Current Design Alternatives	Stony Creek Alternative
Species	
Keck's checker-mallow,	No new species to add to overall analyses
palmate-bracted bird's beak,	
Conservancy fairy shrimp,	
vernal pool fairy shrimp,	
vernal pool tadpole shrimp,	
valley elderberry longhorn beetle	
California red-legged frog,	
giant garter snake	
western yellow-billed cuckoo.	
southern DPS of North American green sturgeon	
Sacramento River winter-run Chinook salmon	
Central Valley spring-run Chinook salmon, and	
California Central Valley steelhead.	
Critical Habitat	
Yellow-bill cuckoo	Vernal pool fairy shrimp (in vicinity)
Southern DPS of North American green sturgeon	
Sacramento River winter-run Chinook salmon	
Central Valley spring-run Chinook salmon	
Central Valley steelhead	

Listed fish species in Stony Creek -
https://archive.fisheries.noaa.gov/wcr/publications/recovery_planning/salmon_steelhead/domains/california_central_valley/appendix_a_watershed_profiles_7102014.pdf

- Central Valley spring-run Chinook salmon
- Central Valley steelhead

Identified stressors in Stony Creek for fish

- Passage impediments/barriers by Black Butte and North Diversion dams affecting
  - *Proposed removal of North Diversion is likely positive under eyes of NMFS/CDFW*
- immigrating adults
- Water temperature and/or water quality changes in Stony Creek affecting adult immigration and holding, juvenile rearing and outmigration, and embryo incubation

Sites

April 30, 2019

Mr. Russell Attebery, Chairman
Karuk Tribe, Administrative Office
64236 Second Avenue
Post Office Box 1016
Happy Camp, CA 96039

Subject: Sites Reservoir Project Draft EIR/EIS; Karuk Request for Recirculation

Dear Honorable Chairperson Attebery,

We are in receipt of your letter, dated March 6, 2019, requesting revision and recirculation of the Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS) for the Sites Reservoir Project (Project). We greatly appreciate the input from the Karuk Tribe and look forward to meeting with you and your representatives to better understand your concerns; especially related to the Trinity River and the 2000 Trinity Record of Decision. . The following is intended as an initial response to your letter.

The Project proposes the construction and operation of an approximately 1.8 million acre-foot off-stream storage reservoir and associated water management facilities near the town of Maxwell in Colusa and Glenn Counties in the Sacramento Valley in Northern California. The Sites Project Authority, as the California Environmental Quality Act (CEQA) State lead agency, and the Bureau of Reclamation (Reclamation), as the National Environmental Policy Act (NEPA) Federal lead agency, have prepared the Draft EIR/EIS to address the environmental effects of the Project, including the No-Action Alternative and four action alternatives. The Draft EIR/EIS was made available for a 154-day public review and comment period, from August 14, 2017 to January 15, 2018.

The Authority and Reclamation are currently in the process of preparing a Final EIR/EIS for the Project. The Final EIR/EIS will provide responses to all comment letters received during the public review period. Although your March 6, 2019, letter was received after the close of the public review period, all contents will be treated as comments on the Draft EIR/EIS and will be addressed in the Final EIR/EIS. Meanwhile, we offer the following initial responses to key concerns raised in your letter.

Recirculation of the Draft EIR/EIS

Section 15088.5(a) of the CEQA Guidelines provides guidance on when a lead agency is required to recirculate an EIR prior to certification

> (a) A lead agency is required to recirculate an EIR when significant new information is added to the EIR after public notice is given of the availability of the draft EIR for public review under Section 15087 but before certification.

Along with Reclamation, the Authority has reviewed of all comments received on the Draft EIR/EIS,

P.O. Box 517
Maxwell, CA 95955
530.438.2309

including your March 6, 2019 letter, and is preparing responses to those comments. At this time, our preliminary review has not identified any significant new information that would trigger recirculation. The Authority will continue our review of comments and expects to be finalizing the responses to comments and anticipates release of the Final EIR/EIS in the spring of 2020.

Trinity River Concerns

The Final EIR/EIS will have a master response to comments concerning the potential for the Project to impact the potentially affected rivers and their fisheries resources. The technical appendix (Appendix 6) will also be modified to update the analyses, correct errors and better explain the assumptions, contents, results and limitations of the analysis.

Your letter included a reference to an attached memorandum from Kamman Hydrologics. We did not receive the attachment and request that you send it at your earliest convenience so we can better respond to issues raised in the letter.

The Authority looks forward to meeting with you to further discuss the details of the Project. A meeting may help us better understand your concerns and meet the goals of this sustainable surface water management project. If you would like to schedule a meeting or have any questions, please contact me at (530) 410-8250 or in my absence, Rob Thomson at (805) 689-5854.

Sincerely,

Jim Watson
General Manager, Sites Project Authority

Cc: Joshua Saxon, Executive Director, Karuk Tribe
Don Bader, U.S. Bureau of Reclamation
Armando Quintero, Chairman, California Water Commission
Joe Yun, Executive Officer, California Water Commission
E. Joaquin Esquivel, Chairman, SWRCB
Eileen Sobeck, Executive Officer, SWRCB
Hoopa Valley Tribal Council
Yurok Tribal Council
Humboldt County Board of Supervisors
Trinity County Board of Supervisors
Fritz Durst, Board Chair, Sites Project Authority

BATCH 3 RTCs - Direction and/or Info Needs

MR 3 – Alternatives

1. Preferred project
2. Colusa Co Road Alignment
3. Fletcher design – still consistent with memo?
4. Need comparative table of effects, including 'Preferred Alternative'
5. Operational scenario(s) – need input from modeling team, CDFW outcome
6. Water transfers – clarify
7. Ecosystem enhancement storage account actions/ operations and OpFlex
8. Flood control benefits
9. Monitoring and governance
10. Confirm outline for Reservoir Management Plan

MR 4 – Environmental Analysis Process

1. % design at time of DEIR/EIS
2. MR needs to be revisited based on preferred alternative (is it D or B, modified?)
3. Confirm design refinements of preferred alternative (inc. Fletcher, Delevan, power, etc)
4. Need input from permitting re: process
5. Did Reclamation send FWCA letter to USFWS, will there be a report?
6. Describe/update state and federal ESA process
7. Hydropower assumptions
8. Needs 404/408 discussion and additional NEPA w/ USACE
9. SWRCB – water rights process, current assumption is FEIR/EIS will support water rights application

MR 6 – Hydrologic Modeling and Surface Water Resources (waiting to review in detail)

1. Needs to reflect current modeling efforts but also how it relates to prior DEIR/EIS

MR 8 – Fisheries and Aquatic Resources (waiting to review in detail)

1. Relies on BA –has BA effects analysis been reviewed against DEIR/EIS for red flags?
2. Confirm OpFlex w/ Reclamation
3. Confirm accurate based on CDFW process and currently proposed operational scenario(s)

MR 9 – Terrestrial Biological Resources

1. Needs to be consistent with CDFW discussions and draft BA

MR 12 – Hydropower and Economics

1. Needs AECOM input re: power generation
2. Reclamation needs to confirm economic analysis approach
3. Clarify renewables and market effects
4. Confirm Reclamation role and relationship to other projects

From: Herrin, Jeff [jeff.herrin@aecom.com]
Sent: 1/7/2020 12:31:59 PM
To: Spranza, John [John.Spranza@hdrinc.com]; Frederiksen, Lee E. [Lee.Frederiksen@hdrinc.com]
CC: laurie.warner.herson [laurie.warner.herson@phenixenv.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]
Subject: RE: Value Planning Alt Table update
Attachments: Alternative Matrix with Costs.docx

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Tuesday, January 07, 2020 11:32 AM
To: Frederiksen, Lee E. <Lee.Frederiksen@hdrinc.com>; Herrin, Jeff <jeff.herrin@aecom.com>
Cc: laurie.warner.herson <laurie.warner.herson@phenixenv.com>; aforsythe (aforsythe@sitesproject.org) <aforsythe@sitesproject.org>; Arsenijevic, Jelica <Jelica.Arsenijevic@hdrinc.com>
Subject: Value Planning Alt Table update

Lee and Jeff,
We are trying to pull together the high-level screening of the VP latest alternatives and I was wondering if there is an update to the table below that we can use. Thanks.

Features	Value Planning Alternatives								
	1	2	3	4a	4b	5a	5b	6a	6b
Cost ($billions)	$4.0B	$4.0B	$3.9B	$3.8B	$3.9B	$3.5B	$3.9B	$3.4B	$3.6B
Savings from 1.8 MAF Alternative D	$1.2B	$1.2B	$1.3B	$1.4B	$1.3B	$1.7B	$1.3B	$1.8B	$1.6B
1.5 MAF Reservoir	•	•	•	•	•	•	•	•	
1.3 MAF Reservoir									•
Funks/Sites PGP	•	•		•	•	•	•		
Replace Sites PGP with Two Smaller Plants			•					•	•
Delevan Canal/Pipeline Release	•	•	•	•	•				
Dunnigan Canal to CBD Release						•		•	
Dunnigan to River Release							•		•
Multi-Span Bridge	•		•	•	•	•	•	•	•
South Road to Lodoga		•							
South Road to Residents	•		•	•	•	•	•	•	•
Rockfill Embankment Dam	•	•	•			•	•		

Earthfill Dam				•				•	•
Hardfill Dam					•				

John Spranza, MS, CCN
Senior Ecologist / Regulatory Specialist

HDR
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833
D 916.679.8858 M 818.640.2487
john.spranza@hdrinc.com

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Features	Initial Alternatives										
	1	2	3	4a	4b	5a	5b	6a	6b	7	8
Cost ($billions)	4.0	4.0	3.9	3.8	3.9	3.5	3.9	3.4	3.6	3.2	TBD
1.5 MAF Reservoir	•	•	•	•	•	•	•	•			
1.3 MAF Reservoir									•		
1.0 MAF Reservoir										•	•
Funks/Sites PGP	•	•		•	•	•	•				
TCRR and Upgraded TRR PGP			•					•	•	•	
Funks and TRR PGPs direct to Sites											•
Delevan Canal/Pipeline Release	•	•	•	•	•						
Dunnigan Canal to CBD Release						•		•		•	•
Dunnigan to River Release							•		•		
Multi-Span Bridge	•		•	•	•	•	•	•	•	•	
Lower Bridge, Short Span											
South Road to Lodoga		•									•
South Road to Residents	•		•	•	•	•	•	•	•	•	•
Rockfill Embankment Dam	•	•	•			•	•				
Earthfill Dam				•				•	•	•	•
Hardfill Dam					•						

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 1/8/2020 11:16:47 AM
To: Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]; Alicia Forsythe [aforsythe@sitesproject.org]; laurie.warner.herson [laurie.warner.herson@phenixenv.com]
Subject: FW: Information on Stoney Creek
Attachments: final revised Stony Creek BO-GC edits- FINAL.pdf; FINAL RECOVERY PLAN 07_07_2014.pdf

FYI

John Spranza

D 916.679.8858 M 818.640.2487

From: Evan Sawyer - NOAA Federal [mailto:evan.sawyer@noaa.gov]
Sent: Monday, January 6, 2020 12:20 PM
To: Spranza, John <John.Spranza@hdrinc.com>
Cc: Cathy Marcinkevage - NOAA Federal <cathy.marcinkevage@noaa.gov>
Subject: Re: Information on Stoney Creek

Hi John,

I don't have a lot of information regarding Stoney (Stony) Creek but please find the 2008 BiOp on "Lower Stony Creek Water Management" where it was found that Reclamation and the Corps' operation and management of the Stony Creek watershed would not jeopardize NMFS spices or adversely modify their critical habitat (including operations under SWRCB permit #13776). I have also attached NMFS' 2014 Recovery Plan, where Stony Creek is identified as a "Core 3" population for both spring-run and steelhead Northwestern Diversity Groups. According to the Recovery Plan, Stony Creek is the lowest priority candidate for spring-run or steelhead reintroduction. Table 5-9 of the recovery plan, identifies specific recovery actions related to Stony Creek.

Let me know if I can be of further assistance.
Thanks,
Evan Sawyer

On Mon, Jan 6, 2020 at 11:08 AM Spranza, John <John.Spranza@hdrinc.com> wrote:

> Even,
>
> Thanks for taking the time to chat and let me know if you find anything.
>
> Regards,
>
> John.
>
> **John Spranza,**
>
> *Senior Ecologist / Regulatory Specialist*
>
> **HDR**
>
> 2379 Gateway Oaks Drive, Suite 200
> Sacramento, CA 95833
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--

Evan Bing Sawyer,
Natural Resource Management Specialist
NOAA Fisheries West Coast Region
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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

JUN 20 2008

In response refer to:
2007/08985

Mr. Brian Person
Area Manager
Bureau of Reclamation
Northern California Area Office
16349 Shasta Dam Blvd.
Shasta Lake, California 96019-8400

Colonel Chapman
District Engineer, Sacramento District
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Dear Mr. Person and Colonel Chapman:

Please find enclosed NOAA's National Marine Fisheries Service's (NMFS) final biological opinion concerning the effects of lower Stony Creek water management operations on the endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), the Central Valley steelhead (*O. mykiss*), and the designated critical habitats for Central Valley spring-run Chinook salmon and Central Valley steelhead.

The final biological opinion concludes that the proposed action is not likely to jeopardize the continued existence of the above-listed species, nor will it result in the adverse modification of their respective designated critical habitats. Because NMFS believes there is the likelihood of incidental take of listed species as a result of the proposed water management operations, an incidental take statement also is attached to the biological opinion. This take statement includes reasonable and prudent measures that NMFS believes are necessary and appropriate to avoid, minimize, or monitor project impacts. Terms and conditions to implement the reasonable and prudent measures are presented in the take statement and must be adhered to in order for take incidental to this project to be authorized.

We appreciate your continued cooperation in the conservation of listed species and their habitat, and look forward to working with you and your staff in the future. If you have any questions regarding this document, please contact Mr. Michael Tucker in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814. Mr. Tucker may be reached by telephone at (916) 930-3604 or by Fax at (916) 930-3629.

Sincerely,

Russell M Strach

for Rodney R. McInnis
Regional Administrator

cc: Copy to file: ARN151422SWR2000SA5904
NMFS-PRD, Long Beach, CA

Enclosure 1

BIOLOGICAL OPINION

Agencies: U.S. Bureau of Reclamation and U.S. Army Corps of Engineers

Activity: Lower Stony Creek Water Management

Consultation Conducted By: Southwest Region, NOAA's National Marine Fisheries Service (TN 2000/1910)

Date Issued: JUN 2 0 2008

I. CONSULTATION HISTORY

From March 2000 through March 2002, the U.S. Bureau of Reclamation (Reclamation) and the U.S. Army Corps of Engineers (Corps) conducted informal and eventually formal consultation with NOAA's National Marine Service (NMFS) concerning the two agencies' integrated water management operations on lower Stony Creek in Glenn and Tehama Counties, California.

On March 11, 2002, a final biological opinion (BO) was issued to Reclamation and the Corps by NMFS concerning these operations. An expiration date was established for the 2002 BO such that the total time period covered under that BO was not to exceed 3 years from the date of its issuance. The time limit was established because several important studies were underway which were expected to provide extensive new information on the environmental impacts associated with lower Stony Creek water management operations and the potential methods to address those impacts. The research work included a fisheries monitoring and habitat evaluation study on lower Stony Creek, a Northside Diversion Dam barrier analysis, a fish passage/water supply study at Red Bluff Diversion Dam (RBDD), a Stony Creek watershed water supply analysis, and two feasibility studies on the potential rehabilitation of the Orland Project distribution system. Aside from the fish passage/water supply study at Red Bluff Diversion Dam, which has been postponed indefinitely, all of these studies and analyses have now been completed.

In a letter dated February 28, 2005, Reclamation requested reinitiation of formal consultation on the integrated water management operations conducted by Reclamation and the Corps on lower Stony Creek. In a subsequent letter dated March 9, 2005, Reclamation requested that the time period covered by the 2002 BO be extended until the new consultation and BO could be completed.

NMFS replied to Reclamation's February 28, 2005, letter on April 5, 2005, stating that additional information concerning the proposed operations' impacts on listed species and critical habitat would be required prior to reinitiation of formal consultation. In a

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subsequent letter dated April 11, 2005, NMFS replied to Reclamation's March 9, 2005, request for a time extension on the 2002 BO with an amendment extending the BO through March 11, 2006.

Reclamation provided additional information on the project, and in a letter dated August 5, 2005, again requested reinitiation of formal consultation. Since that time additional information on the current project description has been requested by NMFS and provided by Reclamation and the Corps, with the most recent submission provided via e-mail on February 15, 2006.

In a letter dated March 9, 2006, NMFS confirmed that all information necessary to complete an updated, comprehensive analysis of the effects of the proposed project on listed salmonids had been received. In this letter, NMFS also extended the time period covered by the 2002 BO through May 30, 2006. A second letter, dated October 5, 2006, again extended the time period covered by the 2002 BO through January 31, 2007. A third letter, dated April 2, 2007, again extended the time period covered by the 2002 BO through November 30, 2007.

NMFS issued a final draft BO to Reclamation and the Corps on January 29, 2007. Comments and proposed edits were received back from Reclamation and the Corps over a period of several months, with the final comments received on January 31, 2008. NMFS responded to those comments and has now issued this final BO.

II. DESCRIPTION OF THE PROPOSED ACTION

Reclamation and the Corps are proposing to continue to manage the water resources of the Stony Creek watershed by controlling the release of flows from Black Butte Lake (in coordination with upstream reservoir operations) for the purposes of flood control, water delivery for agricultural use, recreation, and natural resource management.

A. Delineation and Description of the Action Area

The projects and specific facilities associated with Stony Creek water management operations include the Orland Project (East Park Dam and Reservoir; Stony Gorge Dam and Reservoir; Rainbow Diversion Dam and East Park Feeder Canal; South Diversion Intake and South Canal; and Northside Diversion Dam (NDD) and the North Canal), Black Butte Project (Black Butte Dam, Lake and Powerplant), and the Central Valley Project (CVP) (Black Butte Lake storage; and the Tehama Colusa Canal (TCC) with associated Constant Head Orifice (CHO)).

