is affected by the proposed action. Effects to individuals is summarized, and the consequence of those effects is applied the VSP concept and used to establish risk to the diversity group, ESU, or DPS.

In designating critical habitat, NMFS considers the physical and biological features (essential features) within the designated areas that are essential to the conservation of the species and that may require special management considerations or protection. Such requirements of the species include, but are not limited to: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, generally, (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species [see 50 CFR § 424.12(b)]. In addition to these factors, NMFS also focuses on the principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. Primary constituent elements may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

The basis of the “destruction or adverse modification” analysis is to evaluate whether the proposed action results in negative changes in the function and role of the critical habitat in the conservation of the species. As a result, NMFS bases the critical habitat analysis on the affected areas and functions of critical habitat essential to the conservation of the species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

A. Impacts on Species

1. Central Valley Spring-Run Chinook Salmon ESU

a. Condition of the ESU

The Central Valley spring-run Chinook salmon ESU is at moderate risk of extinction (Lindley *et al.* 2007). The most recent viability assessment of Central Valley spring-run Chinook salmon was conducted during NMFS’ 2011 status review (NMFS 2011a). This review found that the biological status of the ESU has worsened since the last status review. All Central Valley spring-run Chinook salmon populations are currently at a high risk of extinction (with the exception of the Butte Creek population, which is at a moderate to high risk of extinction). The review recommended that status be reassessed in two to three years if the ESU does not respond positively to improvements in environmental conditions and management actions. The ESU fails all VSP criteria for viability.

b. Viability at the Population Level

The Yuba River population of the spring-run Chinook has low abundance, low productivity, limited spatial structure, and is a population sink for other populations (NMFS 2011a, Schick and Lindley 2007). Low returns of wild spring-run Chinook salmon in some years may represent cohort failures from preceding years. For example, the low returns in 2007 may represent a cohort failure in 2004, with returning wild adult spawners being two-, four-, or five-year-old spring-run Chinook salmon. In addition, low returns may represent cohort failures in several years, with the returning adults being wild spring-run Chinook salmon with natal origins outside of the Yuba River.

The Yuba River population spring-run Chinook salmon has very high hatchery introgression and is not genetically viable. The spatial structure of spring-run Chinook salmon spawning is limited to sparsely available of spawning substrate, and superimposition pressure is high in some years. The river temperatures during outmigration may be too high in some years to allow for successful smoltification and outmigration. The lack of access to historical spawning habitat is the primary driver for the stressors of superimposition by fall-run Chinook salmon and low abundance relative to FRFH fish. High predation, entrainment, and lack of thermal protection for winter outmigrants all reduce the number of spring-run Chinook salmon that leave the river, enter the Delta, and forage in the marine environment. The population has low viability and a high risk of extinction (NMFS 2011a).

Flow conditions in the Yuba River provide greater attraction flow than the Feather River during some years, causing spring-run Chinook salmon from the Feather River to be preferentially attracted into the Yuba River to spawn. This exacerbates baseline hatchery effects and genetic introgression, because it results in an increase in genetic mixing of Feather River wild and hatchery spring-run Chinook salmon with natal Yuba River spring-run Chinook salmon.

The Yuba River population of spring-run Chinook salmon is not likely to survive the conditions perpetuated by the proposed action.

c. Project Effects on Individual Central Valley Spring-Run Chinook Salmon

The prevention of access to habitat upstream of Englebright Dam coupled with the downstream impacts of predation, entrainment, lack of cover, lack of forage, and unprotected outmigration temperatures reduces the capacity of the Yuba River to maintain population abundance and productivity.

Project effects continue the pattern of low abundance, variable/declining growth rate, insufficient spawning substrate, spatial structure overlaps with fall-run Chinook salmon, hatchery introgression, and lack of habitat diversity. The population may not survive climate change or even variable water years, so even minor adverse effects could cause the population to go extinct.

d. Risk to Northern Sierra Diversity Group

The attraction flows presented by the Yuba River attract spring-run Chinook salmon from the Feather River. The Yuba River is a population sink for FRFH and Feather River populations of spring-run Chinook salmon, and may be a sink for other populations in the ESU (Schick and Lindley 2007), because the juvenile rearing and outmigration conditions on the Yuba River are so poor. Given that an estimated 91 percent of spawning spring-run Chinook salmon in the Yuba River represent hatchery fish or wild spring-run Chinook salmon with natal origins outside of the Yuba River, these fish are not likely to contribute to the success of other populations in the Northern Sierra Diversity Group.

The very poor condition of the Yuba River population, in combination with project effects that continue the patterns causing the population to be at risk of extinction, reduces the likelihood that the Northern Sierra Nevada Diversity Group can become viable. The proposed action and interrelated and interdependent actions perpetuate a population sink for spring-run Chinook salmon and perpetuates conditions that prevent the Yuba River population from contributing to the viability of Northern Sierra Nevada Diversity Group. Global warming and increased water consumption, in combination with the Yuba River population being a population sink, increase the risk that the Northern Sierra Diversity group will become extinct.

e. Risk to ESU

The combined impacts of the project and environmental baseline increase the risk of extinction of the populations. Without any recovery actions to stabilize the Yuba River population and allow it to contribute to the recovery of the species, both the survival and recovery of the species are measurably diminished by the proposed action. NMFS' recovery draft plan has identified establishment of additional populations in the Northern Sierra Diversity Group as being important to this species' future viability. The draft recovery plan has also identified that reintroduction of spring-run Chinook into historic higher elevation habitats is also very important to improving Central Valley spring-run Chinook viability.

f. Summary of Effects on the Survival and Recovery of the Species

The proposed action is likely to produce stressors that adversely affect the environment of spring-run Chinook salmon by creating long-term delays or blockages of upstream migration to historic spawning habitat related to the operations and maintenance of dams without adequate fish passage, superimposition of spawning habitat due to lack of spawning habitat availability, continued hybridization with fall-run Chinook salmon and FRFH salmon downstream from Englebright Dam, continued degradation of adult holding, spawning and juvenile rearing habitat downstream from dams, and entrainment and predation of juveniles at project-related facilities. Individuals that are exposed to one or more of these environmental stressors and respond with adverse consequences called take that occur in the form of injury, death, or harm from habitat degradation that actually kills or injures individuals through significant impairment to their breeding, feeding, sheltering, migration, and spawning. These environmental consequences also reduce the survival of individuals and ultimately impairs the long-term survival and viability of the local population by continuing to drive low population abundance rates, variable and declining production rates, impaired spatial and genetic diversity, and continued exposure to hatchery populations. Recognizing that the spring-run Chinook salmon ESU is currently at a moderate to high risk of extinction, any reduction in the viability to the Yuba River population is likely to reduce the viability and increase the extinction risk of the ESU.

The jeopardy standard includes a component of recovery. The proposed action needs to provide adequate potential for recovery, or recovery is appreciably reduced. The NMFS draft recovery plan clearly indicates that the introduction of spring-run Chinook salmon upstream from Englebright Dam is necessary for recovery of the species, and the upper Yuba River, upstream from Englebright Dam is identified as a priority reintroduction area. Because the Corps has not elected to provide fish passage as an operational or maintenance aspect of the dam, this recovery action does not have adequate potential to be implemented.

2. California Central Valley Steelhead DPS

a. Condition of the DPS

The Central Valley Steelhead DPS is at moderate risk of extinction (Lindley *et al.* 2007), and the extinction risk is increasing. The most recent viability assessment of Central Valley spring-run Chinook salmon was conducted during NMFS' 2011 status review (NMFS 2011b). This review found that the biological status of the ESU has worsened since the last status review recommend that its status be reassessed in two to three years as opposed to waiting another five years, if it does not respond positively to improvements in environmental conditions and management actions. The ESU fails all VSP criteria for viability.

b. Viability at the Population Level

The population has very high hatchery introgression and is not genetically viable. The spatial structure of Central Valley is limited to sparsely available of spawning substrate, and lack of access to off-channel habitat. The river temperatures during outmigration may be too high in some years to allow for successful smoltification and outmigration, and too low in some years to trigger outmigration. The lack of access to historical spawning habitat is the greatest stressor affecting population viability. High predation and entrainment, and water temperatures that may result in holdback of adult and juvenile fish all reduce the number of Central Valley steelhead that leave the river, enter the Delta, and forage in the Delta or the marine environment. The population has low viability and a high risk of extinction.

c. Project Effects on Individual Central Valley Steelhead

Project effects continue the pattern of low abundance, variable/declining growth rate, insufficient spawning substrate, lack of access to off-channel habitat, hatchery introgression, and lack of habitat diversity. Even minor adverse effects from the proposed action could cause the population to go extinct under declining background climatic conditions.

d. Risk to Northern Sierra Diversity Group

The very poor condition of the Yuba River population, in combination with project effects that continue the patterns causing the population to be at risk of extinction, reduces the likelihood that the Northern Sierra Nevada Diversity Group can become viable. The proposed action and interrelated and interdependent actions perpetuate conditions that prevent the Yuba River population from contributing to the viability of Northern Sierra Nevada Diversity Group. Global warming and increased water consumption, in combination with the Yuba River population being a potential population sink, increase the risk that the Northern Sierra Diversity group will become extinct.

e. Risk to DPS

The combined impacts of the project and environmental baseline increase the risk of extinction of the populations. Without any recovery actions to stabilize the Yuba River population and allow it to contribute to the recovery of the species, both the survival and recovery of the DPS are measurably diminished by the proposed action.

f. Summary of Effects on the Survival and Recovery of the Species

The proposed action is likely to produce stressors that adversely affect the environment of steelhead by creating long-term delays or blockages of upstream migration to historic spawning habitat related to the operations and maintenance of dams without adequate fish passage, superimposition of spawning habitat due to lack of spawning habitat availability, continued hybridization with FRFH steelhead downstream from Englebright Dam, continued degradation of adult holding, spawning and juvenile rearing habitat downstream from dams, and entrainment and predation of juveniles at project-related facilities. Individuals that are exposed to one or more of these environmental stressors respond with adverse consequences called take, that occurs in the form of injury, death, or harm from habitat degradation that actually kills or injures individuals through significant impairment to their breeding, feeding, sheltering, migration, spawning. These environmental consequences also reduce the survival of individuals and ultimately impairs the long-term survival and viability of the local population by continuing to drive low population abundance rates, variable and declining production rates, impaired spatial and genetic diversity, and continued exposure to hatchery populations. Recognizing that the steelhead DPS is currently at a moderate to high risk of extinction, any reduction in the viability to the Yuba River population is likely to reduce the viability and increase the extinction risk of the DPS.

The jeopardy standard includes a component of recovery. The proposed action needs to provide adequate potential for recovery, or recovery is appreciably reduced. The NMFS draft recovery plan clearly indicates that the introduction of steelhead upstream from Englebright Dam is necessary for recovery of the species, and the upper Yuba River, upstream from Englebright Dam is identified as a priority reintroduction area. Because the Corps has not elected to provide fish passage as an operational or maintenance aspect of the dam, this recovery action does not have adequate potential to be implemented.

3. North American Green Sturgeon Southern Population DPS

a. *Condition of the DPS*

The North American green sturgeon southern population DPS is at substantial risk of extinction (Adams *et al*. 2007). The DPS is compromised by low abundance, limited distribution, and lack of population redundancy. The DPS has only one viable population, the Sacramento River population, upon which the Yuba River green sturgeon are dependent.

b. *Viability at the Population Level*

With only five green sturgeon detected in 2011 and infrequent historical sightings by anglers, the population is likely to have been low for some time, probably since construction of Daguerre Point Dam. Green sturgeon continue to be blocked from suitable spawning habitat by Daguerre Point Dam and its impassable fish ladders. The population has a continued lack of habitat availability and diversity; perpetually blocked access to spawning habitat upstream from Daguerre Point Dam; lack of suitable spawning substrate, deep pools, and flows; potentially low food availability for juveniles, due to macroinvertebrate die-offs; and low viability and high risk of extinction.

c. *Project Effects on Individual Green Sturgeon*

Project effects are primarily from interrelated and interdependent actions and consist of low flows, lack of protection from increased temperatures during migration and spawning, and insufficient water depths.

d. *Risk to DPS*

The Yuba River may be a population sink for the only population in the DPS. The combined impacts of the project and environmental baseline increase the risk of extinction of the DPS. Without any recovery actions to stabilize the Yuba River population and allow it to contribute to the recovery of the species, both the survival and recovery of the DPS are measurably diminished by the proposed action. Any green sturgeon spawning in the Yuba River would contribute to the viability of the DPS because there are very few green sturgeon in the DPS and very little spawning habitat within the range of the DPS.

e. *Summary of Effects on the Survival and Recovery of the Species*

The proposed action is likely to produce stressors that adversely affect the environment of green sturgeon by completely blocking upstream migration to historic spawning habitat related to the operations and maintenance of dams without fish passage, predation of juveniles downstream from Daguerre Point Dam, and continued degradation of adult holding, spawning and juvenile rearing habitat downstream from dams. Individuals that are exposed to one or more of these environmental stressors respond with adverse consequences called take, that occurs in the form of injury, death, or harm from habitat degradation that actually kills or injures individuals through significant impairment to their breeding, feeding, sheltering, migration, spawning.

These environmental consequences also reduce the survival of individuals and ultimately impairs the local population's long-term survival viability by continuing to drive low population abundance rates, variable and declining production rates, impaired spatial and genetic diversity, and continued exposure to hatchery populations. Recognizing that the green sturgeon DPS is currently at a moderate to high risk of extinction, any reduction in the viability to the Yuba River population is likely to reduce the viability and increase the extinction risk of the DPS.

The jeopardy standard includes a component of recovery. The proposed action needs to provide adequate potential for recovery, or recovery is appreciably reduced. Recovery planning for green sturgeon recognizes that expanding the current range of spawning and reproduction to areas beyond the Sacramento River will be necessary to recover the species. Because the Corps has not elected to provide fish passage as an operational or maintenance aspect of the dam, this recovery action does not have adequate potential to be implemented.

B. Impacts on Critical Habitat

4. <u>Central Valley Spring-Run Chinook Salmon ESU</u>

a.   Ability of critical habitat to support abundance

It is likely that critical habitat in the Yuba River is a population sink for FRFH and wild Feather River spring-run Chinook salmon. Migration, spawning, and rearing PCEs are so degraded that returning adults largely represent other populations in the ESU. Not only does the critical habitat have little ability to support a viable population, but it reduces the abundance of other populations in the ESU.

b.   Ability of critical habitat to support productivity

The limited amount of spawning habitat on the lower Yuba River, high predation and entrainment, lack of LWM, lack of riparian cover, and depressed foraging conditions prevent the critical habitat from having productivity that would contribute to a viable population.

c.   Ability of critical habitat to support spatial structure

The amount of genetic introgression of Yuba River spring-run Chinook salmon limits the ability of the critical habitat to support a spatially unique population that would contribute to the spatial structure of the ESU.

d.   Ability of critical habitat to support diversity

The critical habitat on the Yuba River cannot support diversity, because of introgression with other runs and lack of run separation from fall-run Chinook salmon.

e. Ability of critical habitat to support conservation of the ESU

Critical habitat on the Yuba River cannot support conservation of the ESU, because the proposed action and interrelated and interdependent actions expose three populations in the ESU to stressors leading to chronic population suppression.

f. Summary of Effects on the Conservation Value of Critical Habitat for the Species

The proposed action is likely to produce stressors that adversely affect the critical habitat of spring-run Chinook salmon by: (1) creating long-term delays or blockages through upstream freshwater migration corridors; (2) delaying or blocking access to spawning habitat; (3) impairing spawning habitat by blocking access to historic habitat and creating spawning gravel depletion downstream from Englebright Dam; and (4) impairing downstream freshwater migration corridors through continued degradation of spawning and juvenile rearing habitat, and contributing to entrainment and predation of juveniles at project-related facilities. These stressors reduce the quality and quantity critical habitat and reduce the conservation value of the primary elements of critical habitat that are essential for the survival of individual fish and the survival and recovery of the local Yuba River population. Any reduction in the conservation value of habitat for a single population that has a moderate to high extinction risk will result in a reduction in conservation value at the ESU scale and is likely to adversely modify or destroy critical habitat for spring-run Chinook salmon.

5. Central Valley Steelhead DPS

a. Ability of critical habitat to support abundance

The measured abundance of Central Valley steelhead in the Yuba River is less than the abundance of spring-run Chinook salmon. The smaller Central Valley steelhead is able to utilize smaller tributaries and of channel habitat than salmon, and in an un-impacted ecosystem Central Valley steelhead numbers would be considerably greater than salmon numbers. The very low Central Valley steelhead numbers in critical habitat on the lower Yuba River, compared to the high amount of occupied *O. mykiss* habitat in the upper Yuba River watershed, demonstrates that the critical habitat in the lower Yuba River contributes very little to Central Valley steelhead DPS abundance. Temperatures below Daguerre Point Dam may cause residualization of Central Valley steelhead when outmigration would result in higher survivorship, particularly when Central Valley steelhead trout are exposed to unsuitable temperatures and an unstable prey base.

b. Ability of critical habitat to support productivity

Central Valley steelhead productivity is low in critical habitat in the Yuba River downstream to the Sacramento River. Spawning and rearing conditions are so degraded for Central Valley steelhead that there may be cohort failure in some years. Productivity is so low that global warming and climate change could cause the population to go extinct. The critical habitat from the lower Yuba River to the Feather River confluence with the Sacramento River does not support productivity of the DPS.

c. Ability of critical habitat to support spatial structure

Central Valley steelhead trout in the Yuba River may not contribute to the spatial structure of the ESU in some years. The population is moderately introgressed with Central Valley steelhead populations throughout the State and may be a population sink for other populations or represent hatchery origin fish that have not been studied. The critical habitat from the lower Yuba River to the Feather River confluence with the Sacramento River does not support spatial structure of the DPS.

d. Ability of critical habitat to support diversity

The *O. mykiss* that would contribute the most to diversity of the DPS are upstream of critical habitat in the Yuba River.

e. Ability of critical habitat to support conservation of the DPS

The Central Valley steelhead population downstream of Englebright Dam is too low, introgressed, and at risk extinction to support conservation of the DPS.

f. Summary of Effects on the Conservation Value of Critical Habitat for the Species

The proposed action is likely to produce stressors that adversely affect the critical habitat of steelhead by: (1) creating long-term delays or blockages through upstream freshwater migration corridors; (2) delaying or blocking access to spawning habitat; (3) impairing spawning habitat by blocking access to historic habitat and creating spawning gravel depletion downstream from Englebright Dam; and (4) impairing downstream freshwater migration corridors through continued degradation of spawning and juvenile rearing habitat, and contributing to entrainment and predation of juveniles at project-related facilities. These stressors reduce the quality and quantity critical habitat and reduce the conservation value of the primary elements of critical habitat that are essential for the survival of individual fish and the survival and recovery of the local Yuba River population. Any reduction in the conservation value of habitat for a single population that has a moderate to high extinction risk will result in a reduction in conservation value at the ESU scale and is likely to adversely modify or destroy critical habitat for steelhead.