The action area for this project includes the active stream channels and riparian corridors of Stony Creek and Little Stony Creek below Rainbow Diversion Dam and East Park Reservoir respectively. Although the listed salmonids addressed in this opinion have long been excluded from the upper watershed above Black Butte Dam, discretionary actions taken during standard operations of the impoundments and facilities in the upper

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watershed have direct impacts on the timing and magnitude of flows and other habitat conditions in the lower creek. These areas must be considered as part of the action area.

B. Facilities and Operations

1. Orland Project

The Orland Project was authorized by the Secretary of the Interior on October 5, 1907, to store water for irrigation purposes. The project incorporates parts of neighboring Glenn, Tehama, and Colusa Counties. Although not officially authorized by the project, additional beneficial uses include recreation and fish and wildlife habitat enhancement. The main facilities of the Orland Project include East Park Dam and Reservoir (51,000 acre-feet storage capacity); Stony Gorge Dam and Reservoir (50,300 acre-feet storage capacity); Rainbow Diversion Dam/East Park Feeder Canal; South Diversion Intake/South Canal; and NDD/North Canal. The South and Northside Diversions supply water to almost 17 miles of canals and 139 miles of smaller lateral ditches.

a. *East Park Dam*

East Park Dam is located on Little Stony Creek in Colusa County approximately 2 miles from the confluence with Stony Creek at creek mile (CM) 62. East Park Reservoir extends 2.25 miles up Little Stony Creek and 4.5 miles up Indian Creek. Runoff from Little Stony Creek watershed provides water to the reservoir. East Park Reservoir also receives inflows from the East Park Feeder Canal which diverts water from Stony Creek at the Rainbow Diversion Dam (approximately CM 65). The East Park Feeder Canal is 7 miles long and has a design capacity of 300 cubic feet per second (cfs). The canal provides water from the main stem of Stony Creek into East Park Reservoir. Releases and spills from East Park Reservoir flow down Stony Creek 18 miles for re-storage in Stony Gorge Reservoir.

The Orland Unit Water Users Association (OUWUA) proposes to operate the East Park Dam based on demand according to the following standard operational procedures. Storage in East Park Reservoir will be maintained as close to the maximum level as possible and water levels will be kept stable until at least June 1 of each year, unless irrigation demands necessitate releases. When necessary, East Park Reservoir storage will be released for irrigation to the minimum storage of 5,000 acre-feet. In the last 16 years (1991 through 2006), East Park Reservoir has been maintained close to the maximum storage for 13 of 16 years and has consistently re-filled in the winter/spring following the draw-down years. The 1964 Exchange Agreement allows Orland Project water held in East Park Reservoir to be exchanged with CVP water stored in Black Butte Lake; releases of Orland Project water are then made from Black Butte Lake storage instead of from East Park Reservoir.

OUWUA proposes to operate the Rainbow Diversion Dam and the East Park Feeder Canal on an as-needed basis to provide supplemental water to East Park Reservoir.

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b. *Stony Gorge Dam/Reservoir*

Stony Gorge Dam is located on Stony Creek at CM 46 in Glenn County. It regulates flows along the middle reaches of Stony Creek and stores surplus water for irrigation purposes. Releases from the reservoir travel 22 to 26 miles down Stony Creek to the Orland Project's diversion points at Black Butte Dam (South Diversion Intake/South Canal) and NDD/North Canal, respectively.

OUWUA proposes to operate the Stony Gorge Dam based on demand according to the following standard operational procedures. Winter storage at Stony Gorge is restricted to 38,311 acre-feet (10 feet below the full storage capacity) in order to provide a buffer to prevent overtopping of the dam during high flow events. Operating procedures state that Stony Gorge Reservoir has no flood storage and is therefore operated to pass all high flows above the maximum winter elevation of 831 feet. Spilling above the 831-foot level continues until approximately the end of February depending upon the long-range forecast. Storage in Stony Gorge Reservoir will be maintained as close to the maximum allowable storage level as possible, unless irrigation demands necessitate releases. When necessary, Stony Gorge Reservoir storage can be released for irrigation to the minimum storage of 7,500 acre-feet. The 1964 Exchange Agreement allows Orland Project water held in Stony Gorge Reservoir to be exchanged with CVP water stored in Black Butte Lake; releases of Orland Project water are then made from Black Butte Lake storage instead of from Stony Gorge. Water left in Stony Gorge Reservoir early in the season is available for releases into lower Stony Creek later in the summer or early fall.

c. *South Diversion Intake and South Canal*

The South Diversion Intake and South Canal were built in conjunction with Black Butte Dam in 1963. Water from Black Butte Dam is released into an afterbay before it is either diverted into the South Diversion Intake structure or allowed to flow downstream into lower Stony Creek. The South Diversion Intake is located approximately 300 yards downstream of Black Butte Dam and at the southern end of the 5- to 10-acre afterbay. The water flows by gravity from the afterbay into the headworks of the South Canal. Orland Project water can originate from several sources including: (1) water released from storage directly from East Park or Stony Gorge Reservoirs, (2) water stored in East Park or Stony Gorge Reservoirs that is exchanged with CVP water stored in Black Butte Lake, or (3) water resulting from available natural inflows.

The maximum design capacity of the South Canal inlet structure is 530 cfs; however, the maximum operating capacity is 250 cfs between Black Butte Dam and Interstate 5 (I-5). Below I-5, the capacity is reduced to 200 cfs, and further reduced to 80 cfs in Lateral 40.

OUWUA proposes to operate the South Diversion Intake and South Canal based on demand for the life of the Orland Project according to the following standard operational procedures. Diversions typically will occur from March through November. Year-round operation may occur depending on water demands and weather patterns. In conjunction with the terms of the Exchange Agreement, diversions into the South Diversion Canal

may result in reductions of Black Butte Lake storage, reducing the amount of water available for release down lower Stony Creek.

d. *Northside Diversion Dam and North Canal*

NDD and North Canal were completed in 1913 and are located on lower Stony Creek approximately four miles below Black Butte Dam. NDD consists of a low concrete weir rising approximately 10 feet above the base streambed level, on top of which metal jacks and wooden flashboards are installed to impound water during the irrigation season. The weir is 375 feet long, trapezoidal, and situated on a clay base. There is an associated concrete apron on the downstream side of the weir that is approximately 20 feet wide along the entire length of the weir. The north end of the diversion dam structure contains a 36-foot-long sluiceway which contains a 12-foot-long by 6-foot-wide, electronically operated drum gate that allows water to be bypassed downstream during diversions into the North Canal. The North Canal headworks is also located on the north side of the dam and is approximately 10 feet wide with two mechanically operated metal gates placed within a concrete frame. The North Canal intake has a maximum design capacity of 150 cfs, however the maximum operating capacity is 130 cfs.

When the flashboards are placed into the diversion dam structure, water from lower Stony Creek is diverted into the North Canal headworks up to a maximum of 130 cfs with an associated minimum bypass of 30 cfs. When water is no longer needed for irrigation or when flood control criteria are triggered, the flashboards are removed to allow Black Butte Lake releases to flow downstream unimpeded. Typically, flashboards are installed in the spring and removed in the fall. However, flashboards may be installed and removed several times during the year due to major flood control releases (*e.g.*, boards were installed/removed three times in the spring of 1998 with the heavy rainfall and flows). If Black Butte Lake is in flood control stage during the irrigation season, the OUWUA is notified by Reclamation prior to major releases (>1500 cfs) and the flashboards are removed to prevent damage to the dam structure. The boards are re-installed after flood releases subside if there is continued demand for irrigation water. If the irrigation demand is 35 cfs or less, diversion can occur without installing the boards. It typically takes 4 to 5 hours to install and remove the flashboards. During placement and removal, flows in the creek must be limited to a maximum of 30 cfs for approximately 24 hours for workers to safely access flashboards.

During diversions into the North Canal, an operational bypass of 30 cfs flows into lower Stony Creek by informal agreement between Reclamation, the California Department of Fish and Game (DFG) and the OUWUA. The Orland Project is entitled to natural flow not to exceed 279 cfs (or 553 acre-feet per day) which is typically taken first if available, plus a maximum of 102,000 acre-feet per year of storage water, if available.

Reclamation retains ownership of the Orland Project facilities, however the facilities have been operated since 1954 by the OUWUA under contract #14-06-200-3502 dated August 26, 1954.

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e. *Exchange Agreement*

An Exchange Agreement (contract #14-06-200-1020A) was implemented between Reclamation and the OUWUA in 1964. This agreement allows the exchange of CVP water stored in Black Butte Lake with Orland Project water stored in Stony Gorge and East Park Reservoirs. As a result of the 1964 Exchange Agreement minimum reservoir storage was established for East Park (5,000 acre-feet to protect the fisheries), Stony Gorge Reservoir (5,000 acre-feet, subsequently amended to 7,500 acre-feet, to protect the fisheries and provide municipal water supplies to Elk Creek and water users along Stony Creek), and Black Butte Lake (20,000 acre-feet to protect the fisheries). A recent update to the Area and Capacity Table for Black Butte Lake (September 2001), showed that storage capacity behind Black Butte Dam has been lost to sedimentation. Consequently, the interim water control diagram indicates that in the event maximum storage behind Black Butte Dam is necessary, between 15 December and 5 April the minimum reservoir storage will be zero; not 20,000 acre-feet. East Park Reservoir is the most difficult of the three Stony Creek reservoirs to fill, and carryover storage left in East Park Reservoir at the end of the irrigation season normally is retained.

f. *Memorandum of Understanding (MOU)*

In 1971, Reclamation, the Corps, DFG and OUWUA entered into an MOU and set forth a document entitled "General Operating Objectives for Stony Creek Reservoirs." The objective of the MOU is to provide stable water levels during a 3 week period in late spring for the maintenance of crappie (*Pomoxis* spp.) spawning habitat in Stony Gorge Reservoir (odd years) and Black Butte Lake (even years). The guidelines state that when water surface temperatures reach 60 °F in the spring, all agencies will endeavor to limit reservoir elevation fluctuations to within plus or minus 2 feet for 3 weeks. In order to accomplish this, a water exchange is made with OUWUA to maintain the 2-foot criteria in Black Butte Lake. Under normal operating conditions, Stony Gorge Reservoir elevation in most years remains within the 2-foot criteria and requires minimal manipulation during the crappie spawning period. This MOU has subsequently been adopted and revised within the State Water Resource Control Board permit #13776 to state that the period for stable water levels be increased from 3 weeks to 4 to 5 weeks.

g. *Ongoing and Proposed Future Orland Project Operations*

OUWUA proposes to continue diversions into the North and South Canals based on water demands and to continue coordinating operations of East Park, Stony Gorge, and Black Butte Dams with Reclamation according to the 1964 Exchange Agreement and the 1971 MOU, with a minimum 30 cfs bypass below the North Canal during diversion activities. Diversions for the Orland Project typically will occur between March and November; however, diversions for irrigation purposes can occur in every month of the year, depending on weather patterns and demand. Based on past operations, annual diversions can be expected to range from 73,900 to 104,824 acre-feet per year although the only restrictions on amounts of irrigation water used are available natural flow not to

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exceed 279 cfs plus a maximum of 102,000 acre-feet per year of storage from the upper reservoirs, if available.

As described above, flashboards will be installed at NDD prior to diversion into the North Canal, and will be removed after irrigation demands no longer exist. If releases in excess of 1500 cfs are called for, Reclamation will notify the OUWUA and allow them the opportunity to remove the flashboards to protect the diversion structure, conditions permitting. For safety purposes, it is necessary to reduce flows from Black Butte Dam to 30 cfs for 24 hours during the removal of the boards. Once the boards are removed, the releases will commence. Once releases are no longer necessary, flashboards may be reinstalled if there are continued irrigation demands, requiring another 24-hour period of 30 cfs flows for reinstallation. However, it is recognized that given the uncertainty in forecasting hydrometeorological conditions, that rare instances may occur which do not allow for 24-hour notification prior to increasing releases from Black Butte Dam. In these instances the communication and coordination of releases will be increased.

2. Black Butte Project

The Corps retains ownership of the Black Butte Project facilities except for the Orland South Canal Diversion Intake. Black Butte Dam flood control operations are determined by the Corps. Reclamation determines irrigation releases during the irrigation season which typically occurs from March to November, but can occur during any month of the year. Operations of the facilities are coordinated between the Corps and Reclamation as established under P.L. 91-502 (1970). Although Black Butte Dam is owned by the Corps, authorizing legislation did not identify an agency responsible for maintaining the channel capacity of Stony Creek below Black Butte Dam.

The Corps' operations of Black Butte Dam and Lake are governed by the Stony Creek Water Control Manual which includes a Water Control Plan and a Flood Control Diagram for Black Butte Lake. These documents provide guidance on when and how to make flood control releases from Black Butte Dam. The Corps proposes to continue operating Black Butte Dam in accordance with the Water Control Plan and Flood Control Diagram as it has since 1963. The Corps is in the process of rewriting the Water Control Manual; the Water Control Plan and Flood Control Diagram are not being changed except to reformat as required by regulation to indicate the reduction in total storage that has occurred due to sedimentation and to reflect a shift in the Water Control Diagram forward 15 days (from September 1-June 15 to September 15-July 1). Corps inspections or maintenance of the outlet works or powerplant facilities will require some outlet gates to be closed, however, a minimum of 30 cfs flow will be maintained during these outages by keeping at least two gates open. Annual and 5-year inspections typically will occur during mid-November.

a. *Flood Control Diagram*

Since 1962 the Corps, Sacramento District, has operated the Black Butte Project for flood control in accordance with the Flood Control Diagram of the Water Control Manual.

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Flood control reservation in Black Butte Lake increases uniformly from 0 acre-feet on September 15 to a maximum reservation of 136,200 acre-feet (gross pool) by December 15. A minimum reservation of 106,400 acre-feet is required from November 25 to February 6, Conditional flood control reservation is up to a maximum of 136,200 acre-feet from December 15 to April 5, decreasing again to zero on June 30. The required reservation is determined by use of a ground wetness index during this period.

The maximum scheduled flood control release from Black Butte Dam is 15,000 cfs depending on a release schedule that correlates peak inflow for a specific event and the percentage of the flood control storage reserve in use. The controlled capacity through the outlet works is 22,800 cfs. The rated spillway capacity (uncontrolled weir) for the dam is 76,600 cfs. Flood control operations by the Corps begin when the storage in Black Butte Lake exceeds the flood control space required at any particular time as determined by the Flood Control Diagram.

According to the Flood Control Diagram, "required gross flood control reservation in Black Butte Lake may be reduced by creditable flood control space known to exist in East Park and Stony Gorge Reservoirs. The flood control requirement in Black Butte Lake is equal to the gross flood control reservation minus the total creditable transfer space."

b. *Operations Forecasting*

The California-Nevada River Forecast Center (CNRFC) provides the Corps with both 6-hour full natural flow forecasts for the Black Butte Project and 6-day Quantitative Precipitation Forecasts (QPF). Respectively, these forecasts extend 60 and 72 hours into the future. Even though the Corps' Water Control Plan does not currently require using forecasted data to operate the projects, these forecasts are used in Corps flood control models and to operate the Black Butte project. It is the Corps's intention to formally incorporate forecasting into the Water Control Plan in the near future.

c. *Reclamation Operations*

Reclamation directs Black Butte Project operations for water conservation storage and to supply water for irrigation during the non-flood control season. The only space allocation made in Black Butte Lake for CVP operations is a 20,000 acre-feet minimum pool storage for recreation and fisheries purposes. Any rainfall and natural inflows into Black Butte Lake that are in excess of what the Orland Project uses are stored as CVP water. Available CVP water has been defined by Reclamation as excess water during the non-flood period projected to be available for use based on storage as of June 1 of each year, accounting for required water rights. Factors of evaporative losses, minimum releases, minimum pools, and conditions of the permit are accounted for in the determination of available water. The average annual yield after all accounting is approximately 56,000 to 59,000 acre-feet.

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Reclamation proposes to continue water management of the three reservoirs in coordination with the OUWUA and the TCCA when the flood season is over, and to coordinate irrigation deliveries to the TCCA during the periods of April 1 through May 15 and September 15 through October 29 when water is needed, and if there is allowable storage of CVP water in the three reservoirs. Irrigation deliveries will not exceed 38,293 acre-feet annually according to the SWRCB permit #13776 issued April1, 1996. Reclamation will continue to coordinate irrigation deliveries with the OUWUA meeting Orland Project demands when water is available.

If Black Butte Lake is not encroached, Reclamation uses ramping rates of 30 percent per hour or 50 cfs, whichever is greater, to prevent overtopping when the lake is full and to provide water deliveries in a timely fashion.

104,657 acre-feet of water is needed to meet the exchange agreement requirements, maximum irrigation demands and current minimum instream flows below Black Butte Dam. This 104,657 acre-foot amount includes:
20,000 acre-feet of minimum pool in Black Butte Lake,
12,500 acre-feet of minimum pool in East Park and Stony Gorge reservoirs,
16,364 acre-feet of the 30 cfs minimum instream flow below Black Butte Dam from April-December,
15,715 evaporation losses from April-December,
1,785 acre-feet of additional 10 cfs minimum instream flow during rediversion below the TCC (90 days maximum), and
38,293 acre-feet of CVP water (maximum) to the TCCA for irrigation deliveries.

The Orland Project also maintains a right to divert up to 279 cfs of natural inflow into Black Butte Lake from the upper basin. These requirements in Black Butte Lake for water allocation and water exchanges can stay in effect in a dry year. Water indices such as the Sacramento Valley Water Year Hydrologic Index (based on carryover storage and rainfall in Shasta Lake) are useful but not reliable in forecasting conditions on Stony Creek and, because conditions change monthly, weekly and sometimes daily in the Stony Creek watershed, forecasting has not been used by Reclamation water managers. Factors such as late storms and high inflow after April 1 can drastically change allocations which are reassessed on a daily basis. Reclamation manages all water exchanges to maximize water conservation in the upstream reservoirs in preparation for potential future drought conditions. Should conditions occur such that more than 104,657 acre-feet are present, or expected to run off into Black Butte Lake on or after April 1, and the upstream reservoirs are full, Reclamation could release greater instream flows for fishery benefits so long as such releases do not affect the Orland Project's right to divert up to 279 cfs of daily inflow.

When basin conditions are dry and storage at Black Butte is low, operational options dictate using some or all of the upstream storage using the 1964 exchange agreement. Only 12, 500 AF would be exchanged for maintaining minimum pools in East Park (5,000 AF) and Stony Gorge (7,500 AF). East Park, being the most difficult to fill, would be the last to be used. Operations would use Stony Gorge storage first, drawing it

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down to 25,000 AF, and then drawing down East Park to 23,000 AF. If demands dictate, Stony Gorge would be drawn down to the minimum pool of 7,500 AF. If demands continue, East Park could be drawn down to the minimum pool of 5,000 AF.

d. *CVP Integration*

The Black Butte Project was financially and operationally integrated with the other storage features of the CVP in 1970 (P.L. 91-502, 84 Stat. 1097). As a result, Black Butte Lake now provides the maximum practicable amount of storage for conservation of irrigation water without impairment of the flood control functions. Water conserved in Black Butte Lake is authorized to be used for irrigation purposes and to meet such domestic, municipal, and industrial demands as may occur. The estimated conservation yield of Black Butte Lake was 59,000 acre-feet. On the average, it was estimated that 10,600 acre-feet of water would be made available for use in the watershed area above Black Butte Lake and an additional 48,600 acre-feet average annual yield would be available below the dam.

Releases are determined by the needs of the downstream water users during the irrigation season through Reclamation, and by flood control parameters during the flood control season through the Corps. The major downstream water users are the OUWUA authorized through the Orland Project and the CVP contractor districts served through the CVP facilities operated by the Tehama Colusa Canal Authority (TCCA).

e. *Tehama Colusa Canal/Constant Head Orifice*

The TCC was constructed as part of the CVP facilities in 1965 for the distribution of water diverted from the Sacramento River at RBDD. The TCC and the Corning Canal, which are integral parts of the TCCA canal system, both receive their primary water supply from RBDD, and are operated and maintained by the TCCA under a long term contract with Reclamation. The TCC extends from RBDD for 111 miles through Tehama, Glenn, and Colusa Counties with its terminus in Yolo County. The originating capacity of the TCC at RBDD is 2,530 cfs, reducing to 1,700 cfs at the downstream end.

The TCC, which intersects with lower Stony Creek approximately 30 miles below RBDD, siphons water under Stony Creek. At this crossing, the CHO was constructed in 1974 to divert water from the TCC into the creek for fishery enhancement purposes, but this diversion was discontinued in 1975 when a plan to restore Stony Creek's winter-run, fall-run and steelhead spawning habitat was abandoned due to the high cost of stream channel and gravel rehabilitation as well as problems such as land acquisition and access.

Since 1993, the CHO has been used in reverse to divert stored CVP water released from Black Butte Lake into the TCC when RBDD is not operating. Daily diversions at the CHO have averaged approximately 180 cfs when taken, between 1993 and 2000. Although never rated for a maximum capacity, the CHO diversions have at times been as high as 685 cfs. Rediversion operations involve the construction of a gravel berm upstream of the TCC/CHO to direct water into the canal. The berm

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construction/rediversion operations have been conducted under informal consultations with NMFS since 1993. Bypass culverts are installed to allow a minimum of 40 cfs down Stony Creek during rediversion, as required by the State Water Resources Control Board (SWRCB) permit. Reclamation proposes to continue annual rediversions of CVP stored water from Black Butte Lake, as described above, until a long-term solution to fish passage and water delivery limitations at RBDD is reached.

f. *State Water Resources Control Board Permit*

According to SWRCB permit #13776, the TCCA can only receive CVP water during the operation season of April 1 through May 15 and September 15 through October 29, for an annual maximum of 38,293 acre-feet. Other flow constraints include (1) maintaining a continuous bypass flow of not less than 40 cfs immediately downstream of the CHO when rediverting water, (2) ramping stream flows down at a rate of no more than 30 percent per hour or 50 cfs, whichever is greater, and (3) providing a fish distribution flow of not less than 100 cfs for a period of 24 hours prior to rediversion. The intended purpose of this distribution flow is to flush juvenile fish out of the area above the CHO so that they will not become entrained into the diversion.

g. *Coordinated Management*

In addition to the operating objectives of the 1971 MOU between Reclamation, the Corps, OUWUA and DFG, and the 1964 Exchange Agreement between Reclamation and the OUWUA for water transfer between East Park, Stony Gorge, and Black Butte Lakes, Reclamation manages water releases from Black Butte Lake cooperatively with the Corps when releases are needed during the flood control season. Reclamation's Willows office and the Corps' water management staff communicate daily during the flood control season regarding inflows, predicted precipitation, storage, demand, and other operation issues. When Black Butte Lake water is no longer released for flood control, any water remaining in the lake is considered CVP water.

h. *Miscellaneous Diversions in the Upper Watershed*

In 2005 Reclamation executed the renewal of five binding agreement water contracts in the Black Butte Unit of the Sacramento River Division and entered into Section 7 consultation for the long-term (40 year) renewal. The water contractors were: Stony Creek Water District for a diversion of 2,920 acre-feet, Stonyford for a diversion of 40 acre-feet, Whitney Construction for a diversion of 25 acre-feet, 4-E Water District for a diversion of 20 acre-feet, and the U.S. Forest Service for a diversion of 55 acre-feet, for a the total amount of 3,060 acre-feet of water. The contracts expire in 2010, 2020, or 2024. Reclamation initiated consultation on the effects of renewal of these contracts with NMFS on April 16, 2004. In a letter dated January 10, 2005, NMFS provided a determination that the effects of these contract renewals were analyzed and covered under previous biological opinions. A February, 2005 memorandum from the U.S. Fish and Wildlife Service provided a "not likely to adversely affect listed species or critical habitat" determination.

The Elk Creek Community Services District, another diverter on upper Stony Creek, chose not to enter into a Binding Agreement with Reclamation pursuant to §3404(c)(3) of the CVPIA, and therefore did not participate in the 2005 long-term water service contract renewal process. The District's existing long-term water service contract expires on August 20, 2007. The Region is unable to execute a long-term renewal contract (LTRC) pursuant to §3404(c) of the Central Valley Project Improvement Act (Title XXXIV PL102-575, 106 Stat. 4706) (CVPIA) with the District until the U.S. Fish & Wildlife Service and NOAA Fisheries complete Section 7 consultations under the ESA regarding the revised CVP Operations Criteria and Plan (OCAP). An interim renewal contract (IRC) will be necessary to provide continued delivery of a supplemental supply of CVP water to the District pending completion of the CVP OCAP consultations. By law, the initial interim contract would be limited to 3 years, but it may be limited to 2.5 years to coincide with a termination date of the last day in February (similar to other contracts) of the applicable year, and lasting until the OCAP is completed. Subsequent renewals, if needed, would be for two years, and the long term contract, to be negotiated after the OCAP is completed, would be for 40 years. Both the IRC and the LTRC will incorporate the applicable provisions of the CVPIA and will be modeled after the form of the recently negotiated interim and long-term renewal contracts. This biological opinion does not analyze or authorize these water contracts under the ESA. Reclamation intends to pursue separate environmental documentation and section 7 consultation for these actions.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally listed species (Evolutionarily Significant Units (ESU) or Distinct Population Segments (DPS)) and designated critical habitat occur in the action area below Black Butte Dam and may be affected by water management operations:

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

The threatened southern DPS of North American green sturgeon (*Acipenser medirostris*) is not found in Stony Creek and therefore will not be affected by the proposed project.

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A. Species and Critical Habitat Listing Status

Sacramento River winter-run Chinook salmon were originally listed as threatened in August 1989, under emergency provisions of the Endangered Species Act (ESA), and formally listed as threatened in November 1990 (55 FR 46515). The ESU consists of only one population that is confined to the upper Sacramento River in California's Central Valley. NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). They were reclassified as endangered on January 4, 1994 (59 FR 440), due to increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and a 99 percent decline between 1966 and 1991. Critical habitat area was delineated as the Sacramento River from Keswick Dam, (river mile (RM) 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta (Delta), including Kimball Island, Winter Island, and Brown's Island; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge. Although juvenile winter-run Chinook salmon are known to use the lower portion of the action area for non-natal rearing, the area is not included as critical habitat for winter-run Chinook salmon.

Central Valley spring-run Chinook salmon were listed as threatened on September 16, 1999 (50 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. A final rule designating critical habitat for Central Valley spring-run Chinook salmon was published on September 2, 2005 (70 FR 52488). The rule became effective on January 2, 2006. The designation includes numerous streams and stream reaches throughout the Central Valley, including portions of lower Stony Creek from the mouth upstream to NDD.

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 River (inclusive of and downstream of the Merced River) basins in California's Central Valley. A final rule designating critical habitat for Central Valley steelhead was published on September 2, 2005 (70 FR 52488). The rule became effective on January 2, 2006. The designation includes numerous streams and stream reaches throughout the Central Valley, including lower Stony Creek from the mouth upstream to Black Butte Dam.

The critical habitat designations for Central Valley spring-run Chinook salmon and Central Valley steelhead identify the primary constituent elements (PCEs) of critical habitat which include those physical and biological features of the habitat that are essential to the conservation of the species. The PCEs of critical habitat for these species are made up of specific physical and biological components such as water of an appropriate quality and quantity, suitable spawning substrates, forage and food sources, and natural cover such as shade, submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. PCEs within lower Stony Creek include freshwater spawning sites, freshwater rearing sites and

freshwater migration corridors. The condition of these PCEs in lower Stony Creek has been impacted by past human activities and will be described more fully below in the Environmental Baseline section of this document.

NMFS recently has completed an updated status review of 16 salmon ESUs, including Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon, and concluded the species' status should remain as previously listed (70 FR 37160). On January 5, 2006, NMFS published a final listing determination for 10 steelhead DPSs, including Central Valley steelhead. The new listing determination became effective on February 6, 2006 (71 FR 834), and concludes that Central Valley steelhead DPS will remain listed as threatened.

B. Species Life History and Population Dynamics

1. Chinook Salmon

a. *General Life History*

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

Chinook salmon mature between two and six years of age (Myers *et al.* 1998). Freshwater entry and spawning timing generally are thought to be related to local water temperature and flow regimes (Miller and Brannon 1982). Runs are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

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 also are necessary to allow adult passage to upstream holding habitat. The preferred temperature range for upstream migration is 38 °F to 56 °F (Bell 1991, DFG 1998). Adult winter-run Chinook salmon enter San Francisco Bay from November through June (Hallock and Fisher 1985) and migrate past Red Bluff Diversion Dam (RBDD) from mid-December through early August (NMFS 1997). The majority of the run passes RBDD from January through May, and peaks in mid-March (Hallock and Fisher 1985). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Adult spring-run Chinook salmon enter the Delta from the Pacific Ocean beginning in January and enter natal streams from March to July (Myers *et al.* 1998). In Mill Creek, Van Woert (1964) noted that of 18,290 spring-run Chinook salmon observed from 1953 to 1963, 93.5 percent were counted between April 1 and July 14, and 89.3 percent were counted between April 29 and June 30. 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.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs; 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 (FWS 1995). The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad. Bell (1991) identifies the preferred water temperature for adult spring-run Chinook salmon migration as 38 °F to 56 °F. 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 fish can become stressed as temperatures approach 70 °F. Reclamation reports that spring-run Chinook salmon holding over the summer prefer water temperatures below 60 °F, although salmon can tolerate temperatures up to 65 °F before they experience an increased susceptibility to disease. The upper preferred water temperature for spawning Chinook salmon is 55 °F to 57 °F (Chambers 1956, Reiser and Bjornn 1979). Winter-run Chinook salmon spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick dam and RBDD (Vogel and Marine 1991). The majority of winter-run Chinook salmon spawners are three years old. Physical Habitat Simulation Model (PHABSIM) results (FWS 2003) indicate winter-run Chinook salmon suitable spawning velocities in the upper Sacramento River are between 1.54 feet per second (ft/s) and 4.10 ft/s, and suitable spawning substrates are between 1 and 5 inches in diameter. Initial habitat suitability curves (HSCs) show spawning suitability rapidly decreases for water depths greater than 3.13 feet (FWS 2003). 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). PHABSIM results indicate spring-run Chinook salmon suitable spawning velocities in Butte Creek are between 0.8 ft/s and 3.22 ft/s, and suitable spawning substrates are between 1 and 5 inches in diameter

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(FWS 2004). The initial HSC showed suitability rapidly decreasing for depths greater than one foot, but this effect was most likely due to the low availability of deeper water in Butte Creek with suitable velocities and substrates rather than a selection by spring-run Chinook salmon of only shallow depths for spawning (FWS 2004).

The optimal water temperature for egg incubation is 44 °F to 54 °F (Rich 1997). Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, disease, predation, poor gravel percolation, and poor water quality. Studies of Chinook salmon egg survival to hatching conducted by Shelton (1955) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. The length of time required for eggs to develop and hatch is dependent on water temperature and is quite variable. Alderdice and Velsen (1978) found that the upper and lower temperatures resulting in 50 percent pre-hatch mortality were 61 EF and 37 EF, respectively, when the incubation temperature was constant.

Winter-run Chinook salmon fry begin to emerge from the gravel in late June to early July and continue emerging through October (Fisher 1994), generally at night. Spring-run Chinook salmon fry emerge from the gravel from November to March and spend about 3 to 15 months in freshwater habitats prior to emigrating to the ocean (Kjelson *et al.* 1981). 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 small insects and crustaceans.

When juvenile Chinook salmon reach a length of 50 to 75 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures. In the mainstems of larger rivers, juveniles tend to migrate along the margins and avoid the elevated water velocities found in the thalweg of the channel. When the channel of the river is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1982). Stream flow and/or turbidity increases in the upper Sacramento River basin are thought to stimulate emigration. Emigration of juvenile winter-run Chinook salmon past RBDD may begin as early as mid-July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991, NMFS 1997). From 1995 to 1999, all winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). Spring-run Chinook salmon emigration is highly variable (DFG 1998). Some may begin outmigrating soon after emergence, whereas others over summer and emigrate as yearlings with the onset of intense fall storms (DFG 1998). The emigration period for spring-run Chinook salmon extends from November to early May, with up to 69 percent of young-of-the-year outmigrants passing through the lower Sacramento River and Delta during this period (DFG 1998).

Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, Delta, and their tributaries. Spring-run Chinook salmon juveniles have been observed rearing in the lower part of non-natal tributaries and intermittent streams during the winter months (Maslin *et al.* 1997, Snider 2001). Within the Delta, juvenile Chinook

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salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels and sloughs (McDonald 1960, Dunford 1975). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, Sommer *et al.* 2001, MacFarlane and Norton 2002).

Winter-run Chinook salmon fry remain in the San Francisco Bay estuary until they reach a fork length of about 118 mm (*i.e.*, 5 to 10 months of age) and then begin emigrating from the estuary to the open ocean as early as November and continue through May (Fisher 1994, Myers *et al.* 1998). Little is known about estuarine residence time of spring-run Chinook salmon. 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 (McFarlane and Norton 2002). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon), MacFarlane and Norton (2002) concluded that unlike populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry. Spring-run Chinook yearlings are larger in size than fall-run Chinook and ready to smolt upon entering the Delta; therefore, they probably spend little time rearing in the Delta.

b. *Population Trend – Sacramento River Winter-run Chinook Salmon*

The distribution of winter-run Chinook salmon spawning and rearing historically was limited to the upper Sacramento River and tributaries, where spring-fed streams allowed for spawning, egg incubation, and rearing in cold water (Slater 1963, Yoshiyama *et al.* 1998). The headwaters of the McCloud, Pit, and Little Sacramento Rivers, and Hat and Battle Creeks, provided clean, loose gravel, cold, well-oxygenated water, and optimal flow in riffle habitats for spawning and incubation. These areas also provided the cold, productive waters necessary for egg and fry survival, and juvenile rearing over summer. Construction of Shasta Dam in 1943 and Keswick Dam in 1950 blocked access to all of these waters except Battle Creek, which is blocked by a weir at the Coleman National Fish Hatchery and other small hydroelectric facilities (Moyle *et al.* 1989, NMFS 1997). Approximately, 299 miles of tributary spawning habitat in the upper Sacramento River is now blocked. Yoshiyama *et al.* (1998) estimated that the Upper Sacramento River in 1938 had a "potential spawning capacity" of 14,303 redds. Most components of the winter-run Chinook salmon life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the habitat blockage in the upper Sacramento River.

Following the construction of Shasta Dam, the number of winter-run Chinook salmon initially declined but recovered during the 1960s. The initial recovery was followed by a steady decline, subsequent to the construction of RBDD, from 1969 through the late 1980s (FWS 1991). Since 1967, the estimated adult winter-run Chinook salmon population ranged from 117,808 in 1969, to 186 in 1994 (NMFS 1997). The population declined from an average of 86,000 adults in 1967 to 1969 to only 1,900 in 1987 to 1989, and continued to remain low, with an average of approximately 2,500 fish for the period from 1998 to 2000 (Table 1). Between the time Shasta Dam was built and the listing of

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winter-run Chinook salmon as endangered, major impacts to the population occurred from warm water releases from Shasta Dam, juvenile and adult passage constraints at RBDD, water exports in the southern Delta, acid mine drainage from Iron Mountain Mine, and entrainment at a large number of unscreened or poorly-screened water diversions (NMFS 1997).

Population estimates from 2001 through 2004 show relatively consistent population levels with at least 4,000 more adults than any of the previous 15 years (Table 1). The 2005 run (15,829 fish) was the highest since the listing. Also, there is an increasing trend in the five-year moving average (491 from 1990-1994 to 9,483 from 2000-2005), and the five-year moving average of cohort replacement rates has increased and appears to have stabilized over the same period.