6. <u>North American Green Sturgeon Southern Population DPS</u>

a. Ability of critical habitat to support abundance

The five green sturgeon observed in 2011 in the Yuba River are too few to support a viable population, and are likely part of population that has a wider distribution than just the Yuba River. With favorable flow conditions in in the lower Yuba River in 2011, only five green sturgeon being observed, habitat conditions below Daguerre Point dam being poor for green sturgeon, and Daguerre Point Dam having inadequate fish passage for green sturgeon (they are blocked), NMFS concludes that the habitat in the Yuba River is currently very limited and limiting for green sturgeon.

b. Ability of critical habitat to support productivity

The spawning, rearing, and foraging conditions in the Yuba River are too poor and degraded to support productivity of the DPS.

c. Ability of critical habitat to support spatial structure

The habitat downstream of Daguerre Point Dam is too limited in flow, depth, and substrate to support a population that would support the spatial structure of the DPS.

d. Ability of critical habitat to support diversity

There are too few green sturgeon in the Yuba River to support diversity of the DPS.

e. Ability of critical habitat to support conservation of the DPS

The poor condition of critical habitat on the Yuba River, combined with the very low green sturgeon population numbers indicates that this population is experiencing depensation and may be a population sink. The critical habitat cannot support the conservation of the DPS.

f. Summary of Effects on the Conservation Value of Critical Habitat for the Species

The proposed action is likely to produce stressors that adversely affect the critical habitat of green sturgeon by: (1) creating long-term delays or blockages through upstream freshwater migration corridors; (2) limiting the spatial extent of spawning habitat to one remaining pool with the complex flow, depth and substrate characteristics necessary to attract spawning adults; and (3) impairing downstream freshwater migration corridors through continued degradation of spawning and juvenile rearing habitat, and contributing to the predation of juveniles downstream from Daguerre Point Dam. These stressors reduce the quality and quantity critical habitat and reduce the conservation value of the primary elements of critical habitat that are essential for the survival of individual fish and the survival and recovery of the local Yuba River population. Any reduction in the conservation value of habitat for a single population that has a moderate to high extinction risk will result in a reduction in conservation value at the ESU scale and is likely to adversely modify or destroy critical habitat for steelhead.

X. CONCLUSIONS

After reviewing the best available scientific and commercial information, the current status of the species and their designated critical habitat, the environmental baseline for the action area, the expected effects of the proposed action, cumulative effects, and the combined effects of the environmental baseline, the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is likely to jeopardize the continued existence of federally threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, the threatened Southern DPS of North American green sturgeon.

Likely to destroy or adversely modify critical habitat for federally threatened Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon.

XI. REASONABLE AND PRUDENT ALTERNATIVE

To avoid jeopardizing the continued existence of spring-run Chinook salmon, steelhead, and green sturgeon in the Yuba River, the Corps must implement the following:

Conduct operations and maintenance at Englebright and Daguerre Point Dams, using all methods and procedures within the authority of the Corps to conserve spring-run Chinook salmon, Central Valley steelhead, and green sturgeon and to implement a process whereby all applicants, licensees, contractors, and permittees have a regulated obligation to conserve listed species and to be engaged in a process for listed species conservation.

A. Approach to the Reasonable and Prudent Alternative

If NMFS finds that a proposed action is likely to jeopardize a listed species or adversely modify its critical habitat, the ESA requires NMFS to suggest those reasonable and prudent alternatives that it believes would enable the project to go forward in compliance with the ESA. By regulation, a reasonable and prudent alternative (RPA) is defined as “alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the Federal agency’s legal authority and jurisdiction, that is economically and technologically feasible, and that the [NMFS] Director believes would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat” (50 CFR 402.02).

Regulations also require that NMFS discuss its findings and any RPAs with the action agency and utilize the action agency’s expertise in formulating the RPA, if requested (50 CFR 402.14(g)(5)). This RPA was developed through a thoughtful and reasoned analysis of the key causes of the jeopardy and adverse modification findings, and a consideration of alternative actions within the legal authority of the Corps to alleviate those stressors.

Because this complex action takes place in a highly altered landscape subject to many environmental stresses, it has been difficult to formulate an RPA that is likely to avoid jeopardy to all listed species. As detailed in this biological opinion, the current status of the affected species is precarious, and future activities and conditions not within the control of the Corps are likely to place substantial stress on the species.

Consequently, NMFS developed focused actions designed to compensate for a particular stressor, considering the full range of authorities that the Corps may use to implement these actions. The RPA is consistent with the purpose of the proposed action, which includes compliance with the Fish and Wildlife Coordination Act and the ESA.

B. Legal Authorities and Jurisdiction

There are several authorities under which NMFS believes that the Corps could implement the actions in the RPA. In order to meet the requirements of the ESA, the Corps must implement the actions in the timeframes identified. It will be up to the Corps to determine under which authority(s) it will use to meet the time requirements. The Corps should not let any opportunities be lost through inaction.

1. Endangered Species Act

Section 2(b) Purposes: The purposes of this chapter are to provide a means whereby ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section.

Section 2(c) Policy: It is further declared to be the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this chapter.

Section 7(a)(1): The Secretary shall review other programs administered by him and utilize such programs in furtherance of the purposes of this chapter. All other Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this chapter by carrying out programs for the conservation of endangered species and threatened species listed pursuant to section 1533 of this title.

Section 7(a)(2): Each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency (hereinafter in this section referred to as an “agency action”) is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with affected States, to be critical, unless such agency has been granted an exemption for such action by the Committee pursuant to subsection (h) of this section. In fulfilling the requirements of this paragraph each agency shall use the best scientific and commercial data available.

2. Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act of March 10, 1934 (Public Law 73-121, 48 Stat. 401) was written as “An Act to promote the conservation of wild life, fish, and game, and for other purposes.” Section 3(b) of the 1934 Fish and Wildlife Coordination Act states: “Hereafter, whenever any dam is authorized to be constructed, either by the Federal Government itself, or by any private agency under Government permit, the Bureau of Fisheries shall be consulted, and before such construction is begun or permit granted, when deemed necessary, due and adequate provision, if economically practicable, shall be made for the migration of fish life from the upper to the lower and from the lower to the upper waters of said dam by means of fish lifts, ladders, or other devices."

It does not appear that the Bureau of Fisheries was consulted regarding the construction of Englebright Dam. It also does not appear that a report was provided to Congress regarding compliance with the Fish and Wildlife Act of 1934 for the construction of Englebright Dam. Lacking evidence to the contrary, it appears that Englebright Dam was constructed without complying with the Fish and Wildlife Coordination Act of 1934.

3. Water Resources Development Act

Section 906, of the Water Resources Development Act of 1986, as amended (Title 33 – Navigation and Navigable Waters; Chapter 36 – Water Resources Development Subchapter V– General Provisions) authorized mitigation for damages to fish and wildlife. Section 2283 of Title 33 includes a section for fish and wildlife mitigation including

> "(b) Acquisition of lands or interest in lands for mitigation" and
>
> "(b)(1) After consultation with appropriate Federal and non-Federal agencies, the Secretary is authorized to mitigate damages to fish and wildlife resulting from any water resources project under his jurisdiction, whether completed, under construction, or to be constructed. Such mitigation may include the acquisition of lands or interests therein…"

Section (e) of Title 33 addresses enhancements cost as Federal costs

> "in those cases when the Secretary, as part of any report to Congress, recommends activities to enhance fish and wildlife resources, the first costs of such enhancement shall be a Federal cost when –
>
> (1) Such enhancement provides benefits that are determined to be national, including benefits to species that are identified by the National Marine Fisheries Service as of national economic importance, species that are subject to treaties or international convention to which the United States is a party, and anadromous fish;
>
> (2) Such enhancement is designed to benefit species that have been listed as threatened or endangered by the Secretary of the Interior under the terms of the Endangered Species Act, as amend (16 U.S.C. 1531 et seq.)…"

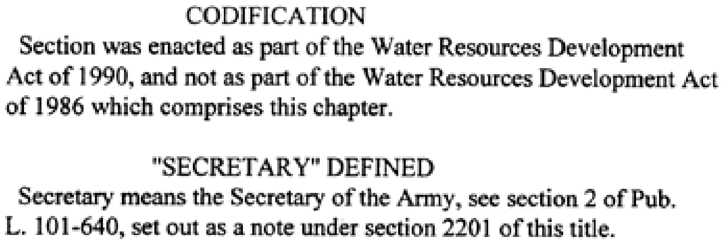
Section 1135, of the Water Resources Develop Act of 1986, as amended, (Title 33 – Navigation and Navigable Waters, Chapter 36 – Water Resources Development, Subchapter V – General Provisions, §2309a. Project Modifications for Improvement of Environment) authorizes project modifications for the improvement of the environment. That section states:

> "(a) Determination of need: The Secretary is authorized to review water resources projects constructed by the Secretary to determine the need for modifications in the structures and operations of such projects for the purpose of improving the quality of the

> environment in the public interest and to determine if the operation of such projects has contributed to the degradation of the quality of the environment. (b) Authority to make modifications: The Secretary is authorized to carry out a program for the purpose of making such modifications in the structures and operations of water resources projects constructed by the Secretary which the Secretary determines (1) are feasible and consistent with the authorized project purposes, and (2) will improve the quality of the environment in the public interest. (c) Restoration of environmental quality: (1) IN GENERAL – if the Secretary determines that construction of a water resources project by the Secretary or operation of a water resources project constructed by the Secretary has contributed to the degradation of the quality of the environment, the Secretary may undertake measures for restoration of environmental quality and measures for enhancement of environmental quality that are associated with the restoration, through modifications either at the project site or at other locations that have been affected by the construction of operation of the project, if such measures do not conflict with the authorized project purposes."

Section 2316 of the Water Resources Development Act of 1990 (Title 33 – Navigation and Navigable Waters, Chapter 36 – Water Resources Development; Subchapter V – General Provisions, Environmental Protection Mission) states that one of the primary missions of the Corps of Engineers is environmental protection. It states:

> "(a) General rule, The Secretary shall include environmental protection as one of the primary mission of the Corps of Engineers in planning, designing, constructing, operating, and maintaining water resources projects."



CODIFICATION

Section was enacted as part of the Water Resources Development Act of 1990, and not as part of the Water Resources Development Act of 1986 which comprises this chapter.

"SECRETARY" DEFINED

Secretary means the Secretary of the Army, see section 2 of Pub. L. 101-640, set out as a note under section 2201 of this title.

Section 206, Water Resources Development Act of 1996, as amended, (Title 33 – Navigation and Navigable Waters Chapter 36 – Water Resources Development; Subchapter V – General Provisions, §2330, Aquatic Ecosystem Restoration) authorizes the Corps to carry out ecosystem restoration and projection projects. This section states:

> "(a) General authority. The Secretary may carry out an aquatic ecosystem restoration and protection project if the Secretary determines that the project – (1) Will improve the quality of the environment and is in the public interest; and (2) is cost-effective."

4. <u>Licenses, Easements and Access Permits</u>

Through easements, licenses, and access permits the Corps will grant for the hydropower projects, water diversions, and other uses of its lands, the Corps may condition those permits with conditions that require the permit recipients to fund or implement RPA actions or conservation measures identified in this biological opinion.

5. Environmental Stewardship

It appears that the Corps has discretion through its environmental program to provide fish passage at Englebright Dam. This program emphasizes environmental restoration and stewardship (http://www.corpsresults.us/environment/). The Corps' website states: " The Corps stewardship program focuses on the ongoing care and protection of the 12 million acres of rivers, lakes and wetlands for which we are directly responsible. The twin goals of our stewardship efforts are to help maintain healthy ecosystems and to ensure the availability of these natural resources for future generations." In NMFS' biological opinion restoring anadromous fishes to their historic habitat and supporting restoration of viability of species listed under the ESA, would fit with the Corps' identified stewardship goals, and watershed approach to water resources management.

6. Federal Power Act

Section 4(e) of the Federal Power Act states in part: that the issuance of a license for hydropower within a government reservation "…shall be subject to and contain such conditions as the Secretary of the department under whose supervision such reservation falls shall deem necessary for the adequate protection and utilization of such reservations." Through the relicensing process the Corps has the opportunity to impose conditions on the hydroelectric projects it has permitted to use its facilities or given easements upon real estate owned by the Corps. The authority of section 4(e) of the Federal Power Act is very broad, and has been used for actions both on and off of Federal reservations (see Forest Service 4(e) conditions for the Baker River Hydroelectric Project). As an example, through section 4(e) the Corps has the ability to require upstream and downstream fish passage of the hydroelectric projects at Englebright Dam. They could also require maintenance and operations expenses for their campgrounds on Englebright Reservoir.

While the Corps and the Federal Energy Regulatory Commission have entered into a memorandum of understanding (MOU) regarding relicensing issues, that MOU states that the MOU does not alter any authority of either agency. Thus, the MOU does not restrict the Corps from utilizing their full authority under the Federal Power Act.

C. Summary of the RPA

There are a number of stressors associated with the Corps' operation and maintenance of Englebright Dam and reservoir, and Daguerre Point Dam. These include operation and maintenance of the dams which perpetuates the existence of the dams and the effects on ESA listed fish species. These effects include precluding fish from accessing historic areas in which the fish hold, spawn, incubate, and rear. This has resulted in losses of spring-run Chinook from fall-run Chinook spawning in the same location at a later time (redd superimposition), which destroys spring-run Chinook eggs, genetic introgression between fall-run and spring-run Chinook, genetic introgression between hatchery and wild spring-run Chinook, genetic introgression between hatchery and wild steelhead. Poor fish passage at Daguerre Point Dam is another stressor, through delay of spring-run Chinook and steelhead, blockage of green sturgeon, and likely increased predation for downstream migrating juveniles. The continued operation of Englebright Dam has resulted in decreased productivity of spawning and rearing through interruption of ecosystem processes. These include depleting the river of gravel and large woody material. The lack of gravel in the reach below Englebright Dam had totally eliminated its ability to provide spawning habitat, until some small recent additions by the Corps. The lack of large woody material in the lower Yuba River has reduced its productivity by reducing cover, and food. Through the Corps authorities it has the ability to condition licenses, easements, and permits associated with entities that affect water management in the Yuba River. Though these licenses, easements, and permits are part of the operations of the Corps Yuba River dams, they have chosen to not condition those documents to provide protection for ESA listed fish species. The Corps also through their operations for Englebright Dam have the authority to submit conditions to protect, mitigate, and enhance fish resources to the Federal Energy Regulatory Commission in the relicensing proceedings for the hydroelectric projects associated with Englebright Dam.

NMFS concentrated on actions that have the highest likelihood of alleviating the stressors with the most significant effects on the species, rather than attempting to address every project stressor for each species or every PCE for critical habitat. For example, different runs of Chinook salmon are comingled downstream of Englebright Dam. This results in disruption of spring-run Chinook salmon redds by fall-run Chinook salmon. In the near term, we identified measures to increase spawning habitat (gravel augmentation), in the long term we identified fish passage upstream of Englebright Dam to allow spring-run Chinook salmon access to historic spawning habitat to alleviate this stressor.

The effects analysis in this biological opinion explains that the adverse effects of the proposed action on listed anadromous fish and their critical habitats are both direct and indirect. The altered environment includes changes in habitat formation, species composition, and water quality, among others. Consequently, NMFS must take a broad view of the ways in which the project agency can improve the ecosystem to ameliorate the effects of their actions and avoid actions that will jeopardize the continued existence of the affected listed species. This broad approach is necessary because the poor condition of the ESA listed species in the Yuba River was brought about over a long period of time, was due to a number of factors, including the Corps' continued operation and maintenance of Daguerre and Englebright Dams. It is necessary to include a broad approach to the stressors associated with this project to avoid reducing the likelihood of both the survival and recovery of spring-run Chinook, steelhead, and green sturgeon in the Yuba River watershed.

This RPA is composed of numerous elements for each of the various project associated stressors and must be implemented in its entirety in order to avoid jeopardy and adverse modification. There are several actions that allow the project agency options for alleviating a particular stressor. NMFS' interest is in reducing the negative effects of the stressors in order for the Corps' proposed action to avoid jeopardizing the continued existence and impairing the viability of the ESA listed species. There may be several approaches that can address a stressor or multiple stressors. NMFS interest is that the approaches that are selected have a high likelihood of success in avoiding impairing ESA listed species' viability.

NMFS recognizes that the RPA must be an alternative that is likely to avoid jeopardizing listed species or adversely modifying their critical habitats, rather than a plan that will achieve recovery. Both the jeopardy and adverse modification standards, however, include consideration of effects on an action on listed species' chances of recovery. NMFS believes that the RPA does not reduce the likelihood of recovery for any of the listed species. The RPA cannot and does not, however, include all steps that would be necessary to achieve recovery. NMFS is mindful of potential social and economic consequences of reducing water deliveries and electricity, and has carefully avoided prescribing measures that are not necessary to meet section 7 requirements.

An RPA must avoid jeopardy to listed species in the short term, as well as the long term. Essential short-term actions are presented and are summarized for each species to ensure that the likelihood of survival and recovery is not appreciably reduced in the short term (*i.e.*, one to five years). This consultation also includes long term actions that are necessary to address project-related adverse effects on the likelihood of survival and population viability of the species over the next two decades.

Some of the near-term actions will include:

- Fish passage design and evaluation studies at Daguerre Point and Englebright dams;
- Improved fish passage at Daguerre Point Dam;
- Assisted fish passage at Englebright Dam;
- Gravel augmentation and channel restoration;
- Predator removal;
- Salmonid and green sturgeon monitoring;

Some of the long-term actions will require evaluation, planning, permitting, and funding. These include:

- Fish passage at Englebright Dam;
- Gravel augmentation and channel restoration;
- Predator removal;
- Salmonid monitoring and adaptive management, and
- Green sturgeon monitoring and adaptive management.