Table 1. Winter-run Chinook salmon population estimates from Red Bluff Diversion Dam counts, and corresponding cohort replacement rates for the years since 1986.

Year	Population Estimate (RBDD)	5-Year Moving Average Population Estimate	Cohort Replacement Rate	5-Year Moving Average of Cohort Replacement Rate
1986	2,596	-	-	-
1987	2,186	-	-	-
1988	2,885	-	-	-
1989	696	-	0.27	-
1990	430	1,759	0.20	-
1991	211	1,282	0.07	-
1992	1,240	1,092	1.78	-
1993	387	593	0.90	0.64
1994	186	491	0.88	0.77
1995	1,297	664	1.05	0.94
1996	1,337	889	3.45	1.61
1997	880	817	4.73	2.20
1998	3,002	1,340	2.31	2.49
1999	3,288	1,961	2.46	2.80
2000	1,352	1,972	1.54	2.90
2001	8,224	3,349	2.74	2.76
2002	7,441	4,661	2.26	2.26
2003	8,218	5,705	6.08	3.02
2004	7,701	6,587	0.94	2.71
2005	15,829	9,483	2.13	2.83

c. *Status - Sacramento River Winter-run Chinook Salmon*

Numerous factors have contributed to the decline of winter-run Chinook salmon through degradation of spawning, rearing, and migration habitats. The primary impacts include blockage of historical habitat by Shasta and Keswick Dams, warm water releases from Shasta Dam, juvenile and adult passage constraints at RBDD, water exports in the

southern Delta, heavy metal contamination from Iron Mountain Mine, high ocean harvest rates, and entrainment in a large number of unscreened or poorly screened water diversions. Secondary factors include smaller water manipulation facilities and dams, low recruitment of spawning gravel due to blockage behind upstream dams, loss of rearing habitat in the lower Sacramento River and Delta from levee construction, marshland reclamation, and interaction with and predation by introduced species (NMFS 1997).

Since the listing of winter-run Chinook salmon, several of the factors that led to the decline of the species have been addressed and improved through restoration and conservation actions. The impetus for initiating restoration actions stem primarily from the following: (1) ESA section 7 consultation reasonable and prudent alternatives on temperature, flow, and operations of the CVP and State Water Project; (2) SWRCB decisions requiring compliance with Sacramento River water temperature objectives which resulted in the installation of the Shasta Temperature Control Device in 1998; (3) a 1992 amendment to the authority of the CVP through the Central Valley Project Improvement Act (CVPIA) to give fish and wildlife equal priority with other CVP objectives; (4) fiscal support of habitat improvement projects from the CALFED Bay-Delta Program (*e.g.*, installation of a fish screen on the Glenn-Colusa Irrigation District diversion); (5) establishment of the CALFED Environmental Water Account (EWA); (6) Environmental Protection Agency (EPA) actions to control acid mine runoff from Iron Mountain Mine; and (7) ocean harvest restrictions implemented in 1995.

Due to these restoration and recovery efforts, water temperatures in the upper river have generally been maintained within an acceptable range for winter-run migration, incubation and rearing, suitable spawning gravel has been replenished through gravel augmentation programs below Keswick Dam, and migrational barriers have been reduced at RBDD and Anderson-Cottonwood Irrigation Dam (ACID).

The susceptibility of winter-run Chinook salmon to extinction remains linked to the elimination of access to their historical spawning grounds and the reduction of their population structure to a single, relatively small population. Recent trends in winter-run Chinook salmon abundance and cohort replacement are positive and may indicate some recovery since the listing. However, the population remains below the draft recovery goals established for the run (NMFS 1997). In general, the recovery criteria for winter-run Chinook salmon includes a mean annual spawning abundance over any 13 consecutive years to be 10,000 females and the geometric mean of the cohort replacement rate over those same years to be greater than 1.0.

d. *Population Trend – Central Valley Spring-run Chinook Salmon*

Historically, spring-run Chinook salmon were predominant throughout the Central Valley occupying 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). 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 the 1940s (DFG 1998). Before construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry 1961). Following the completion of Friant Dam, the native population from the San Joaquin River and its tributaries (*i.e.*, the Stanislaus and Mokelumne Rivers) was extirpated. Spring-run Chinook salmon no longer exist in the American River due to the operation of Folsom Dam. Naturally spawning populations of Central Valley spring-run Chinook salmon currently are restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (DFG 1998).

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the Feather River Hatchery (FRH). In 2002, FRH reported 4,189 returning spring-run Chinook salmon, which is 22 percent below the 10-year average of 4,727 fish. However, coded-wire tag (CWT) information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run Chinook salmon populations in the Feather River due to hatchery practices. Because Chinook salmon are not temporally separated in the hatchery, spring-run Chinook and fall-run Chinook are spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon. 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. The genetic integrity of this population is at question because there is significant temporal and spatial overlap between spawning populations of spring-run and fall-run Chinook salmon (Good *et al.* 2005). For the reasons discussed previously, Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance.

Since 1969, the Central Valley spring-run Chinook salmon ESU (excluding Feather River fish) has displayed broad fluctuations in abundance ranging from 25,890 in 1982 to 1,403 in 1993 (DFG unpublished data). Even though the abundance of fish may increase from one year to the next, the overall average population trend has a negative slope during this time period. The average abundance for the ESU was 12,499 for the period of 1969 to 1979, 12,981 for the period of 1980 to 1990, and 6,542 for the period of 1991 to 2001. In 2003 and 2004, total run size for the ESU was 8,775 and 9,872 adults respectively, well above the 1991 to 2001 average.

Evaluating the ESU as a whole, however, masks significant changes that are occurring among metapopulations. For example, while the mainstem Sacramento River population has undergone a significant decline, the tributary populations have demonstrated a substantial increase. Average abundance of Sacramento River mainstem spring-run Chinook salmon recently has declined from a high of 12,107 for the period 1980 to 1990, to a low of 609 for the period 1991 to 2001, while the average abundance of Sacramento River tributary populations increased from a low of 1,227 to a high of 5,925 over the same periods. Although tributaries such as Mill and Deer Creeks have shown positive escapement trends since 1991, recent escapements to Butte Creek, including 20,259 in 1998, 9,605 in 2001, and 8,785 in 2002 are responsible for much of the increase in

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tributary abundance (DFG 2002, DFG unpublished data). The Butte Creek estimates however, do not include prespawning mortality. In the last several years as the Butte Creek population has increased, mortality of adult spawners has increased from 21 percent in 2002 to 60 percent in 2003 due to disease associated with high water temperatures and over-crowding. This trend may indicate that the population in Butte Creek may have reached its carrying capacity (Ward *et al.* 2003) or are near historical population levels.

The extent of spring-run Chinook salmon spawning in the mainstem of the upper Sacramento River is unclear due to overlapping spawning periods with fall-run Chinook salmon. During aerial redd counts very few redds (less than 15 per year) were observed during September (generally accepted as the primary spawning period for spring-run Chinook salmon) from 1989 to 1993, and none in 1994 (FWS 2003). Recently, the number of redds in September has varied from 29 to 105 during 2001 though 2003 depending on the number of survey flights (DFG, unpublished data). In 2002, based on RBDD ladder counts, 483 spring-run Chinook adults are estimated to have spawned in the mainstem Sacramento River (DFG 2004). In 2003, that estimate dipped to zero, and in 2004 the number of spring-run Chinook adults estimated to have spawned in the mainstem Sacramento River was 575 (DFG 2004).

e. *Status of Spring-run Chinook Salmon and Critical Habitat*

The initial factors that led to the decline of spring-run Chinook salmon were related to the loss of upstream habitat behind impassable dams. Since this initial loss of habitat, other factors have impacted spring-run Chinook salmon critical habitat, contributed to the instability of the population and affected the ESU's ability to recover. These factors include a combination of physical, biological, and management factors that have reduced the quantity and quality of critical habitat PCEs and directly reduced population numbers. Climatic variation, water management activities, hybridization with fall-run Chinook salmon, predation, and harvest have all impacted spring-run Chinook salmon critical habitat and population numbers (DFG 1998).

Since spring-run Chinook salmon adults generally hold over for several months in small tributaries before spawning they are extremely susceptible to the effects of low flows and high water temperatures. During the drought from 1986 to 1992, Central Valley spring-run Chinook salmon populations declined substantially (DFG 1998). Dry hydrologic conditions result in reduced flows and warm water temperatures which negatively impact adults, eggs, and juveniles. For adult spring-run Chinook salmon, reduced instream flows delay, or in some instances completely block access to holding and spawning habitats. Water management operations including reservoir releases and unscreened or poorly-screened diversions along spring-run Chinook salmon migration routes compound drought-related problems by further reducing river flows, warming river temperatures, and entraining juveniles.

Several actions have been taken to improve and increase the PCEs of critical habitat for spring-run Chinook salmon, including improved management of Central Valley water

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(*e.g.*, through use of CALFED EWA and CVPIA (b)(2) water accounts), implementing new and improved screen and ladder designs at major water diversions along the mainstem Sacramento River and tributaries, removal of several small dams on important spring-run Chinook salmon spawning streams, and changes in ocean and inland fishing regulations to minimize harvest. Although protective measures and critical habitat restoration likely have contributed to recent increases in spring-run Chinook salmon abundance, the ESU is still below levels observed from the 1960s through 1990. Threats from hatchery production (*i.e.*, competition for food between naturally spawned and hatchery fish, and run hybridization and homogenization), climatic variation, reduced stream flows, high water temperatures, predation, and large scale water diversions persist. Because the Central Valley spring-run Chinook salmon ESU is confined to relatively few remaining streams and continues to display broad fluctuations in abundance, the population is at a moderate risk of extinction.

2. Steelhead

a. *General Life History*

Based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, steelhead can be divided into two life history types: stream-maturing and ocean-maturing. Stream-maturing steelhead enter freshwater in a sexually immature condition and require several months to mature and spawn, whereas ocean-maturing steelhead enter freshwater with well-developed gonads and spawn shortly after river entry. These two life history types are more commonly referred to by their season of freshwater entry (*i.e.* summer [stream-maturing] and winter [ocean-maturing] steelhead). Only winter steelhead are currently found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento River system prior to the commencement of large-scale dam construction in the 1940s (Interagency Ecological Program [IEP] Steelhead Project Work Team 1999). At present, summer steelhead are found only in North Coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

Winter steelhead generally leave the ocean from August through April, and spawn between December and May (Busby *et al.* 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and the associated lower water temperatures. The preferred water temperature for adult steelhead migration is 46 °F to 52 °F (McEwan and Jackson 1996, Myrick 1998, Myrick and Cech 2000). Thermal stress may occur at temperatures beginning at 66 °F and mortality has been demonstrated at temperatures beginning at 70 °F. The preferred water temperature for steelhead spawning is 39 °F to 52 °F, and the preferred water temperature for steelhead egg incubation is 48 °F to 52 °F (McEwan and Jackson 1996, Myrick 1998, Myrick and Cech 2000). The minimum stream depth necessary for successful upstream migration is 13 cm (Thompson 1972). Preferred water velocity for upstream migration is in the range of 40-90 cm/s, with a maximum velocity, beyond which upstream migration is not likely to occur, of 240 cm/s (Thompson 1972, Smith 1973).

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Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Nickleson *et al.* 1992, Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapolov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams. Most steelhead spawning takes place from late December through April, with peaks from January though March (Hallock *et al.* 1961). Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity, and may spawn in intermittent streams as well (Everest 1973, Barnhart 1986).

The length of the incubation period for steelhead eggs is dependent on water temperature, dissolved oxygen concentration, and substrate composition. In late spring and following yolk sac absorption, fry emerge from the gravel and actively begin feeding in shallow water along stream banks (Nickelson *et al.* 1992).

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. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. 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 refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Some older juveniles move downstream to rear in large tributaries and mainstem rivers (Nickelson *et al.* 1992). Juveniles feed on a wide variety of aquatic and terrestrial insects (Chapman and Bjornn 1969), and emerging fry are sometimes preyed upon by older juveniles.

Steelhead generally spend two years in freshwater before emigrating downstream (Hallock *et al.* 1961, Hallock 1989). Rearing steelhead juveniles prefer water temperatures of 45 °F to 58 EF and have an upper lethal limit of 75 EF. Reiser and Bjornn (1979) recommended that dissolved oxygen concentrations remain at or near saturation levels with temporary reductions no lower than 5.0 mg/l for successful rearing of juvenile steelhead. During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Bell (1973) found that silt loads of less than 25 mg/l permit good rearing conditions for juvenile salmonids.

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. Some may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Barnhart (1986) reported that steelhead smolts in California range in size from 140 to 210 mm (fork length). 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.

b. *Population Trends – Central Valley Steelhead*

Steelhead historically were well distributed throughout the Sacramento and San Joaquin Rivers (Busby *et al.* 1996). Steelhead were found from the upper Sacramento and Pit River systems (now inaccessible due to Shasta and Keswick Dams), south to the Kings and possibly the Kern River systems (now inaccessible due to extensive alteration from water diversion projects), and in both east- and west-side Sacramento River tributaries (Yoshiyama *et al.* 1996). The present distribution has been greatly reduced (McEwan and Jackson 1996). The California Advisory Committee on Salmon and Steelhead (1988) reported a reduction of steelhead habitat from 6,000 miles historically to 300 miles today. Historically, steelhead probably ascended Clear Creek past the French Gulch area, but access to the upper basin was blocked by Whiskeytown Dam in 1964 (Yoshiyama *et al.* 1996). Steelhead also occurred in the upper drainages of the Feather, American, Yuba, and Stanislaus Rivers which are now inaccessible (McEwan and Jackson 1996, Yoshiyama *et al.* 1996).

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

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

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

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The only consistent data available on steelhead numbers in the San Joaquin River basin come from DFG mid-water trawling samples collected on the lower San Joaquin River at Mossdale. These data indicate a decline in steelhead numbers in the early 1990s, which have remained low through 2002 (DFG 2003). In 2004, a total of 12 steelhead smolts were collected at Mossdale (DFG, unpublished data).

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996).

Recent snorkel surveys (1999 to 2002) indicate that steelhead are present in Clear Creek (J. Newton, FWS, pers. comm. 2002, as reported in Good *et al.* 2005). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other streams previously thought to be void 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 (Demko *et al.* 2000). It is possible that naturally spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999).

c. *Status of Central Valley Steelhead and Critical Habitat*

Both the BRT (Good *et al.* 2005) and the Artificial Propagation Evaluation Workshop (69 FR 33102) concluded that the Central Valley steelhead DPS is "in danger of extinction." However, in the proposed status review NMFS concluded that the DPS in-total is "not in danger of extinction, but is likely to become endangered within the foreseeable future" citing benefits of restoration efforts and a yet-to-be funded monitoring program (69 FR 33102). Central Valley steelhead already have been extirpated from most of their historical range. Critical habitat concerns for steelhead focus on the widespread degradation, destruction, and blockage of freshwater habitat within the region, and impacts to PCEs are similar to those discussed for Chinook salmon above. Widespread hatchery steelhead production within this DPS also raises concerns about the potential ecological interactions between introduced stocks and native stocks. Because the Central Valley steelhead population has been fragmented into smaller isolated tributaries without any large source population and the remaining habitat continues to be degraded by water diversions and other land use practices, the population is at high risk of extinction.

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IV. ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem within the action area (USFWS and NMFS 1998). The action area includes Stony Creek and its riparian corridor from East Park Reservoir downstream to the confluence with the Sacramento River. The main focus of this analysis centers on the area that is accessible to anadromous species and is designated as critical habitat for Central Valley steelhead, the lower 24.6 miles of Stony Creek between Black Butte Dam and the confluence with the Sacramento River. The lower 19.7 miles of this reach, from NDD to the confluence with the Sacramento River also is designated as critical habitat for Central Valley spring-run Chinook salmon.

Stony Creek is the second largest tributary of the Sacramento River on the west side of the Sacramento Valley, and drains approximately 741 square miles along the eastern slopes of the California Coastal Range. The Stony Creek watershed is characterized by cool, wet winters with high flows, and hot dry summers with low summer and fall flows, with an average precipitation of 15 inches in the lower watershed. Within the upper watershed, variable winter rains and snow (annual precipitation of 32 inches) provide inflow into three reservoirs which affect water releases to lower Stony Creek.

A. Status of the Listed Species within the Action Area

Although Chinook salmon and steelhead are known to occur in lower Stony Creek (Corwin and Grant 2004; Brown 1994; DFG 1983; Reavis 1983), information on recent spawning is greatly limited (Corwin and Grant 2004). The installation of the Glenn Colusa Irrigation District (GCID) siphon under Stony Creek in 1999 has opened up much of the lower creek to anadromous salmonid use over a much greater portion of the year. Prior to installation of the siphon, a gravel berm was constructed during each irrigation season from 1911-1999 at the GCID canal crossing of Stony Creek at CM 3.3, which created an intermittent barrier to both upstream and downstream salmonid migration (Mike Hughes, personal communication, 2007). In many years this berm was able to withstand winter flows and therefore blocked passage throughout the year. In those years that the berm was washed out by high winter flows, it was generally rebuilt early in the spring (March or April) to allow irrigation water delivery. Even with the removal of this intermittent barrier, the potential for recovery of salmonid populations within lower Stony Creek currently is limited by passage barriers and diversions such as the CHO gravel berm during the irrigation season (typically late March to mid May), the NDD, and Black Butte Dam, as well as frequent fluctuations in stream flows with extended periods of extremely low base flows, elevated water temperatures and limited spawning and rearing habitat.

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

Spring-run Chinook salmon are known to have historically spawned in the Stony Creek watershed (Yoshiyama *et al.* 1996). There is documentation of salmon spawning at the

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confluence of Stony Creek and Little Stony Creek, although habitat conditions in this reach would indicate that these were likely fall-run Chinook salmon. The spring-run are likely to have spawned further up in the watershed above 2,000 feet of elevation, as they do in other tributaries to the Sacramento River. Prior to the placement of irrigation dams, Stony Creek was considered "a very good salmon stream" (Clark 1929). By 1928 spring-run Chinook salmon were nonexistent on Stony Creek due to irrigation diversions that blocked migration to the upper watershed and kept the lower stream dry except during the rainy season (Clark 1929). There is no evidence or documentation of winter-run Chinook salmon spawning in Stony Creek.

The life history and spawning strategies of spring-run Chinook salmon require them to reach upstream cold-water habitats during the spring, summer and early fall seasons. The construction of the GCID diversion, Stony Gorge and Black Butte Dams blocked the spring run from accessing the cold water habitats of upper Stony Creek in order to complete their life cycle. This loss of access to cold water habitats has caused the complete extirpation of spawning populations of spring-run Chinook salmon from the Stony Creek watershed (Yoshiyama et al 1996). It is unlikely that any action short of the removal of these dams or construction of fish passage facilities on these dams could facilitate the return of a spawning population of spring-run Chinook salmon to the system.

Several sampling efforts conducted over the past 20 years have captured juvenile spring- and winter-run Chinook salmon and steelhead in Stony Creek, mostly near the confluence with the Sacramento River (Reavis 1983, Maslin and McKinney 1994, Brown 1994, Corwin and Grant 2004). In addition, juvenile Chinook salmon (undetermined ESU) have been collected as far upstream as CM 12.9 (DFG 1983). As stated above, habitat conditions in lower Stony Creek do not support spring- or winter-run Chinook salmon spawning and it is therefore assumed that all juveniles of these two ESUs found within Stony Creek represent non-natal rearing. However, fall-run Chinook salmon spawning has been documented in lower Stony Creek and newly hatched fall-run fry have been collected in the creek (Corwin and Grant 2004).

2. Central Valley Steelhead

There have been only limited efforts to determine the presence or extent of steelhead spawning in Stony Creek and those limited efforts have not detected any such spawning. Murphy (1946) conducted a survey of the upper reaches of Stony Creek and Grindstone Creek (a tributary to Stony Creek) in August of 1946, prior to the existence of Black Butte Dam, during which he documented abundant rainbow trout. The existence of rainbow trout (and possibly juvenile steelhead) in these areas during the late summer of a drought year indicates that the habitat was suitable to support steelhead on a year round basis. Although steelhead production has not been documented in Stony Creek, the suitability of the habitat coupled with the documentation of anadromous Chinook salmon accessing these areas upstream of present-day dams (Yoshiyama *et al.* 1996) is a strong indication that steelhead would have spawned in Stony Creek as well (McEwan 2001).

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Corwin and Grant (2004) conducted limited spawning surveys in lower Stony Creek from 2001 through 2004, primarily looking for Chinook salmon spawners. No adult steelhead were detected during this study. However, the extent of these surveys was greatly limited by high turbidity and lack of access to most of the creek (due to denial of access to private lands). Therefore the researchers concluded that they could neither confirm nor discount the presence of steelhead spawning during that period (Reclamation 2004).

The same study (Corwin and Grant 2004) monitored for juvenile salmonids through fyke netting and beach seining on lower Stony Creek. Again, no natal steelhead were detected during the 4-year study period. However, the scope of sampling was limited both spatially (many areas of the creek could not be sampled due to lack of landowner permission) and temporally (sampling efforts were not persistent throughout the study period). While the failure to detect natal juvenile steelhead under this sampling regime is a strong indication that there was no significant steelhead production in Stony Creek during this period, the possibility of successful steelhead spawning can not be definitively excluded, as sampling efforts were intermittent and access to suitable monitoring sites was not granted by landowners (Reclamation 2004).

Other sampling efforts that have captured juvenile steelhead in Stony Creek (Maslin and McKinney 1994, Brown 1994) found only larger juveniles (>100 mm) in the lower reaches of the creek, and concluded that they were likely non-natal to Stony Creek.

B. Status of Critical Habitat within the Action Area

The PCEs of critical habitat for spring-run Chinook salmon and steelhead in Stony Creek have been severely impacted and degraded by human activities and manipulation of the creek. The PCEs that have been most heavily impacted include suitable migration corridors, spawning sediments, creek hydrology including timing and magnitude of flows, suitable water temperatures, and shaded riparian aquatic (SRA) habitat including large woody debris.

1. Migrational Barriers

Migration of anadromous salmonids into sections of the upper Stony Creek watershed was originally blocked by East Park Dam on Little Stony Creek, and the associated Rainbow Diversion Dam on Stony Creek, in 1910 and 1914 respectively. The GCID gravel berm near the mouth of Stony Creek also intermittently blocked migration from 1911-1999. In 1928, the construction of Stony Gorge Dam further prevented salmonid passage into the reach between Stony Gorge Dam and the previously built dams. Since 1963, anadromous salmonids have been restricted to the lower 24.6 miles of Stony Creek by the construction of Black Butte Dam.

NDD located at CM 19.7 is a weir structure spanning the entire creek. The concrete spillway creates a nearly vertical drop to the downstream water surface which has been determined to impede upstream adult passage under most flow conditions, and makes it impossible for juveniles to move upstream of the dam at any time (Corwin and Grant

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2004). On top of this spillway, flashboards are typically put in place from March through October to allow water diversions into the North Canal. However, these flashboards have, at times, been in place during all months of the year dependent on water demands and weather patterns. When flashboards are in place they create a total barrier to upstream passage so that adult and juvenile salmonids are unable to access the area above NDD. In addition, any juveniles migrating downstream from above the dam during irrigation diversions would have a strong likelihood of entrainment into the North Canal as the majority of summer flows are diverted into the canal. NDD flashboards are typically in place during much of the fall-run Chinook salmon adult migration period and during the latter part of the fall-run Chinook salmon, and steelhead juvenile emigration periods.

Since 1993, a seasonal passage impediment has existed at the CHO (CM 13) during rediversion operations which may occur from April 1 through May 15 and September 15 through October 29. During CHO operations, a gravel barrier is placed across Stony Creek to facilitate the diversion of water into the TCC via the CHO. Although a minimum bypass flow of 40 cfs is maintained downstream of this seasonal berm during the operation of the CHO, this temporary barrier may impede both upstream and downstream passage of salmonids. As with NDD, any juveniles migrating downstream from above the diversion structure would have a strong likelihood of entrainment into the TCC as the majority of the water flowing downstream is diverted into the canal during the diversion period. Upstream passage may be prevented or delayed during the fall-run Chinook salmon adult immigration period and during the fall- and spring-run Chinook salmon, and steelhead juvenile emigration periods.

Prior to 1999, a gravel berm was constructed (or maintained) on the creek each spring at the GCID main canal (approximately 3 miles upstream of the confluence of Stony Creek and the Sacramento River) and left in place through the irrigation season (generally March through November). The berm created a barrier which prevented fish passage into and out of the creek during the irrigation season, and in years when the berm was not blown out by winter flows, it remained a barrier to fish passage throughout the year. In 1999, a siphon was placed under Stony Creek at this site, and there is no longer any structural barrier there.

2. Spawning Substrate

Black Butte Dam blocks the transport of all but the finest sediment from the upper basin into lower Stony Creek. Prior to construction of the dam, the channel was a high gradient, bedload dominated system with sharp fluctuations in discharge, where the channel carrying the main flow shifted periodically. Post-dam, the flood peaks have been attenuated, and spring runoff often is stored for planned releases. Channel width and sediment transport have been reduced in the upper reaches and significant channel realignment has occurred. The sources of most bedload and suspended sediment have been eliminated by Black Butte Dam. High volume releases can produce accelerated bank erosion below the dam, which is the primary source of coarse bedload recruitment into the lower creek.

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Several spawning sediment analyses have been conducted on lower Stony Creek over the past 40 years. Puckett (1969) conducted a spawning habitat survey during the mid-1960s, shortly after the completion of Black Butte Dam, before the impacts of the dam on substrate composition and distribution would have been apparent. Puckett (1969) sampled within three half-mile reaches of lower Stony Creek. These sites were at the U.S. Geological Survey (USGS) gage near Hamilton City, one-half mile downstream of the Road P crossing near Orland, and two miles below Black Butte Dam. The results of this investigation determined that the average substrate particle size was too small in the two lower study areas, but was adequate for Chinook salmon spawning in the upper most location, above NDD. Again, this study was conducted shortly after the construction of Black Butte Dam, and it is likely that the substrate characteristics throughout lower Stony Creek have changed significantly in the ensuing 35 years of dam operations.

In the late 1990s, David Vogel (1998) conducted an investigation of spawning gravel substrate in lower Stony Creek. Vogel concentrated a large majority of his sampling effort (15 of 18 samples) within the upper two miles of the creek, directly below Black Butte Dam. The decision to concentrate on this area was apparently based on Puckett's finding that this area had contained the highest quality spawning substrate some 30 years prior. Vogel (1998) concluded that "nearly all samples possessed a level of fine particles (mostly sand) within the level of concern for salmonid reproduction".

The combination of high winter flushing flows and a lack of sediment recruitment has severely impacted the uppermost stretch of lower Stony Creek, below Black Butte Dam. While Puckett (1969) determined that this section of the creek had the highest quality of spawning gravels shortly after Black Butte Dam was constructed, recent analysis of this area revealed that most of the channel has become incised down to a bed of older resistant alluvium (existing conditions report) and some areas have become completely denuded of all gravels and sediments with only bed rock and hard pan clay remaining, leaving the area unusable as spawning habitat (personal observation, Mike Tucker, June 2006).

The most recent scientific analysis of spawning substrate in lower Stony Creek was conducted by Corwin and Grant (2004). These investigators collected samples from 8 locations between the mouth of Stony Creek and I-5 at CM 16.2 (see Table 2). There were no samples taken above the I-5 site (upper 8.4 miles of lower Stony Creek) in the area most heavily concentrated on by the previous two studies, again due to denial of access by private landowners.

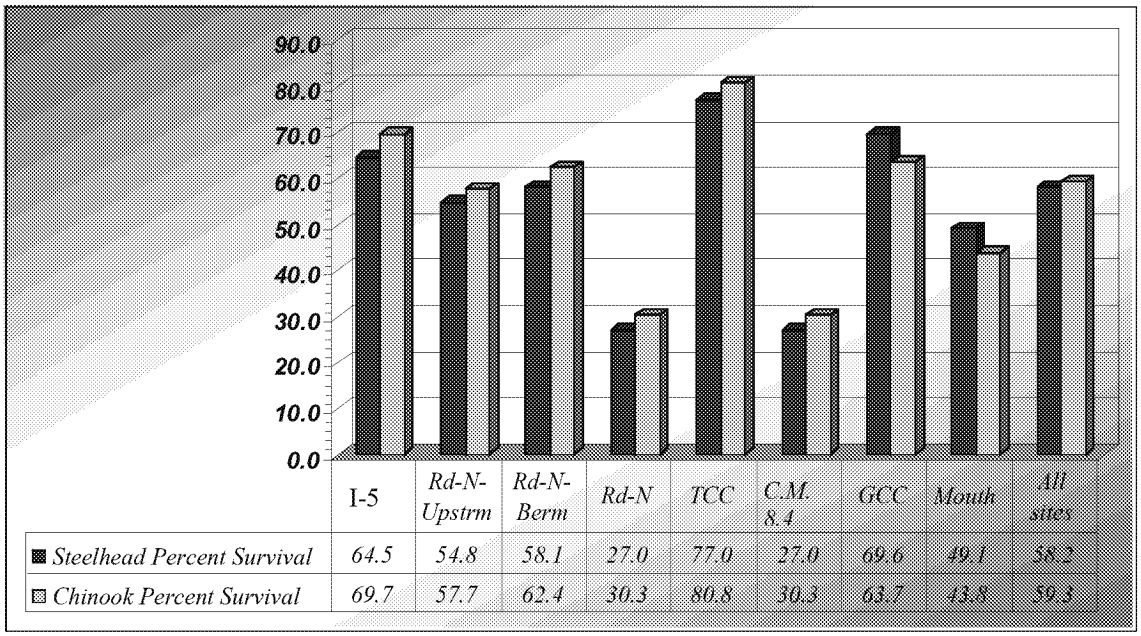
Table 2. Sampling sites for 2004 sediment study.

Sediment Sample Site	Creek Mile
I-5	16.2
Road N – Upstream	14.2
Road N - Berm	14.1
Road N	14.1
Tehama Colusa Canal (TCC)	13.9

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Creek Mile 8.4	8.4
Glen Colusa Canal (GCC)	3.9
Mouth	0.2

In an analysis provided as supplemental information to Corwin and Grant's initial report (Reclamation 2005a), the investigators used two second order equations taken from Tappel and Bjornn (1983) to describe the relationship between the particle size ratios found in the sediment samples taken from lower Stony Creek and the expected percent survival of Chinook salmon and steelhead that might be spawned in that gravel.



	I-5	Rd-N-Upstrm	Rd-N-Berm	Rd-N	TCC	C.M. 8.4	GCC	Mouth	All sites
Steelhead Percent Survival	64.5	54.8	58.1	27.0	77.0	27.0	69.6	49.1	58.2
Chinook Percent Survival	69.7	57.7	62.4	30.3	80.8	30.3	63.7	43.5	59.3

Figure 1. Predicted percent survival of salmonid embryos to emergence for lower Stony Creek substrate samples. Percent survival is based on two second-order equations developed by Tappel and Bjornn, 1983 (Figure taken from Reclamation 2005a)

As indicated by the graph in Figure 1, estimated percent survival to emergence was below 70 percent for all gravel samples except for the TCC sample which had a percent survival for steelhead and Chinook salmon of 77 percent and 81 percent, respectively. The mean percent survival among all sites for steelhead was 53 percent (Standard Deviation (SD) = 18.4) and ranged from 27 percent for gravel analyzed from Road N and CM 8.4 to 77 percent for the TCC gravel. The mean percent survival for Chinook salmon was found to be 55 percent (SD = 18.4) and ranged from a low of 30 percent for gravel from Road N to 80.8 percent for the TCC gravel. From this analysis the investigators concluded that the quality of gravel for salmonid spawning was fair to poor in the areas sampled (Reclamation 2005a). However, it is important to note that the capture of newly emergent Chinook salmon fry within these reaches proves that successful spawning, incubation, and emergence is occurring in these areas, although the actual percent survival of embryos to emergence is unknown at this time.

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3. Hydrologic Conditions

Natural flow patterns within Stony Creek have been disturbed since 1910 with the construction of East Park Dam. Changes in the natural flow regime have altered the natural cycles by which juvenile and adult salmonids base their migrations. The dams have also decreased gravel and large woody debris recruitment to the lower creek. While storage of natural runoff can reduce flows in the lower creek during certain times of year, at other times dam releases can provide higher flows for longer periods of time than would occur under natural conditions. The existing streamflow conditions below Black Butte Dam are variable and highly dependent on flood control operations, diversions, seepage, and evaporation. Historic records indicate that before the construction of Black Butte Dam (1963), flows in the lower valley reach of Stony Creek diminished to zero or nearly zero in the late summer months of most years. This situation continues to occur today as minimum releases (30 cfs below NDD) can be diminished through evaporation, direct pumping, or absorption into the fluvial substrate of the valley floor before reaching the Sacramento River. In the spring, when Reclamation is diverting at the CHO, flows below NDD (the area currently accessible to anadromous salmonids) are generally higher and colder than they would otherwise be without the existence of Black Butte Dam. This situation may provide improved conditions for salmonids in the area above the CHO for this short period in the spring. However, the majority of these increased flows are diverted into the unscreened CHO, increasing the likelihood of entrainment of juvenile salmonids into the TCC

As a result of the 2002 BO, the Corps refined their flood control ramping rates and other water release protocols in order to improve habitat conditions for listed salmonids on lower Stony Creek. The current ramping rates followed during flood control operations are described below.

The rates of change for increasing flood releases from minimum flow to 1,000 cfs are as follows[1]:

1. When storage encroaches 0 percent to 25 percent of the required flood control space, releases will be increased by no more than 250 cfs/hour.

2. When storage encroaches 25 percent to 50 percent of the required flood control space, releases will be increased by no more than 500 cfs/hour.

3. When storage encroaches 50 percent or more of the required flood control space, releases will be increased by no more than 1,000 cfs/hour.

When flood releases are above 1,000 cfs, releases shall be increased by no more than 1,000 cfs/hour. Exceptions to this requirement shall be allowed to insure the structural integrity of the Corps' facilities[2] and in emergency situations, to protect human lives and property from flood damages.

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The rate of change for decreasing releases are as follows[1]:

1. When flood release is 15,000 cfs to 5,000 cfs, releases will be decreased by no more than 500 cfs/hour.

2. When flood release is 5,000 cfs to 500 cfs, releases will be decreased by no more than 250 cfs/hour.

3. When flood release is 500 cfs to 100 cfs, releases will be decreased by no more than 250 cfs/day at a rate not greater than 30 cfs/hr.

4. When flood release is at or below 100 cfs, releases will be decreased in approximately 10 cfs/hour increments.

[1]*All releases are expected to be within +/- 5 percent of those targeted.*

[2]*Operating experience has shown that when upward release changes are required within the range of 4,000 cfs to 6,500 cfs (depending on reservoir storage) the gates should be operated in such a way as to force a hydraulic jump below the outlet portal by temporarily increasing the release by approximately 2,000 cfs. Once the hydraulic jump is established, the 1,000 cfs per hour (or less) rate of release would resume.*

The Corps has also initiated alternative flood release protocols during the last 5 to 7 percent of floodwater encroachment in Black Butte Lake. These new protocols are intended to provide more reliable and suitable conditions for successful spawning and survival of anadromous salmonids in lower Stony Creek. The basic strategy of these newly adopted release protocols has been to cut releases to between 100 and 200 cfs when the decreasing encroachment level reaches 5 to 7 percent (instead of maintaining higher releases until the reservoir is no longer encroached), with the intent of maintaining minimum releases of 100 cfs or greater for as long as possible during flood control operations while avoiding impacts to the Corps' flood control abilities below Black Butte Dam. These new release protocols have been generally successful in maintaining minimum flows of 100 to 200 cfs during the winter and spring flood control periods since late 2003 when the protocols were initiated.