NMFS considers that the Corps has multiple authorities that would allow it to implement and fund fish passage and the other RPA actions identified below.

The RPA actions have been developed to address specific stressors. Some of the actions are short-term actions, and other actions will take some time to fully implement (long-term actions). Some actions have both short-term and long-term aspects. Table XI-a summarizes the stressors and the actions developed to address them.

Table XI-a. Key species stressors and associated short- and long-term actions in the RPA.

Stressor	Actions	Short-term	Long-term
Blockage of access for green sturgeon to spawning and rearing habitats, possible injury at dam and fish ladders	Provide fish passage at Daguerre Point Dam to provide unimpeded fish passage.	X	
Delay of migration for spring-run Chinook and CV steelhead	Improve fish passage at Daguerre Point Dam to provide fish passage without delays.	X	
Blockage of access to spring-run Chinook and CV steelhead to spawning and rearing habitat upstream of Englebright Dam, introgression with fall-run Chinook redd superimposition downstream of Englebright Dam	Conduct fish passage design and evaluation studies	X	
Blockage of access to spring-run Chinook and Central Valley steelhead to spawning and rearing habitat upstream of Englebright Dam, introgression with fall-run Chinook redd superimposition downstream of Englebright Dam	Provide near-term assisted fish passage upstream of Englebright Dam	X	
Blockage of access to spring-run Chinook and Central Valley steelhead to spawning and rearing habitat upstream of Englebright Dam, introgression with fall-run Chinook redd superimposition downstream of Englebright Dam	Provide long–term fish passage upstream of Englebright Dam		X
Reduction in spawning habitat for spring-run Chinook and Central Valley steelhead, due to gravel depletion and interruption of gravel recruitment since 1941	Add gravel to affected areas and rehabilitate impacted habitats	X	X
Loss of juvenile salmonids at large water diversions through predation	Implement predator reduction measures	X	X
Reduced riparian vegetation means reduced	Augment existing riparian vegetation		

Stressor	Actions	Short-term	Long-term
cover, hence higher predation, reduced production of food, higher water temperatures, and less recruitment of large woody material		X	X
Lack of data and information to assess and monitor the condition of salmonids	Monitor, compile, and assess salmonid information	X	X
Lack of data and information to assess and monitor the condition of green sturgeon	Monitor, compile, and assess green sturgeon information and implementation of adaptive management	X	X

Table XI-b. Table of RPA actions and milestones.

RPA Action	Milestones
Yuba Fish Passage	
Yuba River Fish Passage Strategy and Plan	December 1, 2013
Near-Term Fish Passage Actions	
Yuba Passage Committee	December 2012
Evaluation of fish habitat	January 2013
Fish Passage Evaluation Plan	July 2012 – January 2014
Implement Fish Passage Evaluation Plan	January 2014- 2017
Design and construct adult collection facilities	Beginning in 2014
Implement adult fish passage	March 1, 2014
Identify location and design for downstream fish passage	December 2013
Design and construct downstream collection facilities	January 2014- September 2014
Implement downstream passage	January 1, 2015
Pilot program monitoring	2014-2017
Fish Passage Report	December 31, 2016
Interim fish passage at Daguerre Pt. Dam	Upon issuance of biological opinion
Daguerre Pt. Dam fish passage improvements	
Preliminary engineering design	November 21, 2012
Implementation	November 2017
Long-Term Fish Passage Actions	
Long-Term Fish Passage Plan	December 31, 2017
Implementation of plan	January 31, 2020
Long-term fish passage monitoring	January 2020 - ongoing
Gravel augmentation	Beginning 2012
Channel restoration	Beginning December 2012
Predator control	
Predator control plan	Beginning in September 2012
Implement predator control plan	Beginning November 1, 2012
Implement long-term predator control plan	December 2013
Salmonid Monitoring and Adaptive Man. Program	Upon issuance of biological opinion
Green Sturgeon Monitoring and Adaptive Management Program	Upon issuance of biological opinion
Training Walls	
Identify training walls and property	December 1, 2014
Develop a training wall plan	July 1, 2015
Implement the training wall plan	August 1, 2016

D. Specific Actions under the RPA

1. Yuba River Fish Passage Improvement Strategy and Plan

a. Introduction

The Corps shall develop and implement and Yuba River Fish Passage Improvement Strategy and Plan to reintroduce federally listed anadromous salmonids to historic habitats in the Yuba River upstream from Daguerre and Englebright Dams by December 1, 2013. The primary, and immediately foreseeable components of this strategy and plan are detailed in the following RPA actions that address fish passage. In summary, the strategy and plan will include establishing a Yuba Interagency Fish Passage Steering Committee and the committee will oversee the collection and analysis of biological and engineering science and technology that may be applied to address both near- and long-term fish passage solutions on the Yuba River. The following fish passage actions, although described independently within the RPA, are intended to be rolled into a comprehensive Yuba River Fish Passage and Improvement Strategy as a process for working with other interests in the Yuba River Watershed.

It is NMFS' intention to align short-term and long-term fish passage planning within the Yuba River watershed with other Federal actions. The long time horizon of the consultation requires NMFS to anticipate long-term future events, including increased water demand and climate change. The effects analysis in this biological opinion highlights the difficulty of managing cold water aquatic species downstream of impassible barriers. The analysis shows that even after all discretionary actions are taken to operate New Bullards Bar and Englebright and other reservoirs in the Yuba River watershed to reduce adverse effects on listed spring-run Chinook salmon and Central Valley steelhead, listed salmonids are still at risk from lack of access to historic spawning and rearing habitat, the comingling with fall-run Chinook, Feather River Fish Hatchery spring-run Chinook, and Feather River Hatchery steelhead. The risk results from genetic dilution, and disturbance of spring-run Chinook redds. Another risk to steelhead is water management that provides conditions favorable to a resident life history, rather than a steelhead anadromous life history. Additionally, there are a number of habitat deficiencies that reduce productivity of spring-run Chinook, steelhead, and green sturgeon.

Other activities in the Yuba Watershed that may affect this RPA are the Yuba Salmon Forum and the North Yuba Reintroduction Initiative. The Yuba Salmon Forum is looking at ways to restore salmon and steelhead in the Yuba watershed upstream of Englebright Dam. The Yuba Salmon Forum is considering restoration of salmon and steelhead access to the South Yuba River, Middle Yuba River, North Yuba River upstream of New Bullards Bar Dam, and the reach between New Bullards Bar Dam and Englebright Reservoir. The Yuba Salmon Forum is a collaborative process that began in 2010. The North Yuba Reintroduction Initiative is an effort to look at the reintroduction of spring-run Chinook salmon and steelhead into the North Yuba River upstream of New Bullards Bar Dam. This collaborative process was begun by the Yuba County Water Agency in 2011, but is not tied into the relicensing of their hydroelectric project in the Yuba River watershed.

NMFS also recognizes that the Yuba River Management Team (RMT) established in the Lower River Yuba Accord has been an effective forum for addressing fish issues in the lower Yuba River. Where the opportunities exist, NMFS encourages the Corps to work with other agencies, groups and organizations to identify and develop synergistic opportunities. NMFS believes that broad inclusive, collaborative processes like the approaches used by the RMT, the Yuba Salmon Forum, and the North Yuba Reintroduction Initiative is what is needed to address the fish passage issues in the Yuba River watershed. NMFS encourages the Corps to work with the Yuba Salmon Forum, North Yuba Reintroduction Initiative, RMT, and other parties throughout the Central Valley with interests in fish passage to identify actions where these groups and the Corps might work together to address and implement actions that will provide fish passage upstream of Englebright Dam, and improve fish passage at Daguerre Point Dam, and through those actions address a major stressor in the life cycle of ESA listed salmonids.

Both the Yuba Salmon Forum and North Yuba Reintroduction Initiative are multiparty stakeholder collaborative processes. Both of these processes could develop and implement fish passage efforts in the Yuba River watershed. However, at this time neither process has developed a plan for fish passage, or identified funding for implementing a fish passage plan. Because both of these efforts are voluntary, and early in their development, it is uncertain at this time what plans these processes will develop and it is uncertain if these processes will implement fish passage upstream of Englebright Dam. When these efforts develop fish passage actions, they may be eligible in part, or in whole, as long-term passage actions. The Corps may also develop alternative actions for the RPA and submit them to NMFS for review and approval.

An RPA requiring a fish passage program has recently been issued by the Northwest Region of NMFS, as part of the Willamette Projects Biological Opinion (NMFS 2008). The Corps was one of the federal action agencies for that biological opinion. That jeopardy biological opinion resulted from the operation of a series of Federal projects in Oregon. That RPA represents the state-of-the-art program to address passage concerns such as residualism (failure to complete the downstream migration) and predation. The following suite of actions is similar, but not identical, to those in the Willamette Projects biological opinion. There are several designs available for passage, and some are likely to be more effective in some locations than others. Consequently, while NMFS suggests that the Corps learn from the Willamette experience and other fish passage projects, the actions included here allow the Corps to follow different critical paths. In general this action requires:

> i. The Fish Passage Evaluation Plan includes a fish passage assessment for evaluating spring-run Chinook salmon and steelhead passage upstream of Englebright, Daguerre Point, New Bullards Bar, Log Cabin, and Our House dams. The assessment will develop information necessary for consideration and development of fish passage options for the Northern Sierra Diversity Group of Central steelhead and spring-run Chinook salmon in order to determine the best location for relocating these fish.
>
> ii. The Fish Passage Improvement Plan includes several elements that are intended to proceed in phases. The short-term goal is to increase the geographic distribution, and abundance of listed species. The long-term goal is to increase abundance, productivity, and spatial distribution, and to improve the life history and genetic diversity of the target

species. Several actions are included in this program, as indicated in the following outline of the program.

iii. Implementation of fish passage upstream of Englebright Dam, and improved fish passage upstream of Daguerre Point Dam.

b. Fish passage methods to be considered

Ultimately, volitional fish passage at Englebright Dam and Daguerre Point Dam is the preferred approach for fully seeding historic salmonids habitats and reestablishing viable populations of spring-run Chinook salmon, steelhead, and green sturgeon in the Yuba River Watershed. Restoring volitional fish passage at Englebright Dam and Daguerre Point Dam and reestablishing viable populations will greatly contribute to the continued existence and restore the viability of all three of these species. The continued existence and restoration of spring-run Chinook and steelhead viability is addressed in the RPA through improving spatial structure, improving within species diversity, improving abundance, improving critical habitat, reducing hatchery influences, reducing genetic introgression, and reducing take associated with the project. From an ecological perspective, dam removal is the most preferred approach because it provides unimpeded passage for numerous aquatic species and best restores the natural processes of the river ecosystem. Volitional passage through dam removal or modification of Englebright Dam and/or Daguerre Point Dam shall be addressed in the process to determine how to best achieve fish passage upstream of these dams. NMFS recognizes that volitional fish passage over dams the height of Englebright Dam have not previously been successful, thus short-term actions are included herein until long-term solutions that provide fish passage can be formulated. The process of developing a long term solution should evaluate a broad range of fish passage options.

In the near term, reestablishing wild populations of spring-run Chinook salmon and steelhead in the North Yuba River upstream of New Bullards Bar Dam prior to providing volitional fish passage at Englebright Dam would provide a reliable source stock for reestablishing wild populations in the various reaches upstream of Englebright Dam. Assisted fish passage is to be considered for near-term fish passage implementation upstream of Englebright Dam, and for the long-term in the event that volitional fish passage is not feasible.

2. Near-Term Fish Passage Actions

NTFP 1. Formation of Yuba Interagency Fish Passage Committees

Objective: To charter, and support through funding agreements, an interagency steering committee to provide oversight, technical, management, and policy direction for the Fish Passage Evaluation Program and the Fish Passage Improvement Program. A Yuba Interagency Technical Fish Passage Committee shall also be formed to evaluate fish passage options for Englebright Dam and Daguerre Point Dam and make technical recommendations to the steering committee.

Action: By December 2012, the Corps shall establish, chair and staff the Yuba Interagency Fish Passage Steering Committee. The Committee shall be established in consultation with and the approval of NMFS and shall include at a minimum senior biologists and engineers with experience and expertise in fish passage design and operation, from the Corps, NMFS, CDFG, USFWS. The Committee shall be limited to agency membership unless otherwise approved by the Corps and NMFS. Steering committee membership shall include one lead member and one alternate from each agency. The technical committee will be formed at the direction of the steering committee.

Rationale: Interagency coordination and oversight is critical to ensuring the success of the fish passage program.

NTFP 2. Evaluation of Salmonid Spawning and Rearing Habitat Upstream of Dams

Objective: To quantify and characterize the location, amount, suitability, and functionality of existing and/or potential spawning and rearing habitat for listed species in the Yuba River watershed upstream of Englebright Dam.

Action: Beginning immediately through January 2013, the Corps shall compile and summarize the information about anadromous fish habitat upstream of Englebright Dam to confirmed natural barriers in each of the Yuba rivers and their tributaries. The synthesis shall contain evaluations of habitat necessary to support all salmonids life stages including holding, spawning, rearing, migration, and outmigration. The synthesis shall include information for the existing conditions, and assessment of flow requirements in the Middle and South Yuba rivers, and North and Yuba rivers downstream of New Bullards Bar Dam, as identified by the Technical Committee and approved by NMFS. The Corps shall identify any data gaps, and address them based on guidance from the Technical Committee, including conducting studies.

Rationale: The condition and suitability of historical habitats located upstream of impassable barriers is likely to have changed considerably since last occupied by anadromous fish. The location, quantity, and condition of habitat must be inventoried and assessed in order to evaluate the current carrying capacity and restoration potential. This information is essential to determine where passage and reintroduction are most likely to improve reproductive success for listed fish.

NTFP 3. Development of Fish Passage Evaluation Plan

Objective: To develop a plan that will provide information for making decision about the implementation of long-term fish passage upstream of Englebright Dam. The information that will be developed will be when, where, how, and which adult and juvenile fish will be collected and moved.

Action: From July 2012 through January, 2014, the Corps, with assistance from the Steering and Technical Committees, shall complete a Fish Passage Evaluation Plan. The plan shall include: (1) a schedule for implementing a 3-year Evaluation study upstream of Englebright, New Bullards Bar Dam, and Our House Dam; and (2) a plan for funding the passage program. This plan and its annual revisions shall be implemented upon concurrence by NMFS that it is in compliance with ESA requirements. The plan shall include, but not be limited to, the following:

a. Identify any operational requirements needed for the passage and re-introduction program.

b. Identify protocols for optimal handling, sorting, and release conditions for ESA-listed fish collected at Corps funded fish collection facilities when they are constructed.

c. Identify the number, origin, and species of fish to be released into habitat upstream of Yuba watershed dams, incorporated into the hatchery broodstock, or taken to other destinations.

d. Identify fish passage design studies that are necessary for determining where, how, and when fish passage will be implemented.

e. Identify fish collection and transportation requirements (*e.g.*, four wheel-drive vehicles, smooth-walled annular tanks, large vertical slide gates, provisions for tagging/marking, *etc*.) for moving fish from downstream of project dams to habitats upstream of reservoirs, avoiding the use of facilities or equipment dedicated for other purposes (*e.g.*, existing transport trucks).

f. Identify optimal release locations for fish, based on access, habitat suitability, disease concerns, and other factors (*e.g.*, those which would minimize disease concerns, recreational fishery impacts, interbreeding with non-native *O. mykiss* strains, regulatory impacts, special authorities for studies/construction, complications from upstream dams, *etc*.).

g. Identify and evaluate options for providing tailored ESA regulatory assurances for non-Federal landowners upstream of the dams where species could be re-introduced.

h. Identify interim downstream fish passage options through reservoirs and dams with the objective of identifying volitional and assisted downstream passage scenarios and alternatives for juvenile spring-run Chinook salmon and steelhead migrating through or around project reservoirs and dams. If these options are not considered feasible, identify interim non-volitional alternatives. Near-term operating alternatives that are determined to be technically and economically feasible and biologically justified shall be identified by the Corps and the steering committee agencies.

i. Describe scheduled and representative types of unscheduled, maintenance of existing infrastructure (dams, transmission lines, fish facilities, *etc*.) that could adversely impact listed fish, and describe measures to minimize these impacts.

j. Describe procedures for coordinating with Federal and State resource agencies in the event of scheduled and unscheduled maintenance.

k. Describe protocols for emergency events and deviations.

Action: The Corps shall annually revise and update the Fish Passage Evaluation Plan. The revisions and updates shall be based on results of Fish Passage Evaluation Plan activities, construction of new facilities, recovery planning guidance, predicted annual run size, and changes in hatchery management. By January 15 of each year, the Corps shall submit a revised draft plan to NMFS. By February 15, NMFS shall advise the Corps whether it concurs that the revised Fish Passage Evaluation Plan is likely to meet ESA requirements. The Corps shall release a final updated Fish Passage Pilot Plan by March 14 of each year.

Rationale: The Fish Passage Evaluation Plan is a critical link between measures in the proposed action and this RPA and the long-term fish passage program. The plan will provide a blueprint for obtaining critical information about the chances of successful reintroduction of fish to historical habitats and reducing the harm from the truncated spatial distribution of the affected populations caused by the Corps' continuing operation and maintenance of Daguerre and Englebright Dams. By including emergency operations within the Plan, field staff will have a single manual to rely on for all fish-related protocols, including steps that should be taken in emergency situations to minimize adverse effects to fish.

NTFP 4. Implementation of Fish Passage Evaluation Plan and Pilot Reintroduction Program

Objective: To implement short-term fish passage actions that will inform the planning for long-term passage actions.

Action: From January 2014 through at least 2017, the Corps shall begin to implement the Fish Passage Program (see specific actions below). The Evaluation Plan and Pilot Reintroduction Program will, in a phased approach, provide for fish passage design studies and pilot reintroduction of spring-run Chinook salmon and steelhead to habitat upstream of Englebright Dam. This interim program will be scalable depending on source population abundance, and will not impede the future installation of permanent fish passage facilities. This program is not intended to achieve passage of all anadromous fish that arrive at collection points, but rather to phase in passage as experience and success with the passage facilities is gained.

Rationale: The extent to which habitats upstream of Englebright Dam can be successfully utilized for the survival and production of anadromous fish is currently unknown. However, based on much of this habitat being historic habitat and given the evaluations that identify these areas as having high potential for salmonid production, the current existing potential salmonid habitats upstream of Englebright have been identified as having a high potential for success. A pilot reintroduction program will allow fishery managers to incrementally evaluate reintroduction locations, techniques, survival, distribution, spawning, incubation, production, juvenile rearing, and migration. The pilot program also will test juvenile collection facilities.

This action requires facility improvements, modifications, or replacements, as needed, and establishes dates to complete work and begin operation. In some cases, work could be initiated sooner than listed above, and NMFS expects the Corps to make these improvements as soon as possible.

Because these facilities will be used at least in the near term in lieu of volitional fish passage to provide access to historical habitat upstream of the dams, and because the height of New Bullards Bar Dam and other reasons make volitional fish passage unlikely at that dam, this measure is an essential first step toward addressing low population numbers caused by decreased spatial distribution, which is a key limiting factor for spring-run Chinook salmon and Central Valley steelhead.

Upstream fish passage is the initial step toward restoring productivity of listed fish by using large reaches of good quality habitat upstream of dams. Restriction to degraded habitat downstream of the dams, and adverse interactions with other populations has impaired reproductive success and has contributed to steep declines in abundance.

<u>NTFP 4.1. Adult Fish Collection and Handling Facilities</u>

Beginning in 2014, the Corps, with assistance from the Steering Committee, shall design, construct, install, operate and maintain new fish collection, handling and transport facilities. The objective is to provide interim facilities to pass fish upstream of Yuba dams and reservoirs, and to provide effective and safe downstream fish passage.

The Corps shall incorporate NMFS' Fish Screening Criteria for Anadromous Salmonids (NMFS 1997b), as applicable to capture facilities use and the best available technology for upstream passage. During the design phase, the Corps shall coordinate with NMFS to determine if the fish passage designs should accommodate potential actions related to the long term fish passage requirements such as dam removal or modification.

The Corps shall complete all interim steps in a timely fashion to allow them to meet the following deadlines for completing construction and beginning operation of the facilities listed below. These steps may include completing plans and specifications. The Corps shall give NMFS periodic updates on their progress. The order in which these facilities are completed may be modified with NMFS' concurrence, based on interim analyses and biological priorities.

a. Adult River Fish Facility – Collection facility shall be operational no later than March 1, 2014.

b. Downstream Fish Collection Facility – Collection facility shall be operational no later than January 1, 2015.

<u>NTFP 4.2. Adult Fish Release Sites Upstream of Dams and Juvenile Fish Sites Downstream of Dams</u>

The Corps shall provide for the safe, effective, and timely release of adult fish upstream of dams and juvenile fish downstream of dams downstream of target reintroduction areas. The Fish Passage Plan must identify collection and release sites and methods. Fish transport and release locations and methods shall follow existing State and Federal protocols. With assistance from the Steering Committee and Technical Committee, and in coordination with applicable landowners and stakeholders, the Corps shall complete construction of all selected sites by March 1, 2014.

NTFP 4.3. Capture, Trapping, and Relocation of Adults; Short-term Fish Passage Actions: capture, transport and relocation of adult anadromous salmonids

By March 1, 2014, the Corps shall implement upstream fish passage for adults via “trap and transport” facilities while it conducts studies to develop and assess long-term upstream and downstream volitional and assisted fish passage alternatives. The Fish Passage Evaluation Program is a first step in providing anadromous fish passage to historical habitat upstream of Englebright Dam but will not be sufficient by itself.

The number of fish that shall be relocated is expected to vary depending on the source population, source population size, and the results of fish habitat evaluations and modeling of carrying and production capacity. The Steering Committee and Technical Committee will work in consultation with the NMFS Southwest Fisheries Science Center to develop adult relocation source populations and abundance targets. The Steering Committee and Technical Committee shall evaluate the use of wild and hatchery sources and develop strategies that minimize risk to existing wild populations.

NMFS considers volitional passage to be the preferable alternative in most circumstances. In the short term, upstream passage can be provided with fish collection and transport mechanisms, while the Corps evaluates program effectiveness and passage alternatives associated with volitional passage.

NTFP 4.4. Interim Downstream Fish Passage through Reservoirs and Dams

Beginning in 2015, as part of the pilot fish passage program, and following the emergence of the first year class of reintroduced fish, and until permanent downstream passage facilities are constructed or operations are established at Corps dams, the Corps shall carry out interim operational measures to pass downstream migrants as safely and efficiently as possible through or around reservoirs and dams under current dam configurations and physical and operational constraints, consistent with authorized purposes.

Near-term operating alternatives shall be identified, evaluated, and implemented if determined to be technically and economically feasible and biologically justified by the Corps, within the framework of the Annual Operating Plan updates and revisions, and in coordination with the Fish Passage Plan Steering and Technical Committees. Interim devices shall be constructed to collect emigrating juvenile salmonids and emigrating post-spawn adult steelhead from tributaries, main stems upstream of Corps reservoirs, or heads of reservoirs operated under interrelated and interdependent actions. Fish shall be safely transported through or around reservoirs as necessary and released downstream of currently impassible dams.

The Corps shall evaluate potential interim measures that require detailed environmental review, permits, or Congressional authorization as part of the Fish Passage Plan. The Corps shall complete this component of the plan by April 30, 2015, including seeking authorization (if necessary) and completing design or operational implementation plans for the selected operations. Measures to be evaluated include, but are not limited to, partial or full reservoir drawdown during juvenile outmigration period, modification of reservoir refill rates, and using outlets, sluiceways, and spillways that typically are not opened to pass outflow.

NTFP 4.5. Juvenile Fish Collection Prototype

Objective: Based upon selection of reintroduction area(s), determine the most appropriate head of reservoir or other juvenile collection facilities. Safe and timely downstream passage of juvenile spring-run Chinook salmon and juvenile and adult post-spawn steelhead is a critical component to the success of the Fish Passage Program.

Beginning in January 2014, with input from the Fish Passage Steering Committee and Technical Committee, the Corps shall plan, design, build, and evaluate a prototype head-of-reservoir juvenile collection facility upstream of either New Bullards Bar Dam and/or Englebright Dam. Construction shall be complete by September 2014.

Because the head-of-reservoir fish collection concept is virtually untested, it would be imprudent to require such facilities without prior field studies, design, and prototype testing to validate the concept. For this measure, NMFS defines “prototype” to refer to temporary facilities intended for concept evaluation, not long-term operations. Further, “prototype” does not necessarily refer to a single concept; multiple concepts may be tested simultaneously. Possible options include, among others: (1) floating collectors in the reservoir near the mouths of tributaries; (2) use of curtained or hardened structures near mouths of tributaries, that block surface passage into reservoirs; (3) fish collection facilities on tributaries upstream of the reservoir pools; and (4) a combination of the above to maximize collection in high flow and low flow conditions.

By the end of 2013, the Corps, with assistance from the Fish Passage Steering and Technical Committees and concurrence by NMFS, shall identify a preferred location(s) and design(s) for construction of the prototype(s). Construction of the prototype facility(s) must be completed in time to conduct a minimum of two years of biological and physical evaluations of the head-of-reservoir prototype collection facilities by the end of 2016. The Fish Passage Steering Committee shall have opportunity to comment on study proposals and a draft report on the effectiveness of the facilities, including recommendations for installing full-scale head-of-reservoir facilities at this and the other reservoir. The draft report shall be provided to NMFS for review no later than September 1, 2016. By December 31, 2016, after receiving concurrence from NMFS on the draft report, the Corps shall make necessary revisions to the draft report and issue a final report. The report shall recommend technically and biologically feasible head-of-reservoir facilities, capable of safely collecting downstream migrating fish, and capable of increasing the overall productivity of the upper basins, then the Corps shall include such facilities in the design alternatives that they consider in the Fish Passage Plan studies.

NTFP 4.6. Pilot Program Effectiveness Monitoring and Evaluation

From 2014 to 2017, the Corps shall study, and provide annual reports on, the elements of the pilot program, including adult reintroduction locations, techniques, survival, distribution, spawning, and production; and juvenile rearing, migration, recollection, and survival. The objective is to gather sufficient biological and technical information to assess the relative effectiveness of the program elements and determine the feasibility of long-term passage alternatives. A final summary report of the 2-year pilot effort shall be completed by February 15, 2017.

NTFP 5. Fish Passage at Daguerre Point Dam

Objective: The best possible fish passage at Daguerre Point Dam with the existing facilities and development and implementation of a long-term fish passage solution.

Actions: Until such time as reasonable and prudent action for long-term fish passage at Daguerre Point Dam is fully implemented, the Corps shall maintain the current fish passage facilities at Daguerre Point Dam to prevent avoidable impairment of passage of listed salmonids. At a minimum this shall include:

a. Operation of the gates to the fish ladders in a manner that is protective of fish.

b. Develop and implement a plan for the placement of flash boards on Daguerre Point Dam to improve fish passage. Monitor effectiveness of fish passage through flow measurements, fish enumeration, and tagged tracking of fish.

c. The Corps shall continue to implement the 2009 Fish Passage Sediment Management Plan, including:

   i. Conducting weekly surface and subsurface inspection of the Daguerre Point Dam fish ladders for debris, including for debris on the bottom of the ladder. Debris shall be removed within 12 hours, unless high river flows make access unsafe. During flows of 4,200 cfs or greater, the Corps shall conduct daily inspections of the ladders and remove debris within 12 hours, unless high river flows make access unsafe.

   ii. Inspection and clearing of the channels connecting the upper end of the fish ladders to the river channel.

Rational: To minimize take of listed species, until improved fish passage can be implemented.

NTFP 6. Daguerre Point Dam Fish Passage Improvement

Objective: Develop and implement safe and efficient fish passage at Daguerre for all ESA listed species.

Action: As part of the Fish Passage Improvement Plan develop and implement new fish passage at Daguerre Point Dam that eliminates the blockage for green sturgeon and the delay for salmonids moving upstream, and provides safe downstream fish passage.

a. The Corps shall complete the feasibility study and preliminary engineering design (PED) phases for the fish passage improvement project, as described in the Corps 2007 biological assessment, by November 21, 2012.

b. The Corps shall commence implementation of the preferred alternative, as approved by NMFS, to improve fish passage for adult and juvenile spring-run Chinook salmon, steelhead, and green sturgeon at Daguerre Point Dam, developed through the feasibility study and PED process, by November 2017.

c. Develop and implement a plan for operation and maintenance of the new fish passage system by July 2018. This plan will be submitted to NMFS for review and approval by May 2018. This plan should incorporate, as appropriate for safe fish passage, identified in the near-term actions for Daguerre Point Dam and any actions identified in the Fish Passage Improvement Plan.

Rationale: To address take of ESA listed species at this dam, by providing access for green sturgeon to habitat for spawning, incubation, and rearing, by eliminating delays that salmonids experience in their upstream migration, and by reducing or eliminating sources of mortality associated with downstream passage at this site of ESA listed juvenile fish.

NTFP 7. Comprehensive Fish Passage Report

Objective: To evaluate the effectiveness of fish passage alternatives and make recommendations for the development and implementation of long-term passage alternatives and a long-term fish passage program.

Action: By December 31, 2016, the Corps shall prepare a Comprehensive Fish Passage Report. The Report shall include preliminary determinations by the Corps regarding the feasibility of fish passage and other related structural and operational alternatives. The report should include specific recommendations for improvements to highest priority sub-basins and/or features and to include recommendations for major operational changes. It will also include identification and evaluation of high priority actions and may suggest modifying the scope or timelines of these high priority actions, based on the predicted outcome of long-term efforts.

Re-initiation trigger: If the fish passage improvements are determined not likely to be technically or biologically feasible by December 31, 2016, then the Corps and the Steering Committee shall identify other alternatives that would be implemented within the same timelines as those identified in this RPA. The Corps shall submit specific implementation plans for alternative actions to NMFS, and NMFS shall evaluate whether the actions proposed in the implementation plans are likely to have the biological results that NMFS relied on in this biological opinion. The alternatives must be within the same Yuba River Watershed, identify high elevation habitats upstream of dams that provide similar habitat characteristics in terms of water temperatures, habitat structure (sufficient pool depths and spawning gravels), ability to withstand long-term effects of climate change, and must demonstrate an ability to support populations that meet the characteristics of a population facing a low risk of extinction according to the population parameters identified in Lindley *et al.* (2007), “Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin.” If the Corps believes that the proposed passage locations may not be feasible, the Fish Passage Steering Committee should be directed to develop early assessments of alternative actions that meet the performance standards described above in order to maintain the schedule proposed in this action. NMFS shall notify the Corps as to whether the proposal is consistent with the analysis in this biological opinion. If not, the Corps will request re-initiation of consultation.

3. Long-Term Fish Passage Actions

Based on the evaluations and actions described above, the Corps shall implement a comprehensive, long-term fish passage program. The objective of the long term fish passage RPA is to address the stressors caused by the Corps operation and maintenance of Englebright Dam and Daguerre Point Dam, such as spring-run Chinook redd loss through superimposition by fall-run Chinook, genetic introgression between spring-run Chinook and fall-run Chinook, genetic introgression between hatchery and wild spring-run Chinook, genetic introgression between hatchery and wild steelhead, possible habitat influences leading to steelhead resident life history preference, and increasing abundance, productivity, spatial structure and improving diversity of steelhead, spring-run Chinook and green sturgeon through increasing the amount and type of habitat to which they have access.

LTFP 1. Long-term Funding and Support to the Interagency Fish Passage Steering Committee and Technical Committee

If the Comprehensive Fish Passage Report indicates that long-term fish passage is feasible and desirable, the Corps shall continue to convene, fund, and staff the Fish Passage Steering Committee and Fish Passage Technical Committee.

LTFP 2. Action: Long-Term Fish Passage Plan and Program

Objective: Provide structural and operational modifications to allow safe fish passage and access to habitat upstream and downstream of Englebright Dam and upstream of Daguerre Point Dam.

Actions: Based on the results of the Comprehensive Fish Passage Report, the Corps, with assistance from the Steering Committee, shall develop a Long-term Fish Passage Plan and implement a Long-term Fish Passage Program. The Corps shall submit a plan to NMFS on or before December 31, 2017, which shall describe planned long-term upstream and downstream fish passage facilities and operations, based on the best available information at that time. The plan shall include a schedule for implementing a long-term program for safe, timely, and effective anadromous fish passage by January 31, 2020. Safe downstream passage may include screening of intakes or diversions at dams, or fish collection facilities.

The Long-term Fish Passage Plan and Program shall target the following performance standards: (1) demonstrated ability to withstand long-term effects of climate change; and (2) must support populations in the target watersheds that meet the characteristics of a population facing a moderate risk of extinction by year five (2025) and a low risk of extinction by year 15 (2035), according to the population parameters identified in Lindley *et al.* (2007), "Framework for

Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin."

The structural and operational modifications needed to implement the program shall be developed as high priority measures in the plan. The plan shall include an evaluation of a range of structural and operational alternatives for providing fish passage upstream of Englebright Dam. The Corps will evaluate the information gathered through plan development, the NEPA process, ESA recovery planning (including life cycle modeling developed as part of the recovery planning process), university studies, local monitoring efforts public comment, and other relevant sources, to determine which alternative(s) will provide the most cost-effective means to achieve adequate passage benefits to avoid jeopardy to ESA-listed fish from the Corps' Yuba River dams in the long term. The Corps shall proceed with the action(s) that sufficiently address the adverse effects of the Project, in the context of future baseline conditions. The Corps shall submit specific implementation plans to NMFS, and NMFS shall evaluate whether the actions proposed in the implementation plans meet ESA requirements, consistent with this biological opinion. NMFS will notify the Corps as to whether the proposal is consistent with ESA obligations.

The Corps also shall analyze structural and operational modifications to provide downstream fish passage as part of the plan, following the same process as that for providing upstream passage.

The time frame for implementing the long-term passage measures may extend beyond the time frame of this biological opinion. However, the Corps must begin some actions during the term of this biological opinion, including investigating feasibility, completing plans, requesting necessary authorization, and conducting the NEPA analysis.

Rationale: This suite of actions ensures that fish passage actions will be taken by specified dates, or that the Project will be re-analyzed based upon new information. As noted in this biological opinion, lack of passage is one of the most significant limiting factors for the viability of the affected populations of spring-run Chinook salmon and steelhead. As described in the effects analysis of this biological opinion, this also exposes populations to additional and significant stressors from project operations that also limits their viability and ability to survive downstream of dams. Providing fish passage to historical spawning and rearing habitats would effectively mitigate for unavoidable adverse impacts of the project on listed fish.

Long-term fish passage should significantly increase abundance and spatial distribution of spring-run Chinook salmon, and Central Valley steelhead because the fish will have access to upstream spawning and rearing habitat, and the juveniles will have access downstream to the ocean for growth to maturity. This action will address the habitat access pathway of critical habitat by improving access past physical barriers, thereby improving the status of PCEs for spawning, rearing, and migration of spring-run Chinook salmon, and Central Valley steelhead populations.

NMFS selected the January 31, 2020, full implementation date to align with the planning processes related to FERC hydropower licensing of the Narrows I Project (expiring in 2013).

LTFP 2.1. Long-term Adult and Juvenile Fish Passage Facilities

Based on the results of the Comprehensive Fish Passage Report and the Fish Passage Plan, and with the assistance of the Steering Committee, the Corps shall construct long-term fish passage facilities necessary to successfully allow upstream and downstream migration of fish upstream of Englebright Dam and reservoir by 2020.

LTFP 2.3. Long-term Fish Passage Monitoring and Evaluation

The Corps, through the Steering and Technical committees shall develop a Long-term Fish Passage Monitoring and Evaluation Plan by 2020, to monitor all elements of the Long-term Fish Passage Program including adult reintroduction locations, techniques, survival, distribution, spawning, and production; and juvenile rearing, migration, recollection, and survival. Annual reports shall be submitted to NMFS by September 30 of each year.

4. Gravel Augmentation Program

Objective: Provide spawning habitat for spring-run Chinook and steelhead in the reach below Englebright Dam, where gravel is depleted.

Action: The Corps shall develop and implement a long-term gravel augmentation program to restore quality spawning habitat downstream of Englebright Dam.

GAP 1. The Corps shall implement their "Gravel/Augmentation Implementation Plan (GAIP) for the Englebright Dam Reach of the Lower Yuba River, CA", September 30, 2010, beginning in 2012.

GAP 2. The Englebright Dam Reach is defined as the Yuba River downstream of Englebright Dam down to just downstream of the confluence with Deer Creek, including the area known as Sinoro Bar.