Reclamation conducted an analysis of water use and water availability on lower Stony Creek in 2004 (Reclamation 2004) to investigate the potential effects on the available water supply from implementing minimum instream flow requirements of 100 and 150 cfs during the cold water periods (*i.e.*, generally November through May). A water resources model was required to address the system impacts of increasing minimum flows. As a result, CALSIM was selected as the model to evaluate potential long-term impacts on reservoir storage and water supply deliveries. Based on 80 years of available data, the study period analyzed was Water Years1921 through 2000.

The model described OUWUA's average contract demands of 104.9 TAF and TCCA's maximum demands of 38.3 TAF which can only be met by the available water supply within the basin. To estimate the water available through the peak irrigation season,

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April through September, allocations were determined by the following method and are supported by historical deliveries (1966-98):

1. The sum of the end of March storage in the three reservoirs;
2. Plus an estimate of the April-September unimpaired flow, above what OUWUA is diverting;
3. Minus a minimum system carryover storage target of 32.5 TAF; and,
4. Minus contingencies including 25% of an initial allocation estimate to account for channel recharge to the aquifer and an estimate for irrigation season evaporation.

Reservoir operating criteria were also identified. Reservoir storage-discharge relationships and current area-capacity-elevation tables were incorporated in the model. In addition, each reservoir is operated under the following set of priorities (in order), when possible:

1. Comply with current flood control and/or dam safety requirements;
2. Meet current minimum flow requirements;
3. Stabilize Black Butte Lake or Stony Gorge Reservoir in alternate years for in-lake fishery enhancement by limiting drawdown during the crappie (*Pomoxis* spp.) spawning season; and,
4. Satisfy contractual water supply demands to the OUWUA and the TCCA. Water in excess of these demands remains in storage.

Results of this analysis indicated that implementation of increased minimum flow releases would provide instream benefits for fish when temperatures are suitable, but that in dryer years, would result in lower reservoir system storage, thereby reducing water availability needed for irrigation. The model used the Sacramento Valley Water Year Hydrologic Index to compare hydrological trends in Stony Creek in response to alternative operations, since a hydrologic classification of Stony Creek does not exist

The analysis indicated that 100 percent of Orland Project agricultural demands could be met under the increased 100 cfs minimum flow during all "wet", "above normal", and all but two (out of 14) "below normal" year types (as defined under the Sacramento Valley Water Year Hydrologic Classifications) which occurred in 65 percent of years over the 80-year period of analysis. However, as OUWUA has rights to 100% of the water stored in East Park and Stony Gorge Reservoirs, only flood releases and CVP water stored in Black Butte Lake were considered available to meet the proposed minimum flows in Reclamation's analysis.

The likelihood of meeting full agricultural demands was significantly reduced during most "dry" and almost all "critical" year types. Unfortunately, it is impossible to predict in November, through reservoir storage or long range forecasting, the type of hydrologic classification that will develop as the water year progresses.

Due to the unpredictability of spring reservoir storage and hydrological conditions in the Stony Creek basin, Reclamation conducted an additional cursory analysis which found that if more than 104,657 acre-feet are present, or expected to run off into Black Butte

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Lake on or after April 1, in years when the upstream reservoirs are also full on April 1, Reclamation could release greater instream flows for fishery benefits without impacting agricultural deliveries or minimum pool requirements.

4. Water Temperature

Lower Stony Creek water temperatures are directly influenced by ambient air temperature, solar radiation, shading, channel geometry, volume of water being released down the creek, the water temperatures of Black Butte Lake releases, and, to a lesser degree, the other upstream reservoirs. Releases made from Black Butte Lake are made from the outlet located at the bottom of the lake, ensuring the coldest temperatures possible. Thermal monitoring within Black Butte Lake has indicated that, while there is a slight to moderate thermal stratification during the late spring and summer months (April-September), by the early fall at lowest pool elevations, temperatures within the reservoir can be relatively uniform, generally in the mid-60s °F (Corps 1987). Based on analysis of daily mean temperatures from four monitoring locations on lower Stony Creek from July 1995 to December 1997, temperatures remained fairly consistent from year to year during the winter months. Also, stream temperatures were not significantly different with regard to location during the winter months but increased as much as 18 °F in a downstream direction between CM 24 and CM 7 during the summer months (*i.e.,* May to August).

Mean daily water temperatures at the Black Butte gage (CM 24) in October from 1979 through 1994 (65.8 °F) were just below the maximum threshold of temperature tolerances for prespawning Chinook salmon (66 °F) reported by Ward and Kier (1999). During 1979 through 1994, water temperatures from November through March remained within the optimal range for adult migration, spawning, egg incubation and juvenile rearing for Chinook salmon and steelhead of 38 °F to 56 °F (Bell 1986, McEwan and Jackson 1996). Stream temperatures then remained within the optimal range (<65 °F) for fry/juvenile Chinook and steelhead rearing through at least April and sometimes to mid-June (Reclamation and Corps 2001).

The Black Butte gage is at the upstream portion of lower Stony Creek and is not always reflective of downstream temperatures during the spring, summer, and early fall. Temperature monitoring during 2002 and 2003 showed that water temperatures increased rapidly during May and were higher in a downstream direction (Corwin and Grant 2004). The sampling also demonstrated that any steelhead fry attempting to migrate out of the creek during those years would have encountered lethal conditions in lower Stony Creek by early June.

The multi-agency technical team examining the feasibility of restoring steelhead to the Upper Yuba River watershed formulated recommended water temperatures based on optimal, suboptimal, and chronic to acute stress for steelhead life stages (Table 3).

Table 3_. Recommended temperatures for steelhead in the Upper Yuba River basin (adapted from Stillwater Sciences 2006).

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Steelhead Life Stage	Temperature		
	Optimal[1]	Suboptimal[2]	Chronic to Acute Stress[3]
Upstream migration/adult residence	< 52°F	52-70°F	>70°F
Spawning	<52°F	52-55°F	>55°F
Egg incubation	<52°F	52-55°F	>55°F
Fry & juvenile rearing and outmigration	<65°F	65-68°F	>68°F

[1] Feeding and growth occur; growth dependent on food availability. No sublethal or lethal effects.

[2] No direct mortality, but may result in a higher probability of diminished success (i.e., sublethal effects), especially at high end of range.

[3] Chronic exposure at the low end of the range results in sublethal effects, including reduced growth, reduced competitive ability, behavioral alterations, and increased susceptibility to disease. At higher temperatures in this zone, short-term exposure (minutes to days) results in death.

Using these criteria, water temperatures in Stony Creek at the NDD are suboptimal for steelhead rearing by mid- to late-May and reach chronic to acutely stressful conditions by mid-June. Lower-most Stony Creek becomes lethal to steelhead fry by early June and all of lower Stony Creek becomes lethal during the summer based on sampling in 2002 and 2003 (Corwin and Grant 2004).

5. Riparian Vegetation

The overall habitat quality of the riparian plant communities observed for lower Stony Creek is low with respect to species composition, extent and level of reestablishment, and stand maintenance (Harvey and Associates 2006). There are some small pockets of moderate to high-quality riparian habitat mostly above CM 15, above the TCC, and in the lowermost 2 miles. Interpretation of 1992 aerial photographs shows scattered patches of shrubs, typically well removed from the active channel. Much of the riparian habitat is severely infested with invasive species such as giant reed and salt cedar. To provide maximum contribution to steelhead PCEs, the riparian vegetation would have to be adjacent to the wetted channel to provide shade, cover, habitat complexity, and food sources (terrestrial insects).

Giant reed and salt cedar have displaced native riparian vegetation and have become well established along much of lower Stony Creek. These species can often out-compete native vegetation for a variety of reasons, including their superior ability to colonize disturbed areas (Reclamation 1998). The presence of these species diminishes the overall habitat quality of the stream corridor as they do not provide the erosion resistance of native riparian species and do not contribute large woody material to the stream channel.

Giant reed most likely first appeared in lower Stony Creek sometime shortly before 1950. Although it was largely absent in 1950 according to aerial photography, a few individuals

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were apparent between CM 14.5 and CM 15.0 (Reclamation 1998). The most substantial stands within lower Stony Creek also occurred in this area in 1992 according to aerial photographs. In approximately 1965, shortly after the installation of Black Butte Dam, giant reed began expanding at an increased rate. For example, from 1968 to 1995, giant reed increased in area from 2 to 17 acres between CM 14.5 and CM 15 (Reclamation 1998). Giant reed was well established along most of lower Stony Creek from CM 0 to approximately CM 17 with substantial stands present between CM 10.5 and CM 16 in 1998 (Reclamation 1998). By 2005, giant reed existed as far upstream as CM 22 (Harvey and Associates 2006). It has established in dense thickets, especially in disturbed areas, such as gravel mining sites. Giant reed has also displaced native vegetation along unstable channel reaches since stem and root fragments easily flow downstream and rapidly establish in open substrate.

Along with giant reed, salt cedar is replacing native vegetation along the lower Stony Creek stream corridor and reducing overall riparian habitat quality (Reclamation 1998). According to 1992 aerial photographs, the invasion of both salt cedar and giant reed along lower Stony Creek was most prevalent downstream of the I-5 bridge (CM 16). Like giant reed, salt cedar likely also spread at an increased rate along the corridor after the construction of the Black Butte Dam since salt cedar tends to colonize more rapidly in streams impacted by flow regulations (Reclamation 1998).

B. Factors Affecting Species and Critical Habitat within the Action Area

1. Migrational Barriers

The construction and operation of migrational barriers described in the previous section (East Park, Stony Gorge, Black Butte, and North Diversion Dams, and the TCC and GCID irrigation diversions) has greatly impacted listed salmonids and their critical habitat within Stony Creek. By blocking migration to the upper reaches of Stony Creek, these dams have caused the complete extirpation of all spawning populations of spring-run Chinook salmon, and have severely diminished the potential for steelhead to spawn and survive in Stony Creek. One of the primary constituent elements of critical habitat for spring-run Chinook salmon and steelhead is suitable migration corridors. By blocking migration to the upper reaches of Stony Creek, these dams have completely destroyed the suitability of this PCE in lower Stony Creek, as it can no longer act as a migration corridor to the spawning habitat in the upper watershed.

2. Substrate/Spawning Habitat

The lack of quality spawning substrates described above has reduced the spawning potential for steelhead and Chinook salmon in lower Stony Creek. Many stretches of the upper reach, below Black Butte Dam, are completely devoid of suitable spawning gravels and the high proportion of sand and other small sediments in the lower sections of the creek is likely to cause pre-emergent mortality in a high percentage of the eggs that are deposited in the creek.

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3. Hydrologic Conditions

Low spring and summer flows on lower Stony Creek contribute to warm water temperatures and cause the entire creek to be uninhabitable by salmonids. Even as water temperatures cool in the fall, the flow releases are often maintained at such low levels that no flowing water makes it to the Sacramento River, precluding any fish from migrating into the creek to spawn. During the winter and spring flood control season rapid fluctuations and high peak flows can mobilize creek sediments, causing redds to be washed away or be buried under deposits from upstream. Extreme high flow events of greater than 10,000 cfs or 15,000 cfs occurred in 38 and 17 percent, respectively, of the 24 years of record examined (1965 – 1988). While recent adjustments to the Corps' flood management operations have reduced the severity of these impacts, there is still the potential for these operational flow changes to result in the death of eggs and pre-emergent fry. This circumstance is particularly evident for steelhead which spawn January – March, the principal high-flow period.

4. Water Temperature

Due to high summer water temperatures in lower Stony Creek, spring-run Chinook salmon can not complete their full life cycles in the creek, as both require cooler summer temperatures for adult holding and/or spawning and egg incubation. With regards to steelhead, current water temperature conditions in lower Stony Creek are at best marginal, but generally provide the necessary temperatures to allow successful steelhead reproduction in most years. Water temperatures are optimal (<55 °F) throughout the primary steelhead spawning period (December through March) although temperatures can rise quickly in the spring, leaving the potential for late spawned redds and fry to be lost to lethal temperature conditions. Summertime water temperatures are also well above the lethal level for steelhead, precluding the possibility for juveniles to rear in Stony Creek over the summer. Instead, they would be forced to migrate downstream to the mouth of the creek and into the Sacramento River, where temperatures generally remain suitable for steelhead rearing throughout the year. This type of behavior has been documented in other intermittent tributaries to larger rivers. Everest (1973) found that steelhead spawned in January and February in Sam's and Kane Creeks (intermittent tributaries to the Rogue River in southern Oregon) emerged in April and May, and migrated downstream into the Rogue River as water temperatures surpassed 70 °C, often only a few days before the creeks became intermittent. Similar life history strategies are evident in numerous intermittent tributaries in the upper Sacramento River in the Redding area, where steelhead spawn in the small tributaries and their offspring migrate out to the Sacramento River in the spring before the tributaries go dry. Despite the occurrence of marginally suitable water temperatures for steelhead reproduction, recent monitoring has not detected any successful steelhead reproduction in Stony Creek. High water temperatures are considered to be a significant factor in this lack of a healthy steelhead population in the creek (Reclamation 2001).

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5. Riparian Habitat/Instream Structural Diversity

The sparse riparian vegetation and high proportion of invasive giant reed and salt cedar along lower Stony Creek reduce the quality of the critical habitat for rearing salmonids. The lack of dense overhead cover and shade increases water temperatures, reduces the input of food from terrestrial insects and reduces the ability of juvenile salmonids to find shelter from predators. The lack of large woody debris in the creek further impacts the PCE's for rearing and migrating by reducing the instream structural diversity necessary for juvenile feeding and sheltering. The lack of deeply rooted vegetation along the stream banks also allows for accelerated erosion and sediment influx into the stream.

6. Mining

Since 1977, DFG has not allowed instream pit mining in Stony Creek. However, mid-channel gravel-bar skimming remains the typical mining technique used in lower Stony Creek, and excavation below the level of seasonally replenished aggregate has occurred in the area east and west of the Highway 32 bridge (Glenn County 1997). The mines in this area had permitted extraction rates of 300,000-750,000 CY/y in 1990. These rates are 2 to 6 times the natural pre-dam sediment supply from the upper watershed, and 11 to 29 times the current sediment supply provided by upstream bank erosion (Swanson and Kondolf 1991). These tremendous extraction rates have directly lowered the channel bed within the boundaries of the gravel mines and induced channel incision immediately upstream and downstream. Kondolf and Swanson (1993) state: "Even if extraction were to cease today, the channel will continue to adjust to this catastrophic removal of sediment, probably for decades." In areas where gravel mining activities have created a disturbance threshold that exceeds the maintenance and regeneration capabilities of the native riparian vegetation, invasive weeds such as the Giant reed have become established.

These instream gravel mining activities directly impact salmonids and redds by elevating turbidity levels within and downstream of the extraction zones, and by direct disturbance of fish and eggs present within the extraction zone during instream work. Instream gravel mining also depletes the supply of suitable spawning substrates within the creek, an element that is severely limiting in lower Stony Creek.

7. Bank Stabilization/Agricultural and Residential Land Use

Bank stabilization and riprapping associated with land use activities such as agriculture and home building have altered streambank and channel morphology on lower Stony Creek. These practices have led to reductions in downstream recruitment of gravel and large woody debris which has reduced the quality and quantity of the PCEs of spawning and rearing habitat. It is suspected that groundwater pumping may lower the water table which causes Stony Creek water to absorb into the surrounding alluvium and prolongs the period of time that the creek remains disconnected from the Sacramento River during dry periods. However, groundwater hydrographs show that groundwater levels in, and near, the Orland Project actually rise as evidenced by spring and fall groundwater

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measurements (www.ca.water.gov). DWR hydrographs also show an increase in groundwater levels in proximity to the TCC and in related service areas since the mid-1980's. In addition, small unscreened water diversions for agriculture use result in direct entrainment of emigrating salmonids.

8. Species Interactions

In addition to salmonids, lower Stony Creek supports a wide variety of native non-salmonid migratory and resident species, and numerous introduced non-salmonid species. These species may compete with Chinook salmon and steelhead for food and/or suitable habitat, and several may prey upon salmonid fry and juveniles. Population estimates of these species and potential for adverse impacts to salmonids are unknown at this time. Adult Sacramento pikeminnow are known to be abundant in Stony Creek during the spring (the species' spawning period) and are known to prey on salmonid fry. Table 4 shows all fish species reported from various past studies of Stony Creek. The table gives the species names, status as to being exotic or native to the creek, and the area in which they were found.

Table 4
Fish Species Reported In The Stony Creek Watershed

Common Name	Scientific Name	Native / Exotic (N/E)	Above Black Butte Dam	Below Black Butte Dam	Source
Chinook Salmon	*Oncorhynchus tshawytscha*	N		X	a,c,d
Steelhead Trout	*Oncorhynchus mykiss mykiss*	N		X	d
Rainbow Trout	*Oncorhynchus mykiss*	N	X		a,b,c
Sacramento Sucker	*Catostomus occidentalis*	N		X	a,b
Common Carp	*Cyprinus carpio*	E	X	X	a,b,c
Sacramento Squawfish	*Ptychocheilus grandis*	N		X	a,b
California Roach	*Hesperoleucus symmetricus*	N		X	a.b
Speckled Dace	*Rhinichthys osculus*	N		X	a,b
Brown Bullhead	*Ameiurus nebulosus*	E		X	a
Mosquito fish	*Gambusia affinis*	E		X	a,b
Largemouth Bass	*Micropterus salmoides*	E	X	X	a,b,c
Green Sunfish	*Lepomis cyanellus*	E	X	X	a,b,c
Bluegill Sunfish	*Lepomis macrochirus*	E	X	X	a,b,c
Threespine Stickleback	*Gasterosteus aculeatus*	N		X	a,b

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Bigscale Logperch	*Percina macrolepida*	E		X	b
Riffle Sculpin	*Cottus gulosus*	N		X	b
Prickley Sculpin	*Cottus asper*	N		X	b
Hitch	*Lavinia exilicauda*	N		X	b
Golden Shiner	*Notemigonus crysoleucas*	E		X	b
Hardhead	*Mylopharodon conocephalus*	N	X	X	b,c
White Crappie	*Pomoxis annularis*	E	X	X	b,c
Black Crappie	*Pomoxis nigromaculatus*	E	X		c
Striped Bass	*Morone saxatilis*	E	X		c
Smallmouth Bass	*Micropterus dolomieu*	E	X	X	b,c
Channel Catfish	*Ictalurus punctatus*	E	X	X	b,c
White Catfish	*Ameiurus catus*	E	X	X	b,c
Black Bullhead	*Ameiurus melas*	E		X	b
Tule Perch	*Hysterocarpus traski*	N		X	b
Warmouth	*Lepomis gulosus*	E		X	b
Threadfin Shad	*Dorosoma petenese*	E	X	X	b,c
Redear Sunfish	*Lepomis microlophus*	E	X		c
Lamprey	*Lampetra spp.*	N		X	b

Sources:
a. Puckett, 1969
b. M. Brown, 1995
c. DFG (unpublished files Region II)
d. Maslin and McKinney, 1994

C. Likelihood of Species Survival and Recovery in the Action Area

Under baseline conditions, there is zero likelihood of survival and/or recovery of naturally reproducing populations of winter-run Chinook salmon and spring-run Chinook salmon in lower Stony Creek. There is no evidence indicating that winter-run Chinook salmon ever spawned and reproduced in Stony Creek, and it is likely that winter-run use of the creek has always been, as it is today, as opportunistic non-natal rearing habitat.