GAP 3. The Corps shall place a minimum of 15,000 short tons of graded and washed gravel and cobble into the Englebright Dam Reach annually. This will continue until the gravel/cobble deficit (estimated at 63,077 to 100,923 short tons in the GAIP) for the Englebright Dam Reach is eliminated. Thereafter, gravel placement will be made to replace gravel that has moved downstream out of the placement areas. Gravel deposits will be placed at a time and manner each year as approved by NMFS.

GAP 4. The amounts of gravel required by this measure may be modified by NMFS, if additional information becomes available and is provided to NMFS. Gravel deposition by the Corps may be reduced or deferred if it is determined by NMFS that placement of the gravel would be detrimental to fish resources in the Yuba River (e.g. gravel did not move downstream from the deposition area, and additional gravel would create non-desirable stream flow conditions).

GAP 5. The gravel/cobble deposits will be monitored annually by the Corps, and at a time that will provide information to NMFS about the amount of gravel to place in the river each year.

GAP 6. The gravel deposits and the areas to which gravel has moved will also be monitored weekly by the Corps during the Chinook salmon spawning period, and at least three times during the steelhead spawning period, for use by these species. This information will be included in the annual report.

GAP 7. The gravel/cobble mix to be deposited in the Englebright Dam Reach will be washed, and graded to a mix of sizes as approved by NMFS based on hydraulic and biologic suitability. The material will be rounded rock, appropriate for salmonid spawning, not fractured rock.

GAP 8. An annual report regarding the actions under this gravel augmentation action will be provided to NMFS, and made available to the public on the Corps Sacramento District website. At a minimum the report will include: (1) background; (2) methods; (3) results of gravel placement; (4) gravel movement; (5) results of spawning surveys; (6) analysis and discussion; (7) conclusions and recommendations; and (8) a summary of previous year's activities. Specifically, the report shall include: how much gravel was placed in the Yuba River, where it was placed, when it was placed, and how it was placed. The annual report will be provided to NMFS by January 15 of each year, for the previous year's activities and proposals for the coming year. The annual report shall also include a proposal for the amount of gravel to be place in the upcoming year. The amount of gravel for placement may require modification depending on flow events that occur in the winter and spring.

Rationale: Gravel is a critical component of salmonids spawning habitat. In an unaltered river systems gravel moves through the system with high flow events. The purpose of Englebright Dam is to retain sediment, including salmonids spawning gravel. The natural flow of gravel in the lower Yuba River has been interrupted by Englebright Dam. The operations and maintenance of Englebright Dam have the purpose of keeping Englebright Dam in place and functioning as a dam. The operations and maintenance of Englebright Dam perpetuates the interruption of the movement of gravel in the Yuba River. The Corps have identified that the deficit of gravel in the reach downstream of Englebright Dam (Englebright Dam to Deer Creek) is between 63,077 to 100,923 short tons. It is expected that high flows will cause gravel to move downstream of the Englebright Dam reach, and it will be necessary to replenish the gravel that leaves the Englebright Dam reach. NMFS believes placement of gravel in the reach downstream of Englebright Dam will improve the viability of spring-run Chinook salmon, steelhead, and possibly green sturgeon. Similarly, the area in the Yuba River around the confluence of Deer Creek provides some opportunities to improve habitat and through those habitat improvements, improve spring-run Chinook salmon and steelhead viability.

5. Channel Restoration Program

Objective: Restore properly functioning channel morphology and depositional surfaces, to provide quality spawning habitat downstream of Englebright Dam. This program will work in tandem with the gravel and LWM augmentation programs. The LWM augmentation program is described in the incidental take statement.

Action: The Corps shall develop and implement a long-term channel restoration program to restore properly functioning channel morphology and depositional surfaces downstream of Englebright Dam.

CR 1. The Corp shall develop a Channel Restoration Plan for the Englebright Dam Reach, and upper portions of the Narrows Reach (extending from Deer Creek confluence to 1,000 ft downstream) of the Lower Yuba River, CA by December 2012. Specific areas to be included in the Channel Restoration Plan include Sinoro Bar, the mid-channel bar adjacent to the downstream end of Sinoro Bar at the Deer Creek confluence, and potentially other suitable depositions areas or surfaces that no longer function properly due to armoring or deposition of shot-rock. The Channel Restoration Plan will include conceptual level plans for design that identify areas where shot-rock needs to be removed, where channel recontouring should occur, locations for installment of potential flow obstructions, identify areas where local/site specific gravel additions are warranted, and identify sources of shot-rock in the vicinity of Englebright Dam that can be stabilized. At a minimum the Channel Restoration Plan will include shot-rock removal at Sinoro Bar and the mid-channel bar at the entrance to Narrows Gateway, recontouring of these bars, addition of at least eight flow obstruction structures that may potentially be part of the large wood augmentation program, and stabilization of shot-rock sources in the vicinity of Englebright Dam. Localized gravel augmentation at the recontoured bars and hydraulic structures will also be included, specific amounts will be determined as part of the design process and potentially partially accounted for with the annual gravel augmentation supplied at the top if the EDR. An implementation schedule will also be part of this plan. The Channel Restoration Plan shall be submitted to NMFS for approval by December 2012.

CR 2. The first phase of the Channel Restoration Plan will be to develop preliminary engineering plans sufficient to be put out for bid for the development of final engineering plans by a construction/restoration firm. The preliminary engineering plans will be of sufficient detail to develop detailed cost and material estimates, and begin permitting processes. The preliminary engineering plans should utilize 2 or 3D hydraulic modeling as a basis for design. Any additional field data necessary to develop the final designs should be collected as part of this phase. This phase shall be completed within one year after NMFS approval of the Channel Restoration Plan.

CR 3. The second phase of the Channel Restoration Plan will include development of the final engineering designs and initial implementation of these designs. Implementation will include removal of shot-rock and armored surfaces, recountouring of bars, installation of hydraulic structures, and local gravel augmentation. Implementation will also include stabilization of shot-rock sources in the vicinity of Englebright Dam. As-built topographic data will be collected following initial implementation. The final engineering designs and plans shall be completed within two years after NMFS approval of the Channel Restoration Plan.

CR 4. The Corps shall complete the measures identified in the Channel Restoration Plan within five years of NMFS approval of the Channel Restoration Plan.

CR 5. Annual monitoring of the channel restoration projects will be conducted in conjunction with the gravel augmentation monitoring. Annual monitoring will include assessment and measurement of gravel stored at rehabilitated bar surfaces and hydraulic structures. Annual monitoring of restoration areas will also include assessment of whether the projects are functioning as designed and whether any potential modifications are warranted.

CR 6. Annual reporting on the channel restoration program will be included with the annual reporting for the gravel augmentation Program.

CR 7. Performance of channel restoration areas will be assessed annually. Should channel restoration actions fail, either due to high flows, design concept, or other unforeseen events, NMFS will evaluate whether additional restoration actions are warranted within the plan area based on the initial implementation actions and the cause for design failure.

Rationale: Habitat for spring-run Chinook, CV steelhead, and green sturgeon has been lost under Englebright Reservoir and altered downstream of Englebright Dam. Restoration of a portion of the altered channel will provide missing habitat for listed species. The area in the Yuba River around the confluence of Deer Creek provides some opportunities to improve habitat and through those habitat improvements, improve spring-run Chinook salmon and steelhead viability.

6. Predator Control Program

PC 1. Immediate Predator Control Efforts

Objective: To reduce entrainment-related mortality caused by predation to spring-run Chinook salmon and Central Valley steelhead at water diversion facilities and Daguerre Point Dam.

Action: Five areas have been identified associated with Daguerre Point Dam that have populations of predators. These areas are: (a) just downstream of Daguerre Point Dam at the plunge pool; (b) at the South Yuba/Brophy diversion; (c) at the Hallwood-Cordua diversion canal and fish screens; (d) at the outlet of the Hallwood-Cordua fish screen fish return pipe, and just downstream; and (e) at the entrance of the Browns Valley Irrigation District diversion. The Corps shall provide a predator reduction and monitoring plan to NMFS for approval by September 1, 2012. The plan shall address the predator population monitoring, and timing and methods for predator reduction at the five locations. The Corps shall implement a predator reduction program by November 1, 2012. The predator reduction and monitoring plan shall be updated annually, by August 1 of each year. A report will be provided to NMFS August 1 of each year providing information about the predator population, and the results of the predator deduction efforts.

Rationale: Predation is a significant cause of mortality and injury to juvenile spring-run Chinook salmon and Central Valley steelhead in the Yuba River. The operation and maintenance of Daguerre Point Dam perpetuates the existence of the dam, and perpetuates the predation mortality associated with Daguerre Point Dam. Predator removal is critical to enhancing the successful downstream passage and outmigration of juvenile spring-run Chinook salmon and Central Valley steelhead.

PC 2. Predator Control Plan

Objective: To develop a comprehensive predator control plan that reduces predator fields at manmade structures in the lower Yuba River, while minimizing take of adult spring-run Chinook salmon, Central Valley steelhead, and green sturgeon.

Action: By December 2013, the Corps shall implement a long-term plan for predator removal at the South Yuba/Brophy Diversion rock weir and return channel, Hallwood-Cordua Diversion canal, Hallwood-Cordua fish return pipe, Daguerre Point Dam face and fish ladders, and the Browns Valley Diversion channel.

a. The predator control plan shall be established in consultation with and the approval of NMFS and shall include senior biologists and engineers with experience and expertise in predatory fish removal, from the Corps, NMFS, CDFG, and USFWS.

b. The Corps shall develop and submit to NMFS for approval a plan for removing predators at the South Yuba/Brophy Diversion rock weir and return channel, Hallwood-Cordua Diversion canal, Hallwood-Cordua fish return pipe, Daguerre Point Dam face and fish ladders, and the Browns Valley Diversion channel. The plan shall include an analysis of what methodology would be most effective for predator removal and be safest for listed fish.

c. The plan shall include monitoring for predator-removal success, including any adverse effects to listed species.

d. A report shall be provided annual by March 1 of each year, following the first year of implementation. The plan shall be implemented within two years of issuance of this biological opinion.

Rationale: Long-term planning and predator control implementation is needed to ensure that the Yuba River populations of spring-run Chinook salmon and Central Valley steelhead survive while upper watershed passage scenarios are being developed and implemented.

7. Salmonid Monitoring and Adaptive Management Program

Objective: To collect information about the trends and status of salmonids in the Yuba River watershed. This information is needed to understand how ESA listed salmonid populations are performing, how the salmonid populations are performing in relation to the RPA actions, and inform NMFS and other decision makers about future decision, including adaptive management decision (*e.g.*, fish passage).

Actions: Immediately after the issuance of this biological opinion the Corps shall establish this program. The program shall be staffed by the Corps and will be guided by the policy and management advice of an interagency steering committee. The steering committee will be comprised of salmonid experts and representative from the Corps, NMFS, USFWS, CDFG and academic or other agency science programs or steering committees. The program also shall establish a salmonid technical sub-committee. The committees may also have members from other organizations.

SMAMP 1. The Corps shall develop a salmonid monitoring plan to monitor salmonids in the Yuba River watershed that are listed under the Federal Endangered Species Act. The plan shall be submitted to NMFS for approval within one year of the issuance of this biological opinion. The salmonid monitoring plan will develop a spatially and temporally balanced sampling protocol that when implemented will allow for statistically defensible estimates of population status. The sampling will be designed to provide information on the abundance, distribution, productivity, and diversity of salmonids in the Yuba River. It will also be designed to evaluate the performance of the actions in this reasonable and prudent alternative. The plan will include provisions for analysis of the data collected. The plan will incorporate an adaptive management strategy, and recommend a standardized database structure, as well as standardized reporting techniques. The plan shall include a provision for annual reporting to NMFS.

SMAMP 2. In developing the monitoring and adaptive management plan the Corps shall consider other monitoring activities, such as those being implemented by the Yuba River Management Team, and CDFG. The plan shall consider monitoring methods such as the VAKI Riverwatcher, spawner surveys, redd surveys, radio tagging, acoustic tagging, PIT tagging, visual tags, and genetic monitoring. The plan shall include methods to collect data and conduct analysis to provide information about abundance status and trends of adults and juvenile salmonids, spatial and temporal distribution of adult and juvenile salmonids, productivity of adult salmonids (including juvenile numbers), and diversity of adult and juvenile salmonids. The plan shall also include monitoring and analysis of the reasonable and prudent measures (e.g. upstream and downstream fish passage, gravel augmentation, large woody material, diversion screening, riparian planting, etc.). The plan shall also provide for monitoring and analysis of salmonid habitat in the Yuba River watershed.

Rationale: To provide understanding about the trends and status of salmonid populations in the Yuba River watershed. To provide information about the response of the salmonids to the RPA actions, and the continued need for those actions, and to inform those making future decisions regarding the RPA actions.

8. Green Sturgeon Monitoring and Adaptive Management

GS 1. Green Sturgeon Conservation and Management Program

Objective: To provide a policy and management structure for green sturgeon conservation in the Yuba River and Feather River.

Action: Immediately after the issuance of this biological opinion the Corps shall establish this program. The program shall be staffed by the Corps and will be guided by the policy and management advice of an interagency steering committee. The steering committee will be comprised of green sturgeon experts and representative from the Corps, NMFS, USFWS, CDFG and academic or other agency science programs or steering committees. The program also shall establish a green sturgeon technical sub-committee, develop a green sturgeon conservation and management plan, and oversee the implementation of interim green sturgeon protective measures described below. The committees may also have members from other organizations.

Rationale: To provide understanding about the trends and status of the green sturgeon population in the Yuba River watershed. To provide information about the response of green sturgeon to the RPA actions, and the continued need for these actions, and to inform those making future decisions regarding the RPA actions.

GS 2. Green Sturgeon Technical Sub-Committee

Action: The Corps shall assemble, as part of the Green Sturgeon Conservation and Management Program, a Green Sturgeon Technical Sub-committee within six months of issuance of this biological opinion.

a. The Green Sturgeon Technical Subcommittee will be chaired by the Corps and will report to the steering committee. The Subcommittee will be comprised of anadromous fish biologists from the Corps, NMFS, and CDFG, and at least one academic green sturgeon expert. The Corps shall work through the Green Sturgeon Technical Sub-committee to use agency science programs and science centers as resources in developing, implementing, and monitoring interim strategic plans and related actions, and reviewing the Green Sturgeon Conservation and Management Plan.

b. The Corps shall use the Green Sturgeon Technical Sub-committee to develop annual strategic plans for: (i) developing and implementing the Green Sturgeon Conservation and Management Plan described below; and (ii) implementing interim actions described below.

GS 3. Green Sturgeon Conservation and Management Planning

Objective: To formulate a plan that includes short-term and long-term actions that are intended to be phased and implemented over time with the near-term goal of immediately reducing project-related adverse effects of flow and water temperatures on green sturgeon and providing a sustainable ecology that supports the long-term conservation of the species within the action area.

Action: The Corps shall develop, as part of the Green Sturgeon Conservation and Management Program, a Green Sturgeon Conservation and Management Plan within four years of the issuance of this biological opinion. The Green Sturgeon Conservation and Management Plan shall focus on water temperature, flow, and passage. The plan will be developed by the Green Sturgeon Technical Sub-committee with the guidance of the green sturgeon interagency steering committee. The program also shall include monitoring, habitat evaluations, and the development of passage and spawning habitat improvement and water temperature criteria within the Yuba

River and Lower Feather River. The Green Sturgeon Conservation and Management Plan shall at a minimum, include the following components:

a. The Corps shall conduct population, habitat, and facility evaluations.

   i. Evaluating the Abundance and Distribution of Green Sturgeon – the Corps shall consult with the Green Sturgeon Technical Sub-committee to develop and implement a monitoring plan that will estimate the annual abundance of adult green sturgeon in the Yuba River and Lower Feather River, describe their distribution in time and space; and investigate the effect of Yuba River flows and fish passage at Daguerre Point Dam on their distribution. In developing this monitoring plan, the Corps shall consider an approach that applies Dual Frequency Identification Sonar (DIDSON) surveys, or other detection techniques as recommended by the Green Sturgeon Technical Sub-committee. Surveys on the Rogue and Sacramento Rivers have shown that the DIDSON can be used to count green sturgeon in potentially turbid river channels.

      In addition, in developing this monitoring plan, The Corps shall incorporate an approach to estimate the distribution of adult green sturgeon in time and space using acoustic tags and tracking stations. These approaches shall be coordinated with other monitoring and research programs that are using similar techniques for sturgeon monitoring and research in the Central Valley due to the highly migratory nature of these species to help determine how Southern DPS green sturgeon may be using other habitats across their range.

   ii. Characterization of Potential Green Sturgeon Spawning Habitats – The Corps shall use Acoustic Doppler Current Profiler, or other technologies or models as recommended by the Green Sturgeon Technical Subcommittee, to create a cross channel vertical profile of current and temperature in potential spawning areas within the Yuba River. The Corps should consider, in partnership with other entities or agencies, collecting similar data in the Lower Feather River downstream from the Yuba River, in suspected spawning habitats. Analysis of the data shall be used to characterize pools, provide information on existing habitat variables, and determine whether or not sites would provide suitable conditions for spawning.

   iii. Characterization of Green Sturgeon Food Web Dynamics and Food Availability– The Corps shall conduct food web and availability studies throughout the range of green sturgeon in the Yuba River and use bioassessment technologies or models as recommended by the Green Sturgeon Technical Subcommittee.

   iv. Feasibility Studies of Operational and Physical Habitat Modifications for Fish Passage Improvement Actions – If the monitoring study reveals that existing physical impediments to passage within the lower Feather River are significantly reducing the passage benefits of seasonal flow targets, the Corps in consultation with the Green Sturgeon Technical Sub-committee and based on the recommendations of the steering committee, shall identify operational and physical habitat modifications for those impediments, and identify responsible agencies and parties associated with those sites.

b. The Corps shall, in cooperation with the identified parties, contribute to the development of the feasibility of such actions necessary to address project related effects to achieve unimpeded passage conditions during the adult upstream migration period of March through May. Passage criteria shall be developed using the best available scientific or commercial information. Based on these feasibility studies, the Corps shall complete a feasibility report, within two years following the submittal of the Green Sturgeon Conservation and Management Plan. The feasibility report shall recommend a specific alternative for implementation of operational and physical habitat modifications necessary and allocated responsibilities among parties to achieve unimpeded passage conditions during the adult upstream migration at the identified passage impediments.

c. After approval of the plan by NMFS as appropriate, the Corps shall work with the parties to implement the specific alternative within three years following NMFS' approval.

GS 4. Implement the Green Sturgeon Conservation and Management Plan

Program Implementation: The Corps shall consult with the Green Sturgeon Technical Sub-committee, and based on the recommendations of NMFS and the steering committee, develop an implementation plan and schedule. The plan shall include a list of actions and dates for completing habitat improvement actions.

Program Monitoring: **T**he Corps shall consult with the Green Sturgeon Technical Sub-committee, and based on the recommendations of the steering committee, develop a green sturgeon monitoring plan that shall include developing long-term adult population estimates, and collecting information on green sturgeon passage, spawning, rearing, and growth in the Yuba River and in the Feather River downstream of the Yuba River.

Adaptive Management: The Corps shall consult with the Green Sturgeon Technical Sub-committee, and based on the recommendations of the steering committee, include an adaptive management strategy for the plan to be adapted to incorporate evolving developments in the scientific understanding of the species and ecosystem, and for the actions in the plan to be adapted with the changing nature of the best available science.

a. The Corps shall conduct peer review and include the CALFED Science Program, NMFS Southwest Fisheries Science Center, and other independent or academic green sturgeon experts as essential partners in ensuring that the best scientific experts are brought together to assess both the implementation and effectiveness of the green sturgeon actions.

b. The Corps shall include a strategy for seeking peer review of the Green Sturgeon Conservation Management Plan and its various components, but also to review and provide feedback on the long term implementation, monitoring, and research associated with implementation and adaptive management over the proposed 50 year period of the license term.

c. The Green Sturgeon Conservation and Management Plan and any actions recommended by the plan must be approved in writing by NMFS.

GS 5. Near-term Conservation Actions for Green Sturgeon

Action: The Corps shall carry out the following near-term actions until a Green Sturgeon Conservation Management Plan can be developed and implemented. The interim actions are expected to be in place for a total of up to 5 years, upon which time they will either adopted, modified, or adaptively phased out according to the strategy, actions and schedule that will be described in the Green Sturgeon Conservation and Management Plan.

a. Interim Annual Conservation, Monitoring and Management Planning—The Corps shall develop annual conservation, monitoring and management plans within one year of issuance of this biological opinion in consultation with the steering committee and the Green Sturgeon Technical Subcommittee to minimize the potential for the project to adversely affect (1) the successful upstream migration of adult green sturgeon; and (2) the successful spawning, larval development, and early rearing of green sturgeon in the Yuba River and lower Feather River.

b. The monitoring component will include adult passage, distribution, and abundance components that shall be conducted through the interim period in the Yuba River and lower Feather River, and at potentially significant passage impediments, as determined to be appropriate by the Green Sturgeon Technical Sub-committee in consultation with the steering committee. Egg and juvenile detection studies shall be conducted, as determined to be necessary by the Green Sturgeon Technical Sub-committee in consultation with the steering committee to identify spawning success and life stage specific presence and habitat use within the project area.

c. The annual plan will be developed in consultation with and approved by NMFS by March 1 of each year. The strategic plan will recommend an adaptive management process that uses real-time green sturgeon monitoring or other relevant information conducted within the Yuba River and Feather River. The monitoring information will be used by the Green Sturgeon Technical Sub-committee, FRTT, and the Yuba River Management Team in making recommendations regarding green sturgeon conservation.

9. Training Walls

Objective: To identify opportunities to improve habitat for ESA listed species, and to implement habitat improvement.

Action: The Corps shall identify and map the training walls between the Highway 20 Bridge and Daguerre Point Dam by December 1, 2014. The Corps shall also identify land ownership of the training wall and adjacent properties. The Corps shall provide to NMFS, for approval, their criteria for identifying training wall prior to any surveying or mapping. The Corps shall develop a plan for training walls that will identify opportunities to modify the training walls in ways that will benefit ESA listed fish species. The Corps shall provide the plan to NMFS for approval by July 1, 2015. The Corps will begin implementation of the approved plan by August 1, 2016.

Rationale: The Corps' training walls affect natural riverine processes through constriction of the river channel and limiting the areas in which riparian vegetation can become established. NMFS believes restoring natural riverine processes will improve ESA listed species' population viability through improved habitat quantity and quality.

E. Description of how the RPA avoids jeopardy to the species and adverse modification of critical habitat

Actions that increase the number of ESA listed fish, and/or increase the amount of habitat for ESA list fish, or increase the productivity of habitat used by these fish are considered actions that will aid in the restoration of the viability of the ESA listed fish species through increasing abundance, increasing diversity, increasing production, and in increasing growth rates. These actions are intended to allow the Corps to continue operating and maintaining Daguerre and Englebright in a manner that avoids jeopardizing the affected species by reducing the harms from the Corps' action. In our opinion this is not possible to do within the limits of the current distribution of the listed fish species.

The Corps' operation and maintenance of Englebright Dam (to continue the existence of the dam into the foreseeable future) perpetuates the conditions that put spring-run Chinook at risk of extinction. Similarly, the operation and maintenance of Daguerre Point Dam to perpetuate its existence into the foreseeable future, with deficient fish passage facilities, is an action by the Corps that increases the risk of extinction for spring-run Chinook. Because of the limited space in the lower Yuba River, redd superimposition, genetic dilution, and effects of climate change; improving the viability of the listed spring-run Chinook and steelhead downstream of Englebright Dam does not provide the necessary increase in viability. Allowing the fish to access historic habitat upstream of Englebright Dam is expected to increase abundance, provide separation from other populations, address superimposition and genetic dilution, and provide refugia from the adverse effects of climate change. These actions are designed to address the spring-run Chinook impacts associated with the Corps' operations and maintenance of Englebright Dam and Daguerre Point Dam, which have the purpose of perpetuating the existence of the dams, and which have reduced the likelihood of survival and ability of spring-run Chinook to recover.

It is likely that Yuba River historically provided optimal spawning habitat for green sturgeon in areas both upstream of the dams and where reservoirs are today. It is clear that green sturgeon do make it up the river as far as Daguerre Point Dam, and likely prior to construction of Daguerre Point Dam moved further upstream. At this time, we are not aware of practical methods to collect downstream migrating green sturgeon at a large dam. This coupled with much of the habitat that green sturgeon may have used upstream of Englebright Dam being inundated by Englebright Reservoir, and impaired flows upstream of Englebright Reservoir; we have not included any action to pass green sturgeon upstream of Englebright Dam.

The most critical information for reducing uncertainty in status and risks includes estimates of spawner abundance by population, strength and consistency of juvenile recruitment, population parameters by sex, and significant human-caused mortality rates (Beamesderfer *et al.* 2007).

Green sturgeon are long lived, delay maturation to large sizes and spawn multiple times over their lifespan. This life history strategy has proven to be successful in the face of normal environmental variation in the large river habitats where spawning occurs for millions of years. The sturgeon's long lifespan, repeat spawning in multiple years, and high fecundity allows the fish to persist through periodic droughts and environmental catastropophes. The high fecundity allows them to produce large numbers of offspring when suitable conditions occur and compensate for years of poor reproductive conditions. Adult green sturgeon do not spawn every year and only a fraction of the population enters freshwater where they might be at risk of a catastrophic event in any year (Beamesderfer *et al*. 2007).

Because of this dynamic life history, it may not be necessary for suitable spawning conditions to occur in the Yuba River every year in order to maintain population viability, although they may be necessary for some period to re-establish a viable population. Instead, suitable spawning conditions should occur at a frequency necessary for rebuilding and then maintaining a viable population.

Because this biological opinion has found (jeopardy/destruction or adverse modification of critical habitat), the Corps is required to notify the NMFS of its final decision on the implementation of the reasonable and prudent alternatives.

1. Fish Passage at Englebright Dam

Fish passage at Englebright Dam is considered very important for restoring the viability of spring-run Chinook salmon, and for steelhead. Due to effects associated with lack of fish passage to a significant amount of historic spawning and rearing habitat, climate change, superimposition from fall-run Chinook salmon, genetic effects of interbreeding of the two runs of Chinook salmon, interbreeding of wild and hatchery Chinook salmon, interbreeding of wild and hatchery origin steelhead, interbreeding of rainbow trout and steelhead, and potential habitat effects on anadromy of steelhead, it is very important for the continued existence and restoration of the viability of spring-run Chinook salmon and steelhead in the Yuba river for these species to be able to utilize historic habitats upstream of Englebright Dam.

Removal of Englebright Dam is one potential alternative that would address the blockage of upstream spring-run Chinook salmon and steelhead fish passage to historic habitats, and eliminate the likely downstream mortality that would occur for juveniles of these species migrating downstream through Englebright Reservoir. Removal of Englebright Dam would restore access to some of the spring-run Chinook salmon and steelhead historic spawning habitat. Removal of Englebright Dam is expected to address issues of cross breeding between spring-run Chinook salmon and fall-run Chinook salmon, and superimposition of spawning fall-run Chinook salmon on spring-run Chinook salmon redds. Removal of Englebright Dam would also restore natural geomorphic processes that support fish habitat.

Modification of Englebright Dam is an alternative that would addresses blockage of upstream migration of salmonids by allowing for a fish ladder to be installed would allow volitional fish passage, which would provide most of the same benefits to spring-run Chinook salmon and Central Valley steelhead that removal of Englebright Dam would provide. It would not restore natural geomorphic processes. The dam would need to be lowered to a level that would allow installation and operation of a fish ladder that could pass anadromous salmonids upstream successfully. Downstream fish passage would also need to be addressed.

Providing assisted upstream and downstream fish passage is yet another alternative that could address blockage of upstream migration of salmonids by collecting the target species and transporting them upstream to locations at which the fish could survive and successfully reproduce. Downstream collection and transport would also need to be developed. Non-volitional fish passage, by itself, if successful, would not reduce the harm associated with other stressors associated with the Corps proposed project.

2. Fish Passage at Daguerre Point Dam

Daguerre Point Dam impedes spring-run Chinook salmon and steelhead upstream fish passage, and stops green sturgeon upstream fish passage. Daguerre Point Dam causes downstream juvenile spring-run Chinook salmon and steelhead mortality. For fish going downstream over the dam the plunge pool causes disorientation and increases mortality due to predation. It is likely that juvenile fish moving downstream through the fish ladders also experience increased mortality.

Removal of Daguerre Point Dam is one alternative that could address upstream and downstream migration of salmonids and green sturgeon and provide access to historic habitats. Other alternatives include modification of the dam, improvement of the fishways, or construction of natural pass fishways could also address migration of fish to historic habitats. These alternatives may also allow upstream access to predators. The issue of predator access to areas upstream of Daguerre Point Dam must be evaluated and addressed.

As fish move downstream over Daguerre Point Dam they may die due to entrainment and impingement at the unscreened diversion; they may die due to predation associated with the diversions; and they may die due to predation as they move over DPD, due to predation and disorientation from the water turbulence at the foot of the dam where predators are present. Removal of Daguerre Point Dam would remove these causes of the increased juvenile spring-run Chinook and steelhead mortality at this location and avoid potential problems for juvenile green sturgeon moving downstream.

Daguerre Point Dam’s fishways are old in design, and cause delay in the upstream migration of adult spring-run Chinook salmon and steelhead. Daguerre Point Dam’s fishways do not provide upstream fish passage for green sturgeon. Daguerre Point Dam blocks green sturgeon access to historic habitat. This measure requires improved upstream and downstream fish passage for spring-run Chinook salmon, steelhead, and green sturgeon, unless actions are in place for removal of Daguerre Point Dam.

3. Interim Fish Passage at Daguerre Point Dam

Until such time that Daguerre Point Dam is removed or fish passage is improved to fully address the fish passage issues at the dam, the existing fish passage must be maintained to provide the most efficient and effective fish passage possible. This is necessary to minimize the take at Daguerre Point Dam.

4. Gravel Augmentation and Channel Restoration

Englebright Dam blocks the downstream transport and supply of coarse and fine sediment including spawning sized gravel that supports fish spawning habitat, riparian vegetation, and properly functioning channel morphology processes. The intent of this action is to establish and maintain a gravel supply in the Englebright Dam reach, which will also provide a spawning gravel source for reaches further downstream as the sediment mobilizes through time. This will increase spawning habitat for spring –run Chinook salmon, steelhead and green sturgeon. It will also create spawning habitat for fall-run Chinook salmon. Creation of more spawning habitat will support larger populations of these species and address the termination of natural processes.

Based on empirical curves the trap efficiency of Englebright Dam ranges from 74 percent to 99 percent with nearly 100 percent trap efficiency for bedload sized material (Snyder *et al*. 2004). Snyder *et al*. (2004) calculated that Englebright Dam traps approximately 470,000 yd^3 of sediment per year, and about 20 percent of that sediment or 90,000 yd^3 is gravel (Snyder *et al*. 2004). The Yuba River directly downstream of Englebright Dam (Englebright Dam reach) is now almost completely devoid of river rounded gravel and cobble necessary for successful salmonid spawning (Pasternack 2010a). Further downstream in the first alluvial reach downstream of Englebright Dam (Timbuctoo Bend Reach), sediment evacuated from the reach at a rate of 86,500 yd^3 per year from 1999 to 2006 (Pasternack 2008). Thus it appears that sediment is exported from reaches downstream of Englebright Dam at a rate similar to what the annual coarse sediment input is to Englebright Dam.

In the Gravel Augmentation Implementation Plan (GAIP, Pasternack 2010a) the estimated gravel deficit in the Englebright Dam Reach (from approximately the Narrows 2 tailrace to the confluence with Deer Creek) ranges from 63,077 to 100,923 short tons. These estimates are based on a simplified approach of assuming a range of 50 percent to 80 percent of the reach is suitable for gravel storage (*e.g.*, or assuming it will become similar to riffle habitat units) and the wetted areas and depths are based on 2D model runs at 855 cfs. Pasternack (2009) estimated that the gravel augmentation rate to make up the gravel deficit and sustain alluvial deposits at flow obstructions in the EDR would need to be 13,000 to 26,000 yd^3 per year, with the higher estimate dependent on Sinoro Bar restoration activities and how much gravel was placed at Sinoro Bar at the time of restoration.

The channel bed within the Englebright Dam Reach is covered by a veneer of “shot-rock” or irregular-shaped angular cobbles and boulders blasted from surrounding hillsides. The shot rock was generated and spread by rock excavation during the construction of Englebright Dam and hillside scouring during major floods (Pasternack 2010b). Recently, large floods in 1997 and

2005 generated additional angular hillside debris from the vicinity of Englebright Dam and deposited it on top of the mining alluvium in the downstream canyon and specifically on Sinoro Bar (Pasternack 2010b). In addition, historic mining activities within the EDR have reworked alluvial deposits, further depleting gravel resources and creating unnatural channel forms including mining pits. Collectively, these impacts have produced in the EDR and upper portions of the Narrows Reach (includes the downstream end of Sinoro Bar and about 1,000 ft further downstream), a channel morphology that has an armored bed and depositional surfaces that are armored with angular shot-rock that have become perched (elevated above the normal water surface) as the channel incises. This decreases the area where spawning gravel can deposit and decreases the useable area for fish to spawn. This has also lead to increases in water velocities from channel constriction that can be detrimental to salmonid spawning, holding, and rearing habitat. In addition, Englebright Dam impedes and reduces the frequency of LWM delivered and deposited in the reach, which further decreases gravel retention and channel complexity.

Due to these impacts to channel morphology within the EDR and to the two morphologic units immediately downstream of Deer Creek, a channel restoration program should be developed and implemented to coincide with the gravel augmentation program. The channel restoration should include: (1) removing angular shot rock from existing depositional surfaces; (2) recontouring these surfaces to a configuration and elevation that allow for proper function (*i.e.*, regular flow inundation and gravel deposition and scour) and decreases flow constriction; and (3) installing roughness elements such as LWD and boulders to increase gravel retention and channel complexity. As part of the channel restoration program active sources of angular, shot-rock in the vicinity of Englebright Dam should be stabilized. Adding large wood and/or boulders to create local flow obstructions that help retain gravel and add hydraulic complexity to a reach, when implemented in concert with a gravel augmentation program can greatly enhance or rehabilitate morphologic units, create sub-unit hydraulic complexity, and increase the effectiveness of gravel augmentation (Pasternack 2010a).

5. Predator Control

Removal of predators at the South Yuba/Brophy Diversion rock weir and return channel, Hallwood-Cordua Diversion canal, Hallwood-Cordua fish return pipe, Daguerre Point Dam face and fish ladders, and the Browns Valley Diversion channel is likely to reduce predation at these structures by between 90 and 95 percent. This reduction in predation could allow for survivorship of up to 250,000 outmigrating spring-run Chinook and Central Valley steelhead annually

6. Salmonid Monitoring and Adaptive Management

The migration timing and abundance of salmonids in the Yuba River is highly variable and not completely understood. Collection of data, and analysis of data related to salmonid timing, abundance, habitat usage, migration, and genetics is intended to provide the information necessary for making decisions about flow management, fish passage, predator management, and entrainment reduction.

7. Sturgeon Monitoring and Adaptive Management

Knowledge of sturgeon in the California Central Valley is not complete. Information about the distribution and behavior of sturgeon in the Yuba River, Feather River, and Sacramento River will aid in the development of future conservation measures for green sturgeon. Collection of data, and analysis of data related to green sturgeon timing, abundance, habitat usage, migration, and genetics is intended to provide the information necessary identifying factors critical to the wellbeing of green sturgeon, and for making decisions about flow management, and fish passage to address the impaired viability of green sturgeon.

F. Economic and Technical Feasibility of the RPA

Fish passage and other actions in the RPA have been implemented by the Corps and owners of a number of dams in Oregon and Washington states. For example, Mud Mountain Dam (WA) has had fish passage since it was constructed (1937-1948). The Corps is currently adding downstream fish passage at Howard Hanson Dam (WA). This effort was estimated in 2010 to cost over $349,000,000. This project is using Corps ESA funding, and Section 1135 funding (with a 13 percent overall local cost share). Green Peter Dam (OR) has a fish passage system and is being considered for modifications. The Corps' Columbia River dams, and Snake River dams in the states of Washington and Oregon all have extensive fish passage systems that have received extensive fish passage system upgrades over the last 20 years (*e.g.*, Bonneville Dam, The Dalles Dam, John Day Dam, McNary Dam). Based on actions since the 2007 biological opinion, the Corps appears to be reluctant to pursue funding to address environmental issues on the Yuba River.