Spring-run Chinook salmon have been cut off from their historic holding and spawning habitat by the dams on Stony Creek. This blockage of the historic migratory corridor makes it impossible for spring-run Chinook salmon to reproduce in Stony Creek. Spring-run Chinook salmon are now limited to using the creek as non-natal rearing habitat during those periods when water temperatures are suitable and the creek has a flowing connection to the Sacramento River.

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The majority, if not all, of the historic steelhead spawning habitat in Stony Creek has also been cut off by Black Butte Dam. Recent monitoring has not detected any adult or natal juvenile steelhead in lower Stony Creek, and there is no evidence to indicate that steelhead have used the creek as spawning habitat in recent years. However, habitat conditions during the winter spawning and incubation period remain marginally suitable for steelhead reproduction, and it is possible that with the GCID barrier removed from the mouth of the creek since 1999, and ongoing habitat restoration under way, steelhead could eventually recolonize the lower creek and establish a spawning population.

V. EFFECTS OF THE ACTION

For purposes of this analysis, water temperature and flow evaluations in lower Stony Creek are based on official records for the period 1979-1998 (Reclamation 1998, Reclamation and Corps 2001). Project operations and environmental conditions (*i.e.* instream flows, release schedules, water temperatures, etc.) have not changed significantly since this period. This data set is the most recent complete and comprehensive data available and constitutes the best scientific and commercial information available.

A. Approach to the Assessment

1. Information Available for the Assessment

To conduct this assessment, NMFS examined an extensive amount of evidence and information from a variety of sources. Detailed background information on the status of these species and the potential effects of this project on these species has been taken from a number of documents including project-specific environmental reports, peer reviewed scientific journals, primary reference materials, government and non-government reports, project meetings and personal communications.

2. Assumptions Underlying this Assessment

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.

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.

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Because the proposed project is essentially the continuation of water management operations as they have occurred in the recent past, the habitat conditions and the effects of the project that have been observed in the recent past (baseline conditions) are at times described in this section and used as a reasonable estimation of the habitat conditions that can be expected to result from the future effects of the proposed project (effects of the action).

B. Reservoirs Above Black Butte Dam

Under current (and future) operational procedures, storage in East Park and Stony Gorge Reservoirs is maintained as close to the maximum allowable storage levels as possible, unless irrigation demands necessitate releases. The 1964 Exchange Agreement allows Orland Project water held in the upper reservoirs to be exchanged with CVP water within Black Butte Lake. Releases of Orland Project water are then made from Black Butte Lake storage instead of from the upper reservoirs. Water left in the upper reservoir early in the season is available for release to the irrigation system later in the summer or early fall.

In the last 16 years (1991 through 2006), East Park Reservoir has been maintained close to the maximum storage for 13 of 16 years and has consistently re-filled in the winter/spring following the draw-down years. Stony Gorge Reservoir has been drawn down to some extent each fall, but only 6 of those 16 years saw significant draw downs below 32,000 acre-feet of storage (California Data Exchange Center, provisional data).

In years following these rare significant drawdowns, the upper reservoirs refill during the winter months, capturing runoff that would otherwise flow downstream to the lower basin. By capturing this runoff, the refilling of the upper reservoirs delays the filling of Black Butte Lake and may prolong the period of minimum flow releases into lower Stony Creek and therefore extend the period when lower Stony Creek remains dry at its mouth and is hydrologically disconnected from the Sacramento River. When Stony Creek flows fail to reach the Sacramento River this prevents adult steelhead from entering the creek to spawn. The lack of access to Stony Creek in the fall and early winter also prevents fall-run Chinook salmon from spawning in the creek which eliminates an important source of nutrition (*i.e.*, salmon eggs and invertebrates that feed on salmon carcasses) for adult and juvenile steelhead and juvenile winter- and spring-run Chinook salmon. The loss of this important source of nutrients can reduce fitness levels and survival rates of juvenile salmonids rearing in Stony Creek.

C. Black Butte Dam and Lake

The construction of Black Butte Dam on the main stem of Stony Creek in 1963 blocked access by anadromous salmonids to the remainder of their historic spawning habitat within the Stony Creek watershed, including all tributaries to Stony Creek, above Black Butte Dam. The only reach left accessible to these fish is the lower 24.6 miles of creek which runs along the valley floor between the base of Black Butte Dam and the confluence with the Sacramento River. Historical conditions within this reach provided

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very poor if any suitable habitat for salmonid spawning and rearing. High temperatures and low flows created lethal conditions during most summer and early fall months, while high flashy flows carrying heavy sediment loads likely made winter conditions less than optimal for spawning. While the controlled release of stored water from the bottom of Black Butte Lake has likely provided some improvements to habitat conditions such as cooler water later into the spring, more consistent flows and less severe flood conditions, there are still many obstacles to the re-establishment of successful steelhead spawning populations in Stony Creek. These same obstacles prevent the establishment of a significant fall-run Chinook salmon population in Stony Creek, which in turn prevents the influx of important marine based nutrients to the system, impacting the fitness and survival of listed salmonids rearing in Stony Creek.

Black Butte Dam impacts the PCE's of critical habitat in Stony Creek by altering the timing and magnitude of flows as well as sediment transport to lower Stony Creek. Prior to construction of the dam, the channel was a high-gradient, bedload-dominated system with sharp fluctuations in discharge, where the channel carrying the main flow shifted periodically. Post-dam, the flood peaks have been attenuated, and storm runoff is stored for planned releases. Channel width and sediment transport have been reduced in the upper reaches and significant channel realignment has occurred. The sources of most bedload and suspended sediments have been eliminated by the dam. High volume flood control releases can produce accelerated bank erosion, which is the only source for recruitment of coarse bedload within this lower reach. Long-term impacts to PCEs associated with reservoir operations include the decreased recruitment of steelhead and fall-run Chinook spawning gravels, reduced recruitment of woody debris, and encroachment of non-endemic vegetation into spawning and rearing areas resulting in reduced habitat quality (NMFS 1996).

1. Temperature

Lower Stony Creek stream temperatures are directly influenced by ambient air temperature, solar radiation, shading, channel geometry, the temperature and volume of water released from Black Butte Lake. Releases made from Black Butte Lake are made from an outlet located at the bottom of the reservoir, ensuring the coldest temperatures possible. Black Butte Lake often stays relatively shallow during the summer months. Vertical temperature profiles indicate that the lake remains thermally unstable or weakly stratified and is easily mixed vertically by winds and diurnal heating and cooling. The waters are warm throughout the depths during the summer (Corps 1987). Reclamation's analysis of daily mean temperatures from four monitoring locations on lower Stony Creek from July 1995 to December 1997, indicate that winter temperatures are fairly consistent from year to year. Generally, stream temperatures begin to increase in the spring and exceed optimal rearing temperatures (>66 °F) between late April and August. Stream temperatures begin decreasing in September, generally reaching optimal spawning temperatures again in November.

Water temperatures warming up early in the spring can have several adverse effects on listed juvenile salmonids rearing in lower Stony Creek. Elevated temperatures can

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increase susceptibility to diseases, reduce growth rates and increase mortality in salmonids rearing in the creek. High water temperatures can also force juveniles out of the creek into the Sacramento River where rearing habitat is less appropriate for small salmonids than in smaller creeks.

When warm water temperatures are maintained into the fall they can prevent fall-run Chinook salmon from spawning in the creek, thereby eliminating an important source of nutrients for rearing juveniles.

2. Flood Control Operations

The recently revised ramping criteria for flood control releases from Black Butte Lake are described in the Environmental Baseline section of this document. While these revised criteria provide more gradual flow fluctuations during flood control operations than did the old criteria, the flashy nature of Stony Creek still creates situations where it is necessary for releases from Black Butte Dam to increase and decrease rapidly to prevent catastrophic flooding and insure the safety and structural integrity of Black Butte Dam. Stranding of Chinook salmon and steelhead may occur when water levels drop quickly and fish are either left totally exposed in dewatered areas or isolated in wetted areas that are no longer connected to the creek. Incubating eggs are even more susceptible to stranding due to their immobility and the tendency of salmonids to build their redds in shallow riffles. If no additional high flow events follow within a short period of time, isolated fish and eggs are likely to be lost to predation, lethal water temperatures, or desiccation.

The recently revised criteria for management of the bottom 5 to 7 percent of the flood pool in Black Butte Lake (described in the Environmental Baseline section of this document) generally has been successful in maintaining minimum flows of 100 to 200 cfs during the winter and spring flood control periods since late 2003 when the operating agreement was initiated. While no scientific studies have been conducted to analyze the effectiveness of these minimum flows in maintaining suitable steelhead spawning habitat PCEs, they have been found to maintain a flowing connection to the Sacramento River, provide suitable water temperatures for both spawning and rearing, and create a general bank-full condition that maintains connectivity throughout the lower creek, which reduces the potential for stranding and allows free movement through the area (Richard Corwin, Reclamation, pers. comm., May 2005). This recent success in maintaining 100 to 200 cfs minimum flows has occurred during relatively wet years and it is not yet known how successful these new protocols will be in maintaining adequate flows in drier years.

3. Black Butte Dam Powerplant

The Black Butte Dam Powerplant is operated opportunistically to take advantage of releases which are otherwise required for flood control or diversions. Flows releases are not controlled or regulated for hydropower generation. The intake for the powerplant takes water from the base of the dam and therefore provides the coldest water available

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from the reservoir. The powerplant uses only the force of the water to turn the turbines and generate hydropower, and water that is used is subsequently released to lower Stony Creek below Black Butte Dam. Temperature measurements taken at the powerplant tailwaters before release downstream indicate the powerplant does not significantly increase water temperatures downstream. Due to the eventual return of all water used at the powerplant to the creek and the method of power generation, powerplant operations do not affect the amount of flow released into lower Stony Creek from Black Butte Dam and have a negligible effect on the temperatures of flow releases. Therefore, powerplant operations are not likely to impact salmonids in lower Stony Creek.

D. South Diversion Intake and South Canal

The South Diversion Intake and South Canal divert water from an area directly below Black Butte Dam where there is no access for anadromous fish and therefore, no opportunity for listed fish to become entrained in the diversion facility.

South Canal diversions result solely from irrigation demand on the Orland Project south side operations. The Exchange Agreement requires Orland Project irrigation deliveries be provided from Black Butte storage, if available, which allows the upper reservoirs to maintain higher storage while reducing impacts on overall annual system storage since Black Butte flood control procedures require the annual evacuation of Black Butte Reservoir prior to the flood control season (late fall). However, the diversion of this stored water precludes its release into lower Stony Creek where it could otherwise improve the PCEs of critical habitat and improve survival of listed salmonids. If water was not released from Black Butte reservoir for Oreland Project diversions, there would be a greater volume of water left in Black Butte reservoir available for release down Stony Creek in the late fall when the Corps evacuates the reservoir for flood control purposes. Release of higher volumes of water during the late fall period would open up Stony Creek to the Sacramento River, improve habitat conditions in the creek, and allow earlier access to the creek for steelhead and fall-run Chinook salmon. Additionally, in some years, lower reservoir storage may result in higher release temperatures during late spring which could adversely affect listed salmonids incubating or rearing (natal or non-natal) within lower Stony Creek. Elevated temperatures can increase susceptibility to diseases, reduce growth rates and increase mortality in salmonids rearing in the creek. High water temperatures can also force juveniles out of the creek into the Sacramento River where rearing habitat is less appropriate for small salmonids than in smaller creeks. Due to a lack of temperature and habitat modeling for this system, the magnitude of potential impacts to habitat quality resulting from the diversion of this water has not been determined.

E. Northside Diversion Dam and North Canal

North Canal diversions will typically occur during the months of March to November although diversions may occur in any month of the year dependent on water demands and weather patterns. Maximum diversion rates are limited to 130 cfs and there is generally a minimum 30 cfs bypass to lower Stony Creek.

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As with the South Diversion, diversions occurring at the North Diversion Dam result from irrigation demand on Orland Project north side operations. The Exchange Agreement requires Orland Project irrigation deliveries be provided from Black Butte storage, if available, which allows the upper reservoirs to maintain higher storage while reducing impacts on overall annual system storage since Black Butte flood control procedures require the annual evacuation of Black Butte Reservoir prior to the flood control season (late fall).

The release of water for diversion at NDD provides relatively high, stable flows in the upper reach of lower Stony Creek, but the diversion of this water at NDD prevents its continuation down the creek where it could otherwise improve the flow and temperature based PCEs of critical habitat. If water was not released from Black Butte reservoir for Oreland Project diversions, there would be a greater volume of water left in Black Butte reservoir available for release down Stony Creek in the late fall when the Corps evacuates the reservoir for flood control purposes. Release of higher volumes of water during the late fall period would open up Stony Creek to the Sacramento River, improve habitat conditions in the creek, and allow earlier access to the creek for steelhead and fall-run Chinook salmon. Additionally, in some years, lower reservoir storage may result in higher release temperatures during late spring which could affect salmonids incubating or rearing (natal or non-natal) within lower Stony Creek. Elevated temperatures can increase susceptibility to diseases, reduce growth rates and increase mortality in salmonids rearing in the creek. High water temperatures can also force juveniles out of the creek and into the Sacramento River where rearing habitat is less appropriate for small salmonids than in smaller creeks. Due to a lack of temperature and habitat modeling for this system, the magnitude of potential impacts to habitat quality resulting from the diversion of this water has not been determined.

1. Adult Migration, Spawning, and Egg Incubation

In most years, November is the month when water temperatures in Stony Creek cool to the level of preferred temperatures for migrating steelhead adults. Upstream migration and spawning is limited to the reach of Stony Creek below Black Butte Dam due to the impassable nature of this facility. In most years, diversions at NDD have ceased by mid-November, prior to the initiation of the steelhead spawning migration in the Central Valley, and do not resume until late March, after the upstream migration period has ended (DFG 1993). During periods of non-diversion at NDD, the flashboards are removed from the crest of the dam and a large drum gate on the east side of the dam is often raised to allow creek flows to pass through this section of the dam.

A recent barrier analysis conducted by Reclamation (Corwin 2003) found that upstream passage at NDD is completely blocked during periods when the flash boards are installed and that even when the flash boards are removed (*i.e.*, typically from November through March, when most adult Central Valley steelhead migrate), the dam is impassable to average length steelhead at all flow levels. Only steelhead 640 mm and over, or the upper 10 percent of steelhead measured at RBDD should be able to jump over the lowest

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measured crest height, measured at 4,744 cfs. It also was concluded that steelhead measuring 785 mm and above or 0.4 percent of steelhead measured at RBDD would be capable of jumping the dam at any flow levels examined. This study also found that average sized Chinook salmon from the Sacramento River would be capable of passing NDD at all flows above 1,400 cfs and possibly even lower flows down to 165 cfs (Corwin 2003). While the ability to pass NDD would not be expected to benefit winter- or spring-run Chinook salmon, the ability of fall-run Chinook salmon to pass NDD would allow the influx of important nutrients to the system which could benefit rearing juveniles of all runs of Chinook salmon and steelhead in lower Stony Creek. There has been no monitoring for adult salmonids above NDD and juvenile monitoring in the North Diversion Canal during the irrigation season has not detected any juvenile salmonids.

Installation and removal of NDD flashboards requires that releases from Black Butte be brought to 30 cfs for 24 hours prior to, and for the 4 to 5 hours during, the manipulation of the boards. Installation typically occurs in March when irrigation demands begin (average monthly releases from Black Butte Lake range from approximately 90 cfs to 1,750 cfs) and removal typically occurs in November when irrigation demands subside (average monthly releases from Black Butte Lake range from 33 cfs to 224 cfs). Flow fluctuations during installation and removal of the flashboards have the potential to impede passage, strand adult and juvenile fish and dewater sections of spawning gravel containing incubating eggs and newly hatched fry. Depending on weather conditions at the time of flashboard installation and removal, the required low flow level may temporarily increase water temperatures in the creek. Stranding, dewatering, and water temperature increases are expected to result in physiological stress and possibly mortality of individuals exposed to these conditions. Once the flashboards are in place, NDD becomes a total barrier to upstream passage.

2. Fry, Juveniles, and Smolts

If any adult steelhead are able to traverse NDD and successfully spawn in the reach above the dam, the operation of NDD and North Canal is likely to adversely affect juveniles hatched above the structure. Throughout much of the irrigation season the majority of the water (70 to 80 percent) coming down lower Stony Creek is diverted into the unscreened North Canal. Therefore, downstream migrants which attempt to pass NDD after diversions have begun will have a good chance of being diverted into North Canal where they would not survive.