In the 2009 final designation of green sturgeon critical habitat (74 FR 52300) the economic cost estimate for installing green sturgeon fish passage at Daguerre Point Dam was $351,000. This cost was calculated by attributing 20 percent of the expected costs for salmonids passage plans to green sturgeon critical habitat annualized over 20 years.

For Englebright Dam fish passage, costs were estimated in the Yuba River Fish Passage Conceptual Engineering Project Options (MWH Americas, Inc. 2010). Table XI-c summarizes a range of costs for a variety of fish passage alternatives for Englebright Dam. These costs are similar to the costs of fish passage at other dams.

Table XI-c. Probable costs for fish passage alternatives in 2009 dollars. This table shows the probable construction cost and the wide range in possible costs as suggested by the American Association of Civil Engineers International guidelines.

Alternative		OPCC	Wide Range	
		($Million)	-50 percent	+100 percent
Upstream	Englebright Fish Ladder	$50	$25	$100
	Englebright Tramway	$20	$10	$40
	Daguerre Point Dam Collection and transport	$8.2	$4.1	$16.4
Downstream	Englebright Fish Screens	$79	$40	$158
	Englebright FSC	$50	$25	$100
	Tributary Fish Screens:			
	North Yuba River	$60	$30	$120
	Middle Yuba River	$33	$17	$66
	South Yuba River	$55	$28	$110

Based on the existing economic analyses, the Corps should be able develop an economical and feasible solution to address fish passage at Englebright Dam and Daguerre Point Dam. Considering the fact that fish passage that has been developed at many other dams in North America, it is technically feasible to provide fish passage at the Corps' dams on the Yuba River.

XII. INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the ESA prohibits any taking of endangered species without a permit or 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 to include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). Protective regulations adopted pursuant to section 4(d) of the ESA extend the prohibition to threatened species. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity by a Federal agency or applicant (50 CFR 402.02). Under the terms of section 7(b)(4) and 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of the incidental take statement (ITS).

The reasonable and prudent measures described below are non-discretionary and must be implemented by the Corps, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered in this incidental take statement. If the Corps fails to comply with the terms and conditions of this incidental take statement, they may no longer be in compliance with the ESA. In order to monitor the impact of incidental take, the

Corps must report the progress of the action and its impact on each listed species to NMFS, as specified in this incidental take statement [50 CFR 402.14(i)(3)].

This ITS is applicable to all activities related to operations and maintenance of Englebright Dam and reservoir and Daguerre Point Dam, as described in the Corps' biological assessment and in this biological opinion as revised by the RPA in section XI, including applicable dams and reservoirs; water diversions; administration of contracts, permits and easements; implementation of habitat mitigation measures; operation of fish passage facilities; and research and monitoring activities.

A. Amount or Extent of Take

Incidental take of threatened spring-run Chinook salmon, threatened Central Valley steelhead, and threatened Southern DPS of green sturgeon will occur as a result of implementing the proposed action as modified by the RPA provided in section XI. It is anticipated that over the course of the Corps' continued operations and maintenance, decisions and actions will occur, that will affect the physical environment, regulatory environment, and our scientific understanding of the effects of the proposed action on listed species. The specific effects of the proposed action are expected to vary depending on the how the implementation of short and long term actions described in the RPA is accomplished. However, it is expected that some measurable level of take related to actions undertaken by the Corps that are associated with operations and maintenance of Daguerre Point and Englebright dams and their appurtenant facilities, will continue to affect several life stages of each ESU/DPS covered in this biological opinion.

The expected effects of the proposed action in the Yuba River will result in potential death, injury, or harm to the freshwater life stages of spring-run Chinook salmon, Central Valley steelhead, and/or the Southern DPS of North American green sturgeon in the Yuba and occasionally the lower Feather River downstream from the confluence with the Yuba River. These effects are the result of continued operation of the proposed action. Anticipated effects of the proposed action are expected to include: (1) blocked upstream migration of anadromous fish in the Yuba River at Daguerre and Englebright dams due to impaired, ineffective or lack of fish passage facilities, and the compression of spawning and rearing to reaches of the Yuba River downstream from project dams; (2) generally limited habitat availability of impaired quality (lack of LWD, in-channel riparian, and spawning substrate) for spring-run Chinook salmon, Central Valley steelhead, and Southern DPS green sturgeon on the currently accessible portion of the Yuba River; (3) continued hybridization, through competition for limited spawning space and straying, between Central Valley spring-run Chinook salmon and fall-run Chinook salmon related to the effects described above. These effects are anticipated to be reduced by adjustments made in the proposed action through the RPA. This Incidental Take Statement does not directly address flows related to the Lower Yuba River Accord or operations of Yuba River hydroelectric projects and/or agricultural water diversions, but requires the Corps to utilize their authorities, where applicable, to minimize flow related effects.

NMFS has identified timelines/horizons to the exemption of incidental take coverage and extension of exemptions of incidental take coverage, to ensure that anticipated incidental take are not exceeded or extended for activities may be exceeded: (1) if project activities exceed the criteria described above; (2) if the project is not implemented as described in the biological assessment prepared for this project; (3) or if the project is not implemented in compliance with the terms and conditions of this incidental take statement.

Due to the inherent variability in the biological characteristics of highly migratory aquatic species, including annual abundance and production, distribution, outside hatchery influences, and the mechanisms in which these characteristics overlay with the proposed action, it is not always possible to specifically quantify numbers of individuals that may be incidentally taken. Tables XII-a through XII-c, below, describe the amount or extent of take for each listed species by life history stage, stressor, and location within the action area. The following sections, organized by type of activity within the proposed action, specify an *amount* of take where possible (*i.e.*, collection of adults, monitoring programs, fish salvage estimates, unscreened diversions), but otherwise, specify a geographic and/or temporal *extent* of take. The tables also link take exemptions to performance of the proposed action. In other words, the period of time in which incidental take is exempted, depends upon the Corps ability to meet specified performance goals of the proposed action. If the performance goals are not met (*i.e.*, gravel augmentation plans are not developed or the implementation of such plans is not met as described in the RPA), then incidental take coverage will expire.

The specific amount or extent of take is often a professional estimate based on field studies and observations, fish production modeling, and surrogates of fish exposure and response to physical or biological attributes such as location, time of year, life stage and duration or exposure, analysis conducted in the effects of the action section of this biological opinion. In some cases where specific information on the amount or extent of take is not available (*i.e.*, entrainment, impingement or predation rates at the South Yuba/Brophy diversion), data from a similar stressor at another location (*i.e.*, entrainment data from Hallwood Cordua) is used as a basic metric for estimating the take. Another example is predation at Daguerre Point Dam. Specific predation rates are not available at Daguerre, so predation rates from RBDD prior to gate management improvements were applied with the assumption that they are similar. Also, absent predation rates specific to green sturgeon, we applied the salmonid predation rates from RBDD. When it is not possible to estimate take using the number of fish or percent of a population, measurable ecological surrogates were used.

Additionally, the RPA modifies the proposed action and, although the purpose of the RPA is to increase the abundance, distribution and viability of the species discussed in this biological opinion, there are associated effects to fish that meet the regulatory definition for take, and are thus addressed in this ITS.

Table XII-a. Summary of incidental take of Central Valley spring-run Chinook salmon.

Life Stage	Stressor	Type of Incidental Take CV Spring-run Chinook salmon	Amount or Extent of Take (Take Exemption)
Adult Migration and Holding	Daguerre Point Dam and associated fish ladders	Wounded: Individuals that are wounded by debris in the fish ladder, jumping into fish ladder grates or onto the concrete dam apron. Death: Adult fish jumping out of the lower uncovered bays of the fish ladders.	Up to 2 fish wounded, 1 fish killed, between February and June, through 2018 when fish passage improvements are approved by NMFS and implemented pursuant to the RPA. Once a Daguerre Point Dam fish passage modification is approved by NMFS, the take exemption will be extended until construction of the modification is complete. Upon completion of the modification, the project design and operational performance plans will be reviewed by NMFS and take exemption will be extended to January 31, 2020 as necessary (*i.e.*, not necessary if dam is removed).
	Englebright Dam and associated hydroelectric Facilities	Harm: Adult fish attempting to migrate upstream at Englebright Dam Hydroelectric Facilities. This significantly impairs normal migration behavior and prevents fish from reaching upstream migration corridors, spawning habitat and rearing habitat.	Up to 100 adult fish per year at Narrows II tailrace from February to August though year 2016. Once NMFS-approved assisted fish passage is implemented as described in the RPA, the exemption will be extended through January 31, 2020.

Life Stage	Stressor	Type of Incidental Take CV Spring-run Chinook salmon	Amount or Extent of Take (Take Exemption)
Spawning And Egg Incubation	Limited spawning habitat available downstream from Englebright Dam Includes bedload and spawning gravel depletion, habitat compression and forced relocation of spawning adults downstream from Englebright Dam	Harm: Limited spawning habitat availability and reproductive failure downstream from Englebright Dam that significantly contributes to a reduction of available spawning habitat (reduces population abundance) and increased levels of redd superimposition (results in the death of incubating CV spring-run Chinook salmon eggs)	The annual number of adult fish that are affected by spawning gravel depletion and superimposition per year through the first seven years of the gravel augmentation action in the RPA. The physical indicator of take during this period is associated with the difference between the total spawning gravel depletion in the reach (60,000 – 100,00 tons) and the amount of gravel required in the RPA (15,000 tons per year) The exemption will be reviewed and extended by NMFS on an annual basis depending based on performance of RPA (i.e., placement of required gravel amounts). Once NMFS-approved assisted fish passage is implemented as described in the RPA, the exemption will be extended through January 31, 2020 as necessary.

Life Stage	**Stressor**	**Type of Incidental Take CV Spring-run Chinook salmon**	**Amount or Extent of Take (Take Exemption)**
	Limited spawning habitat available downstream from Englebright Dam Hybridization with fall-run Chinook salmon and hatchery Chinook salmon	Harm: Limited spawning habitat availability downstream from Englebright Dam also significantly contributes to increased levels of hybridization with fall-run Chinook salmon and Feather River hatchery salmon, which injures individuals by reducing their reproductive fitness and fecundity	91 percent of spawning adults in all years and water year types from Englebright dam downstream to Deer Creek, from September through November until 2018 when the NMFS-approved assisted fish passage is in place and implemented as implemented as described in the RPA. Once a NMFS-approved assisted fish passage is implemented as described in the RPA, the exemption will be extended through December 31, 2020.
Juvenile rearing and downstream migration	Water Diversions from the Yuba River associated with Daguerre Point Dam *Unscreened Diversion at South Brophy*	Injury and Death: Entrainment Impingement Predation	During water diversion operations through 2018 upon the installation of NMFS and CDFG approved fish screen. Once the screens are in place, NMFS will review the take exemption and extend as necessary.
	Predation associated with Daguerre Point Dam	Death: Individuals are eaten and killed by predatory fish downstream from Daguerre Point Dam	Year round at the plunge pool downstream from Daguerre Point Dam through November 1, 2012. Up to 55 percent of individuals are expected to be killed through November 1, 2012. Upon NMFS-approval and Corps implementation of a predator reduction and monitoring plan on November 1, 2012, NMFS will review and modify the take exemption as necessary.

Table XII-b. Summary of incidental take of California Central Valley steelhead.

Life Stage	Stressor	Type of incidental take CV Steelhead	Amount or Extent of Take (Take Exemption)
Adult Migration	Daguerre Point Dam and associated fish ladders	Wounded: Individuals that are wounded by jumping into fish ladder grates or onto the concrete dam apron Death: Adult fish jumping out of the lower 8 bays of the fish ladder where no grates are present	Up to 2 fish wounded, 1 fish killed, through 2018 when fish passage improvements are approved by NMFS and implemented pursuant to the RPA, upon which time NMFS will review and amend the take exemptions as necessary. Once a NMFS approved passage modification is in place at Daguerre Point Dam, the take exemption will be reviewed, and extended through December 31, 2020.
	Englebright Dam and associated hydroelectric Facilities	Harm: Adult fish attempting to migrate upstream at Englebright Dam Hydroelectric Facilities. This significantly impairs normal migration behavior and prevents fish from reaching upstream migration corridors, spawning habitat and rearing habitat.	Up to 100 adult fish at Narrows II from February to June though year 2016. Once NMFS-approved assisted fish passage is implemented as described in the RPA, the exemption will be extended through January 31, 2020.

Life Stage	**Stressor**	**Type of incidental take CV Steelhead**	**Amount or Extent of Take (Take Exemption)**
Spawning And Egg Incubation	Limited spawning habitat available downstream from Englebright Dam Includes bedload and spawning gravel depletion, habitat compression from forced relocation of spawning adults downstream from Englebright Dam	Harm: Limited spawning habitat availability downstream from Englebright Dam that significantly contributes to a reduction of available spawning habitat (reduces population abundance) and increased levels of redd superimposition (results in the death of incubating CV steelhead)	Steelhead in the Yuba River downstream from Englebright Dam affected by spawning gravel depletion and superimposition per year through the first seven years of the gravel augmentation action in the RPA. The physical indicator of take during this period is associated with the difference between the total spawning gravel depletion in the reach (60,000 – 100,00 tons) and the amount of gravel required in the RPA (15,000 tons per year) The exemption will be reviewed and extended by NMFS on an annual basis depending based on performance of RPA (i.e., placement of required gravel amounts). Once NMFS-approved assisted fish passage is implemented as described in the RPA, the exemption will be extended through January 31, 2020, as necessary.

Life Stage	**Stressor**	**Type of incidental take CV Steelhead**	**Amount or Extent of Take (Take Exemption)**
	Limited spawning habitat available downstream from Englebright Dam Includes bedload and spawning gravel depletion, habitat compression from presence of Englebright Dam (forced relocation of spawning adults downstream from dam)	Limited spawning habitat availability downstream from Englebright Dam also significantly contributes to increased levels of hybridization with Feather River hatchery steelhead, which injures individuals by reducing their reproductive fitness and fecundity	All spawning adults in all years and water year types from Englebright dam downstream to Deer Creek, from September through November until 2018 when the NMFS-approved assisted fish passage is in place and implemented as implemented as described in the RPA. Once a NMFS-approved assisted fish passage is implemented as described in the RPA, the exemption will be extended through December 31, 2020.
Juvenile rearing and downstream migration	Water Diversions from the Yuba River associated with Daguerre Point Dam *Unscreened Diversion at South Brophy*	Injury and Death: Entrainment Impingement Predation	Year-round during water diversion operations through 2018 upon the installation of NMFS and CDFG approved fish screen. Once the screens are in place, NMFS will review the take exemption and extend as necessary.
	Predation downstream from Daguerre Point Dam	Death: Individuals are eaten and killed by predatory fish at Daguerre Point Dam	Year round at the scour pool downstream from Daguerre Point Dam through November 1, 2012. Up to 55 percent of individuals are expected to be killed through November 2012. Upon NMFS-approval and Corps implementation of a predator reduction and monitoring plan on November 1, 2012, NMFS will extend the take exemption as necessary.

Table XII-c. Summary of incidental take of green sturgeon. The table is organized by life stage then by the number of populations affected by a particular stressor.

Life Stage	Stressor	Type of Incidental Take of Green Sturgeon	Amount or Extent of Take (Take Exemption)
Adult Migration	Blocked upstream passage at Daguerre Point Dam	Injury: Wounded individuals that leap onto the concrete dam apron of Daguerre Point Dam or unsuccessfully attempt to migrate through the fish ladders Harm: Access to historic upstream habitat is blocked by Daguerre Point Dam. Adult fish are not able to ascend the ladder or swim over the dam. This significantly impairs essential behaviors including upstream migration, and spawning	Annual between March and June through 2018 when fish passage improvements are approved by NMFS and implemented pursuant to the RPA, upon which time NMFS will review and amend the take exemptions as necessary.
Holding	Impacts to quantity and quality of holding habitat related to flow and habitat diversity and lack of preferred habitat in the lower Yuba River.	Harm: Degradation of holding habitat from flows that minimizes the holding habitat availability of post-spawned adults downstream from Daguerre Point Dam.	Annual between June and November downstream from Daguerre Point Dam, until 2015, when fish passage improvements described in the RPA are met. Upon NMFS approval of the fish passage improvement plan and its implementation, the take exemption will be reviewed and extended as necessary.

Life Stage	Stressor	Type of Incidental Take of Green Sturgeon	Amount or Extent of Take (Take Exemption)
Spawning	Impacts to quantity and quality of spawning habitat	Harm: Degradation of spawning habitat from flows that minimize the holding habitat availability of post-spawned adults downstream from Daguerre Point Dam.	Annual between March and June downstream from Daguerre Point Dam, until 2015, when fish passage improvements described in the RPA are met. Upon NMFS approval of the fish passage improvement plan and its implementation, the take exemption will be reviewed and extended as necessary
Juvenile rearing and downstream migration	Predation downstream from Daguerre Point Dam	Death: Individuals are eaten and killed by predatory fish downstream from Daguerre Point Dam.	Year round at the scour pool downstream from Daguerre Point Dam through November 1, 2012. Up to 55 percent of individuals are expected to be killed through November 2012. Upon NMFS-approval and Corps implementation of a predator reduction and monitoring plan on November 1, 2012, NMFS will extend the take exemption as necessary.

1. <u>Fish Passage Program</u>

The Fish Passage RPA action, requires the implementation of a Pilot Reintroduction Program, beginning in year 2014. Annual take levels for the program will be determined by the Interagency Fish Passage Steering Committee, provided that NMFS concurs in writing with the specific handling and transport procedures associated with the Fish Passage Pilot Plan. The Corps shall coordinate with NMFS and apply for an ESA section 10(a)(1)(A) research permit to cover the fish collection and transport activities and studies.

This ITS is not covering incidental take of spring-run Chinook salmon or Central Valley steelhead upstream of Englebright Dam. The Interagency Fish Passage Steering Committee shall convene and coordinate with affected parties to determine the best long-term approach to species regulatory status, and make recommendations to that effect. In addition, NMFS is not approving any incidental take coverage for the long-term fish passage actions.

B. Effect of Take

In this biological opinion, NMFS has determined that the anticipated level of incidental take associated with project operations, as modified by the RPA, is not likely to jeopardize the continued existence of spring-run Chinook salmon, Central Valley steelhead, or Southern DPS green sturgeon.

C. Reasonable and Prudent Measures

NMFS believes that the following reasonable and prudent measures are necessary and appropriate to minimize the effect of incidental take of spring-run Chinook salmon, Central Valley steelhead, of Southern DPS green sturgeon:

1. **Reduce entrainment and impingement of spring-run Chinook and Central Valley steelhead that results from the South Yuba/Brophy and the Hallwood-Cordua diversion licenses.**

   Objective: Reduce losses of ESA listed juvenile fish at project-related water diversions.

   Rational: The South Yuba/Brophy diversion does not meet screening criteria, nor has it been demonstrated to NMFS that the current structure prevents entrainment and impingement of ESA listed juvenile fish. On the contrary, the design of the existing structure would appear to be designed to attract and endanger ESA listed juvenile fish.

   The Corps issues a permit to the Cordua Irrigation District to install flashboards on Daguerre Point Dam during low flow periods. The flashboards modify the flow over the dam, so more flow is directed through the north fish ladder. The Hallwood-Cordua diversion is located directly adjacent to the north fish ladder

2. **Enhance migration success for spring-run Chinook and Central Valley steelhead at the Daguerre Point Dam fish ladder.**

   Objective: Improve upstream migration success for adult spring-run Chinook salmon and steelhead until implementation of the RPA.

   Rationale: Near-term fish passage impacts can be minimized through improved maintenance and management of existing fish ladders.

3. **Enhance juvenile rearing habitat for spring-run Chinook and Central Valley steelhead.**

   Objective: To minimize project effects on the quantity and quality of rearing habitat by improving the growth, survival and abundance of juvenile fish, by increasing cover, food, and geomorphic processes associated with instream woody material and riparian habitat.

   Rationale: The recruitment and movement of large woody material in the lower Yuba River has been interrupted since Englebright Dam was built in 1941. Other dams in the Yuba River watershed have contributed to the depletion of large woody material in the lower Yuba River. Large woody material has been shown to be heavily used by juvenile fish. Large complex woody material provides cover for fish, and food through the production of bugs. The cover provided to juvenile is from predators and from high velocity flows. Through these vectors large woody material can increase abundance and productivity of ESA listed fish species. Similarly, riparian vegetation is beneficial to salmonids through shade, cover, and food. The lower Yuba River is lacking in riparian and in channel vegetation. Providing riparian and in channel vegetation will benefit ESA list salmonids through providing cover from predators and high velocity flows, food through bug production that drops into the water, stabilizing and trapping fine sediments that can decrease egg survival, and providing a future source of large woody material.

4. **Minimize the adverse effects related to Waterway 13 on federally listed anadromous fish.**
   Objective: Exclude federally listed anadromous fish from gaining access to Waterway 13 in order to increase their survival in the Yuba River.

   Rationale: Waterway 13 falsely attracts adult fish into a dead end channel for migration and reproduction.

5. **Utilize Corps authorities to improve flow management for listed ESA fish species.**

Objective: To improve flow management for listed ESA fish species.

Rationale: Flows affect many life stages of ESA listed fish species in the Yuba and Feather rivers. Changes in flow management and stressors related to river flow can be reduced.

6. **Monitor the extent of incidental take of spring-run Chinook salmon, Central Valley steelhead and Southern DPS green sturgeon, associated with the proposed action report project implementation and associated incidental take to NMFS**.

   Objective: To monitor the implementation of the proposed action such that the Corps is able to track incidental take of listed fish in order to meet the reporting requirements of this biological opinion.

   Rationale: Current monitoring actions are not sufficient to evaluate project effects such the amount of incidental take is easily quantified.

D. Terms and Conditions

1. **In order to reduce entrainment and impingement of spring-run Chinook and Central Valley steelhead that results from the South Yuba/Brophy and Hallwood-Cordua diversion licenses, the Corps shall ensure implementation of the following**:

   <u>South Yuba/Brophy Diversion</u>

   a. The Corps shall provide NMFS with a draft of the easement for review and approval prior to issuance of the easement. The easement shall include requirements for

      i. Review and approval of the fish screen design by NMFS and CDFG.

ii. Completion of the new fish screens by the end of June 2018.

iii. Development of a plan to monitor and reduce predation associated the diversion, and in the areas upstream and downstream associated with the diversion.

South Yuba/Brophy Diversion

a. If juvenile fish mortality is greater than 10 percent in the vicinity of the diversion, consultation reinitiation of this biological opinion is required.

b. If the new fish screens do not appear to be likely to be installed by the end of June 2018, the Corps shall provide NMFS a plan for review and approval for protecting fish in the vicinity of the diversion by January 18, 2018. The plan shall include an effective method for precluding fish entrainment, impingement, and address predation in the vicinity, and provide for monitoring for fish survival through the area.

Hallwood-Cordua Diversion

a. The Corps shall ensure that future permits issued for the flashboards shall include requirements for monitoring flows, fish survival through the Hallwood-Cordua diversion fish screens and fish return pipe, and for predation in the diversion and immediately downstream of the return pipe. The Corps shall provide the draft permit to NMFS for approval. In the event of no permit being issued, the Corps shall develop a plan for NMFS approval, for the Corps installation and monitoring of fish survival associated with the use of the flashboards. Lacking flashboards the Corps shall develop and implement a plan for monitoring the effectiveness of fish attraction to the north fish ladder during low flows.

2. **In order to reduce entrainment and impingement of spring-run Chinook and Central Valley steelhead that results from the South Yuba/Brophy and Hallwood-Cordua diversion licenses, the Corps shall ensure implementation of the following**:

a. The Corps shall cooperatively manage the VAKI Riverwatcher with CDFG, collecting data on spring-run Chinook and Central Valley steelhead migration to quantify Yuba River populations of these species.

b. The Corps shall extend the license for the VAKI Riverwatcher to cover the period from issuance of this opinion until a long-term contract is completed with YCWA for water diversion at Daguerre Point Dam and to cover the full period of the long-term contract with YCWA.

c. The Corps shall inspect the upstream channels leading to the fish ladders and Daguerre Point Dam annually. The inspections shall be conducted in May. If the inspections reveal that the channels are less than three feet deep, but still appear to be sufficiently functional for fish passage, then the Corps shall submit a dredging plan for NMFS and CDFG approval. Dredging of the channels shall be conducted between mid-July and mid-August of the year of inspection. If the inspections reveal significant sediment buildup that could prohibit access to the fish ladder entrances, then by June 1 of the same year the Corps shall provide to NMFS and CDFG a dredging plan for review and approval, to be implemented prior to mid-June.

d. The Corps shall conduct weekly inspections of the Daguerre Point Dam fish ladders for surface and subsurface debris and shall remove the debris within twelve hours, even if the Corps determines that flow levels are adequate for fish passage.

e. Corps shall routinely inspect the fish ladder gates to ensure that no third parties close them. Routine inspections shall occur at least weekly, and may be conducted under agreement with CDFG.

f. During flows of 4,200 cfs or greater, the Corps shall conduct daily manual inspections of the Daguerre Point Dam fish ladders. Upon discovering debris in the ladders, the Corps shall remove the debris within twelve hours, even if the Corps determines that flow levels are adequate for fish passage. If conditions do not allow for safe immediate removal of the debris, the Corps must remove the debris within twelve hours after flows have returned to safe levels.

g. The Corps shall ensure that the Daguerre Point Dam flashboards are inspected weekly and that they are cleared within 24 hours of finding a blockage, or as soon as it is safe to clear them.

h. The Corps shall ensure that the Daguerre Point Dam flashboards are adjusted, as needed, to increase attraction flows for spring-run Chinook and Central Valley steelhead.

i. The Corps shall ensure that long-term flashboard operations developed by the Corps includes the following:

   - Specific identification of the flow conditions in the lower Yuba River flow that will prompt the placement and removal of the flashboards.
   - A positive and firm commitment for monitoring the flashboards at least once a week to make sure that they have not collected debris that might contribute to juvenile fish mortality.
   - A positive and firm commitment for monitoring the effects of the flashboards on juvenile salmonids and the potential for direct mortality due to entrainment or concentrating juveniles in a manner that promotes predation
   - A positive and firm commitment that if the Corps does not renew the license to Cordua Irrigation District, then the Corps will assume responsibility for implementing the operations and maintenance activities addressing the placement, timing, configuration, and removal of the flashboards at Daguerre Point Dam that are described in the Flashboard Management Plan on a long-term basis.

j. The Corps shall adjust the plan for operation and maintenance of flashboards, as needed, based upon the information generated through monitoring efforts and through coordination with NMFS, CDFG, and USFWS.

k. The Corps shall inspect the upstream channels leading to the fish ladders and Daguerre Point Dam annually. The inspections shall be conducted in May. If the inspections reveal that the channels are less than three feet deep, but still appear to be sufficiently functional for fish passage, then the Corps shall submit a dredging plan for NMFS and CDFG approval. Dredging of the channels shall be conducted between mid-July and mid-August of the year of inspection. If the inspections reveal significant sediment buildup that could prohibit access to the fish ladder entrances, then by June 1 of the same year the Corps shall provide to NMFS and CDFG a dredging plan for review and approval, to be implemented prior to mid-June of that same year. Disposition of sediments dredged from the channels leading to the Daguerre Point Dam fish ladders shall conform with the direction provided by NMFS and CDFG.

l. The Corps shall inspect the channels upstream of the fish ladders at Daguerre Point Dam as soon as practicable following a “high flow event”. If the “high flow event” inspection reveals significant sediment buildup that risks impairing fish passage, the Corps shall dredge the channel in a manner that minimizes adverse impact risks to fish. The channel dredging shall occur as soon as it is safe to operate the dredging equipment.

3. **In order to enhance rearing conditions for spring-run Chinook and Central Valley steelhead, the Corps shall develop and implement a long term program to replenish instream woody material and restore riparian habitat in the lower Yuba River**:

Instream Woody Material

a. The Corps shall initiate a study to determine an effective method of replenishing the supply of large woody material back into the lower Yuba River. This shall be done in a manner that provides instream cover at a range of flow conditions that includes summer and fall low flow periods, invertebrate food sources, micro-habitat complexity created by instream woody material and trap spawning gravel where appropriate.

b. The plan developed by the Corps under this action will be provided to NMFS for approval, by June 1, 2012. The plan must include sources and types of wood, sizes of wood, amounts of wood, methods of placement, locations for placement, and frequency of large wood placement. The plan shall include the development of complex wood structures that contain multiple pieces. The geographic scope of the Large Wood Augmentation Program should include the entire length of the Lower Yuba River downstream of Englebright Dam, in any reach that is currently deficient of large wood loading and can be accessed for wood additions (including aerial access). The plan needs to address anchoring, large complex wood structures (jams), vertical placement of wood (pilings), ballast, and various methods of placement (including aerial).

c. The amount of wood to be place shall be based on deficit and estimated annual recruitment from the unaltered system Yuba River watershed.

d. The program described in this action shall commence placement of wood into the lower Yuba River in 2012. A minimum of 500 pieces 30-60 cm in diameter and a minimum of 730 cm long, and 30 pieces 60-90 cm in diameter and at least 730 cm long, and 10 pieces greater than 90 cm in diameter and 730 cm long shall be placed in 2012, and 2013. Woody material will include 10 percent of pieces that have rootwads attached, not more than 20 percent of the wood pieces can be orchard tree species, and at least 25 percent of the wood pieces must be placed in complex jam structures. This amount of large wood will continue to be placed in the lower Yuba River annually, until modified by NMFS.

e. Because movement of large amounts of large woody material is not necessarily an annual event, the Corps in developing a plan for placing large woody material into the lower Yuba River may address the amount of wood to be placed annually on a 3 year average basis. This means that wood placed in year one could be less than the annual amount, but that amount would need to be made up in years 2 and/or 3.

f. The wood that is placed under this action will be evaluated annually by the Corps to inform decisions about future placements.

g. Reporting shall include, at a minimum, the amount of wood placed, methodology for the wood placement, the location of the placements, types of wood used, anchoring methods, amount of ballast used, and movement of wood placed in previous years.

h. The draft annual plan shall be submitted to NMFS, for approval, by the first business day of February each year.

Riparian Vegetation

a. Corps shall develop and submit to NMFS for approval a plan for planting native riparian vegetation from downstream of Englebright Dam to the Feather River within one year of the date of issuance of this biological opinion. The plan shall address placement of riparian vegetation in the riparian zone and within the river channel. The plan shall reflect analysis of where, and what type of tree planting would be most effective in promoting the successful recruitment of riparian vegetation. Such analysis shall take into account the river’s existing geomorphologic process and expected changes in channel morphology. Riparian planting shall be designed to enhance habitat features while also encouraging natural channel migration, sediment erosion, and sediment deposition. The plan shall identify opportunities for riparian vegetation that take advantage of the placement of large woody material identified in this biological opinion. The plan shall identify the density of plantings and identify: (1) a minimum of 30 acres be planted annually downstream of the Highway 20 crossing of the lower Yuba River; and (2) five miles of shoreline to be planted annually upstream of the Highway 20 crossing. The plan shall also include monitoring for planting success, including animal damage. A report will be provided annual by March 1 of each year, following the first year of implementation. The plan shall be implemented within two years of issuance of this biological opinion.

4. **The Corps shall minimize the adverse effects related to Waterway 13 on federally listed anadromous fish:**

    a. The Corps shall take immediate corrective action to address potential biological concerns associated with Waterway 13 by August 15, 2012. The Corps shall retain oversight over all future maintenance activities that may become necessary if and when the fish barrier at Waterway 13 washes out again, including any repeats of earlier repairs.

5. **The Corps shall utilize their authorities to improve flow management for listed ESA fish species by taking the following actions:**

    a. The Corps shall take actions throughout the term of the biological opinion as the Corps oversees, implements, and issues permits, easements, licenses, or enters into agreements, or the Corps conditions such documents issued by others.

    b. The Corps shall include provisions in any such documents that are tied to a party whose activities influence flows in the Yuba River (e.g. hydropower, water diversions) to improve flow management for ESA listed fish species to the maximum extent of the Corps' legal authorities to do so. These conditions may alter the operations of such a party to provide beneficial flows for salmonids and green sturgeon. This shall include coordination with other water managers to provide flows that are beneficial to salmonids and green sturgeon in the Yuba River and Feather River.

    c. The Corps shall consult with NMFS, and obtain NMFS' approval, about the flow conditions to include in licenses, permits, easements, agreements, documents, or the Corps' conditioning of other documents, prior to finalizing those documents. Some of the documents for which the Corps shall include flow conditions shall be included are:

        - Easements and permits for the Narrows I and Narrows II hydropower projects;
        - The FERC licenses for the Narrows I and Narrows II hydropower projects (e.g. Federal Power Act section 4(e) terms.
        - Permits, easements, licenses, outgrants, or agreements, that are associated with water diversions.

6. **The Corps shall monitor the extent of incidental take of spring-run Chinook salmon, Central Valley steelhead and green sturgeon, associated with the proposed action and provide annual reports on project implementation and incidental take to NMFS**:

   a. Project implementation updates and reports required by these terms and conditions shall be submitted by January 1 of each year to:

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

XIII. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary measures that can be implemented by the action agency, or agencies, to further the preservation of ESA listed species and/or their habitat and may include the implementation of recovery actions, or the development of information or data bases.

1. The should coordinate closely with FERC and FERC applicants to align Corps and FERC actions with respect to initiating and completing ESA section 7(a)(1) consultations in the Yuba River watershed.

2. Corps should encourage license applicants to implement resource actions, including fish passage, which will benefit federally-listed species and their habitats to aid in their recovery.

3. The Corps should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects within the Feather River Basin, and the Lower Sacramento River system.

4. The Corps should ensure that any fish passage scenarios for Central Valley steelhead protect the genetic integrity of the *O. mykiss* on the North Yuba River.

5. The Corps should investigate other FERC-licensed projects that have measurable adverse impacts on water temperatures and river in the Lower Yuba and Feather River and propose corrective actions to minimize such effect, including developing actions to minimize salmonid stranding and redd dewatering associated with controlled, operational ramping and flow fluctuations.

6. The Corps should coordinate with agencies and operators in the Feather River, including FERC and DWR, to develop cooperative fishery conservation and management strategies, such as coordinating attraction and migration flows necessary to facilitate the upstream and downstream migration and survival of adult and juvenile salmon, steelhead, and green sturgeon.

7. The Corps should designate a hatchery liaison to collaborate with the DWR FRFH manager and NMFS to incorporate collect biometric and monitoring data, investigate research questions specific to FRFH hatchery programs, in coordination with fisheries management plans and fish passage strategies described in the RPA for the Yuba River.

8. The Corps should to fund restoration actions, consistent with Federal and State conservation strategies, including NMFS recovery Central Valley salmon and steelhead recovery planning.

9. The Corps should continue working with other Central Valley fish and habitat restoration and water planning projects such as the BDCD to develop partnerships that may facilitate the implementation of the RPA, especially regarding fish passage.

XIV. REINITIATION STATEMENT

This concludes formal consultation on the proposed action. 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 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.

The following are further examples of when a further ESA consultation is warranted.

1. The Corps should reinitiate formal consultation on the long-term effects of operation and maintenance of Englebright and Daguerre Point dams and Englebright Reservoir on the Yuba River by January 31, 2020, on spring-run Chinook salmon, Central Valley steelhead, and green sturgeon and their designated critical habitat in accordance with section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended. The reason for this is to integrate ESA consultation on FERC licensing and other collaborative fish passage planning efforts in the Yuba River watershed.

2. South Brophy Fish Screen: The Corps is proposing to screen the South Brophy diversion. Although this action is conceived in the Corps biological assessment, the details of the specific fish screen type and operations plan have not been developed and

thus the specific effects of fish screen construction and operation have not been analyzed in this biological opinion. We expect that the Corps, and their applicant(s) will coordinate with NMFS and the AFRP Fish Screen Program to as screen designs and configurations are developed.

3. FERC Hydropower Licenses and Agreements: Hydropower facilities that are located within and operated in tandem with the Project are subject to study and licensing processes under the FPA. FERC licenses are scheduled for renewal in 2016. The issuance of licenses and agreements by FERC and the Corps associated with the hydropower facilities affect Yuba River flows, federally-listed anadromous fish species and will be subject to separate ESA section 7 consultation.

4. When RPA performance goals (including scheduling, physical and biological) described are not met and the species are affected in a manner that was not analyzed in the this biological opinion and for which there is take that has not been exempted.

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