Steelhead spawned and reared above NDD would have to disperse out of Stony Creek as young-of-the-year instead of smolts since lethal summer temperatures (>75 °F occurring as early as June and continuing to October) make it impossible for a year-round population of steelhead juveniles to survive above NDD. Dispersal triggered by temperatures increasing above 65 °F may occur from late April to mid-June. Since the North Canal typically is operated during this time, steelhead migrating downstream from above NDD would likely to be entrained into the North Canal. Juvenile spring-run and winter-run Chinook salmon are not expected to rear above NDD and would not be subjected to entrainment into North Canal.

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Reclamation conducted a monitoring program in the North Canal from 2001 through 2004 in which they operated a fyke net in the upper end of the canal during the early summer diversion period (generally April through June) of each year (Corwin and Grant 2004). The fyke net sampled approximately 15 percent of the total flow in the canal during the sampling period and captured nearly 6,000 fish. None of these fish were salmonids. Continued monitoring through 2006 has likewise failed to detect any salmonids in the North Canal (Reclamation 2006). This data, along with the poor passage conditions at NDD and the poor quality of spawning habitat in the creek above NDD all indicate that there is no successful salmonid spawning occurring above NDD, primarily due to the adverse impacts of the proposed project.

F. Constant Head Orifice Rediversion

The CHO is operated based on demands from April 1 through May 15 and from September 15 through October 29, up to a maximum of 38,293 acre-feet per year. Diversions at the CHO may result in reductions of Black Butte Lake storage. The diversion of this stored water provides increased flows down Stony Creek to the CHO but precludes its continuation down the creek below the CHO where it would otherwise be available to manage for improved salmonid critical habitat PCEs. Additionally, in some years, lower reservoir storage may result in higher release temperatures during late spring through early fall which potentially would affect salmonids incubating or rearing (natal or non-natal) within lower Stony Creek. Due to a lack of temperature and habitat modeling for this system, the magnitude of potential impacts to habitat quality resulting from the diversion of this water has not been determined.

1. Adult Migration, Spawning, and Incubation

CHO operations in the spring can occur during the tail end of the upstream spawning migration period of steelhead. However, very few steelhead are anticipated to be migrating at this time into Stony Creek since April is the very end of the spawning period for steelhead (DFG 1993) and fish are likely to have migrated to their spawning grounds earlier in the spring. Additionally, if any steelhead were to spawn in lower Stony Creek in April or May, their eggs would not be likely to survive as water temperatures in this area generally rise above the level that is lethal to incubating steelhead eggs (58 °F) by mid-April (Reclamation and Corps 2001). Therefore, the operation of the CHO is not likely to adversely affect adult Central Valley steelhead migration and spawning.

2. Fry, Juveniles, and Smolts

Steelhead juveniles spawned and reared in lower Stony Creek likely would disperse out of the creek as young-of-the-year instead of age 1+ because high water temperatures make it impossible for juveniles to survive through the summer in lower Stony Creek. Dispersal may be triggered by increasing water temperatures which can exceed 65 °F beginning as early as late April. Since the unscreened CHO may be operated during this time, any steelhead migrating downstream from above the CHO prior to May 15 may be

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entrained into the TCC and would not be expected to survive. In addition, any non-natal rearing winter- and spring-run Chinook salmon and steelhead juveniles located above the CHO likely would disperse out of the creek according to these same temperature triggers and be subject to the same adverse effects. In order to minimize downstream passage problems at the CHO, culverts are placed within the temporary berm to facilitate passage. Also, adverse effects to juveniles are reduced through implementing conditions of the SWRCB permit (*e.g.*, maintaining bypass flows of 40 cfs below the CHO, slowly ramping down flows, and providing a fish distribution flow of 100 cfs prior to rediversion).

Reclamation conducted monitoring of entrainment into the TCC at the CHO in the springs of 2001, 2002, 2004, and 2005 (Corwin and Grant 2004, Reclamation 2005b, Reclamation 2006). No CHO diversions occurred in 2003 or 2006. The first year of sampling (2001) was basically a pilot year in which sampling strategies and protocols were tested and refined. A single fyke net was deployed for approximately 96 hours over a 15-day period. Only five fish and no salmonids were captured in 2001. In 2002 and 2004, two fyke nets were deployed side-by-side throughout most of the diversion period and several thousand fish, mostly Sacramento suckers (*Catostomus occidentalis),* were captured each year. In 2002, a total of 43 juvenile Chinook salmon were captured in the 2 fyke nets, and the expanded estimate of the total number of Chinook salmon entrained into the TCC that year was 328. In 2004, a total of 20 juvenile Chinook salmon were captured in the 2 fyke nets, and the expanded estimate of the total number of Chinook salmon entrained into the TCC that year was 92. In 2005 there was only a short, four-day diversion period (April 22 – 25). The fyke nets were deployed for a total of 69 hours sampling a total of approximately 175 acre feet of water. Only two fish were captured during this sampling effort, neither of which were salmonids. No steelhead were captured during any of the sampling in the TCC.

It is impossible to positively identify which ESU a wild Chinook salmon belongs to without genetic analysis. However, a length criteria analysis developed for juvenile Chinook salmon on the Sacramento River (Green 1992) indicates that all of the salmon captured (43 individuals) in 2002 were in the fall-and late fall-run Chinook salmon category. This same length criteria analysis indicates that in 2004, approximately 65 percent of the Chinook salmon captured were in the fall- and late fall-run category (resulting in an expanded estimate of 60 individuals entrained), and 35 percent were in the spring-run category (resulting in an expanded estimate of 31 individuals entrained). It should also be noted that the length-at-date criteria model for the Sacramento River (Green 1992) is not necessarily a good indicator for determining ESU classifications of Chinook salmon in tributaries of the Sacramento River. Moore (1997) found that Chinook salmon in Blue Tent Creek grew faster and had a higher condition factor than those in the mainstem Sacramento River, and Maslin *et al.* (1997) stated, "Individuals of the correct size to be members of each of the four Sacramento Chinook races were observed (in Sacramento River tributaries) but rapid growth makes race assignment based on size questionable."

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VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Non-Federal actions that may affect lower Stony Creek include agricultural practices, water withdrawals/diversions, gravel mining, and State or privately sponsored habitat restoration and bank stabilization activities.

A. Agricultural Practices

Agricultural practices in the lower Stony Creek watershed are expected to continue into the future at similar acreages and crop types as are found today. Agriculture is the dominant land use in the area with a variety of crops and practices employed. The dominant perennial crops include both permanent pastures and orchards, and annual crops including wheat, hay, field corn, sugar beets, beans, and Sudan grass. A substantial area within the lower watershed is also used for grazing. Most of the grazed land occurs between Black Butte Dam and the TCC (Reclamation 1998).

Grazing along Stony Creek could increase erosion, reduce riparian vegetation and increase the nutrient load into the creek. The application of chemicals and fertilizers to crops along the creek also could increase the level of contaminants entering the creek. Agricultural water use will also impact the condition of PCEs on lower Stony Creek. Groundwater pumping can lower the water table and cause Stony Creek water to absorb into the surrounding alluvium which could prolong the period of time that the creek remains disconnected from the Sacramento River during dry periods, however Orland Project surface irrigation has been shown increases groundwater levels in the project area.

B. Gravel Mining

As of 1998, six instream gravel extraction operations existed along lower Stony Creek, occupying a total of 1,179 acres, and several new gravel mining operations are proposed for development along lower Stony Creek in the near future (Reclamation 1998). According to the draft Stony Creek Watershed Assessment Existing Conditions Report (Harvey and Associates 2006), gravel extraction rates for these mining operations were not publicly available because the data were considered proprietary. However, Swanson and Kondolf (1991) compiled the permitted extractions for the mines active on Stony Creek at the time of their study. The mining operations immediately upstream and downstream from Hwy 32 had combined permitted extraction rates of 300,000-750,000 CY/y in 1990. These rates are 2 to 6 times the natural pre-dam sediment input from the upper watershed, and 11 to 29 times the sediment supply currently provided by upstream bank erosion. Kondolf and Swanson (1993) state: "Even if extraction were to cease today, the channel will continue to adjust to this catastrophic removal of sediment, probably for decades." Gravel mining activities are expected to continue to directly

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impact salmonids and critical habitat by elevating turbidity levels within and downstream of the extraction zones, and by direct disturbance of any fish and eggs present within the extraction zone during instream work. Instream gravel mining will also continue to deplete the supply of suitable spawning substrates within the creek. These spawning gravels are a PCE of critical habitat that is severely limiting in lower Stony Creek, and their continued extraction, with no significant replenishment, will eventually make the creek completely unsuitable for salmonid spawning. Assuming the above mentioned rates of extraction will continue into the future, it is likely that the associated adverse impacts to critical habitat will continue and likely intensify.

C. Invasive Weed Control and Bank Stabilization

In 2000 the Glenn County Planning Department conducted a scoping process to determine the goals for the lower Stony Creek watershed. The goals that landowners identified were invasive species eradication, reduction of erosion, and modification of the release schedule from Black Butte Dam, also to reduce erosion. The Glenn County Resource Conservation District (GCRCD) is in the process of acquiring and coordinating funding, technical assistance, and permits in order to address the issues and concerns identified by the lower Stony Creek landowners.

Currently, the GCRCD proposes to provide technical, funding, and permitting assistance to private landowners on lower Stony Creek to implement the Lower Stony Creek Non-Native Invasive Species Eradication Project. The purpose of the project is to facilitate the eradication of Giant Reed (*Arundo donax)* and Salt Cedar (*Tamarix)*, revegetate the creek banks with native plants, install vegetative and structural bank stabilization features, and coordinate the permitting process. The GCRCD proposes to coordinate projects on private land using standardized and accepted methods and practices of weed management and bank stabilization in such a way that will not endanger, but improve, public and private natural resources and the environment. The GCRCD will then monitor project effectiveness and completeness using a Quality Assurance Project Plan developed by the GCRCD in conjunction with a technical advisory committee.

This project is likely to create some long-term benefits to salmonids and critical habitat PCEs in lower Stony Creek by improving riparian habitat and reducing fine sediment influx into the creek. There also are likely to be some short-term adverse impacts from instream construction of bank stabilization features and pesticide inflow from weed control. There is likely to be a long-term reduction in spawning gravel recruitment into the creek as lateral bank erosion, which is currently the only source of recruitment of new gravels into the creek, will be reduced.

VII. INTEGRATION AND SYNTHESIS

The greatest adverse effect associated with Stony Creek water management operations is the complete blockage of access by anadromous species to their historical spawning and rearing habitat above Black Butte Dam. Because this historic habitat is no longer

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accessible, Chinook salmon and steelhead are relegated to a small reach of the creek containing only marginal habitat that was not historically used to any great extent by these species. This makes these fish particularly vulnerable to the adverse effects of water management operations of the Corps and Reclamation. These Federal agencies, through the storage, release, and rediversion of flows, control the quantity and quality of the small amount of remaining habitat on Stony Creek.

The alteration of the natural hydrologic cycle due to upstream dam operations on Stony Creek has the potential to adversely affect all life stages of steelhead, as well as non-natal juvenile spring-run and winter-run Chinook salmon. Reservoir operations resulting in large scale flow fluctuations could cause adverse effects such as redd scouring or juvenile stranding. Extended periods of low flow releases can result in increased temperatures and reduced habitat availability.

NDD is a significant barrier to anadromous salmonids, and if any adults manage to pass above the dam and successfully spawn, entrainment of juveniles may occur within the North Canal (though no such passage or entrainment has been detected in 4 years of monitoring (Corwin and Grant 2004)). Juvenile steelhead, spring-run and winter-run Chinook salmon rearing in Stony Creek may also be entrained in the CHO Diversion. The diversion of water out of Stony Creek for consumptive purposes reduces flows below those diversions which can result in increased water temperatures and reduced quality and quantity of critical habitat.

The blockage of spawning gravels by Black Butte Dam, along with gravel extraction at the many mining operations along the creek have created a severe shortage of suitable spawning habitat in lower Stony Creek, with the upper end deeply incised down to bare rock and hardpan, and the lower end heavily dominated by fine sediments that can smother salmonid redds and reduce reproductive success. The continuation of these problems along with a new drive to stabilize the banks of the creek and thus eliminate the last source of gravel recruitment into the creek (*i.e.,* lateral erosion which recaptures old gravel deposits from the historic floodplain) will eventually make the creek completely devoid of suitable spawning habitat.

Impacts on Species Survival and Potential for Recovery

In examining the potential impacts of Stony Creek water management operations on the survival and potential for recovery of listed salmonids, one must determine whether or not those impacts are likely to reduce the numbers, reproduction, or distribution of these fish in such a way that their likelihood of recovery and survival within the action area is appreciably diminished, and if so, how those local reductions are likely to affect the overall populations throughout the Central Valley.

1. Winter- and Spring-run Chinook Salmon

With regards to winter-run and spring-run Chinook salmon, it is clear that project impacts on Stony Creek are unlikely to affect either reproduction or distribution of these ESUs as

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there are no spawning populations of either ESU in Stony Creek. The fact that non-natal juvenile winter-and spring-run Chinook salmon have been documented rearing in Stony Creek means that certain impacts of the water management operations such as sustained low flows, flow fluctuations, and unscreened water diversions could cause a reduction in the numbers of fish that use Stony Creek as rearing habitat. However, the majority of juvenile salmon collected in Stony Creek have been found within the lower two miles of the creek (Maslin and McKinney 1994, Corwin and Grant 2004) where they are not exposed to water diversions and they are likely to have the ability to escape to the Sacramento River when conditions in Stony Creek become unfavorable. Therefore, it is likely that very few of the fish that use Stony Creek as a rearing area actually are harmed or killed by the adverse effects associated with water management operations.

In estimating the effect of the loss of a small proportion of Stony Creek juveniles on the broader Central Valley populations of these ESUs, it is important to note that the poor habitat conditions found in Stony Creek (fluctuating flows, high temperatures, low instream habitat diversity, and poor SRA habitat) make it unlikely that this creek is used as non-natal rearing habitat by a significant proportion of the juvenile populations of these ESUs. On the other hand, were the creek managed in a more favorable manner to improve rearing conditions for juvenile salmonids, this large tributary with a long stretch of accessible, low-gradient habitat could serve as high-quality rearing habitat for a larger number of juvenile winter- and spring-run Chinook salmon. Under current conditions, the injury and death of the small number of juvenile Chinook salmon impacted by Federal water management operations is unlikely to result in detectable reductions in the number, reproduction, or distribution of winter- and spring-run Chinook salmon given the large fluctuations in juvenile survival rates experienced by the populations annually. As a result, NMFS finds that it is not reasonable to expect that these juvenile losses will reduce the likelihood of survival and recovery of the Sacramento River winter-run Chinook salmon or the Central Valley spring-run Chinook salmon.

2. Central Valley steelhead

Although steelhead spawning has not been documented in Stony Creek in recent years, there is access to marginally suitable spawning habitat for steelhead in the creek, and it is reasonable to assume that water management operations can and will have an effect on steelhead numbers, reproduction and distribution within Stony Creek. The severity of the adverse impacts produced by current operations will vary from year to year and season to season dependent on hydrologic conditions, irrigation demands and flood control requirements. It is likely that in years when operations produce extreme flow fluctuations, blockage or delay in migration, extended low-flow periods, and other such impacts, steelhead numbers, reproductive success, and distribution will be reduced. If these severe conditions occur on a regular basis, the likelihood of survival and recovery of any local steelhead population would be appreciably reduced.

The determination that the proposed project has the potential to appreciably reduce the likelihood of survival and recovery of the local steelhead population in lower Stony Creek requires that we must next determine the importance of this population to the

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viability of the overall Central Valley DPS. This importance can be measured by the level of contribution that the Stony Creek population makes to the numbers, genetic diversity, and resilience of the greater DPS.

It is likely that prior to the permanent removal of the GCID crossing, favorable conditions for steelhead spawning and fry survival only occurred on an occasional basis and it is unlikely that a significant sustained population could have been established. The longstanding access problem caused by the GCID canal crossing, along with all of the other effects of current water management operations on Stony Creek make it very unlikely that any current population of steelhead on Stony Creek is large enough or genetically distinct enough to contribute significantly to the Central Valley DPS. Based on the likely low value of the Stony Creek population to the overall diversity and resilience of the Central Valley steelhead DPS, NMFS finds that it is not reasonable to expect that reductions in the likelihood of survival and recovery of the local population will result in reductions in the likelihood of survival and recovery of the DPS.

3. Critical Habitat

Habitat conditions in lower Stony Creek below Black Butte Dam always have been marginal in terms of the ability to support spawning populations of Chinook salmon and steelhead. The location on the valley floor and natural hydrologic conditions created an environment that was likely too hot and dry to serve as anything other than a migratory corridor for these fish to access the more suitable habitat found in the upper reaches of the watershed. The controlled release of relatively cool water out of Black Butte Dam has improved the potential for this reach to serve as spawning and rearing habitat, although that improvement is relatively limited and the habitat remains marginal.

While the proposed water management operations to be conducted on lower Stony Creek do not allow the accessible habitat within the creek to meet the full potential to support and conserve listed salmonids, the small amount of habitat available in lower Stony Creek and the incremental level of degradation likely to result from future operations do not appear to significantly degrade the functions for which the habitat is currently being used (primarily as non-natal rearing habitat during cold water periods). Proposed operations are expected to maintain the currently medium conservation value (NMFS 2005) of the habitat and are not expected to diminish the current levels or types of habitat use by salmonids. As a result, NMFS expects that the proposed operations are not likely to diminish the value of critical habitat in lower Stony Creek for the survival and recovery of spring-run Chinook salmon and steelhead, or diminish the value of critical habitat within the overall designation. Lower Stony Creek water management operations are not expected to impact critical habitat for Sacramento River winter-run Chinook salmon, which has not been designated within the creek.

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VIII. CONCLUSION

After reviewing the current status of endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, and critical habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead, the environmental baseline for the action area, the effects of proposed lower Stony Creek water operations, and all other cumulative effects, it is NMFS' biological opinion that lower Stony Creek water operations are not likely to jeopardize the continued existence of these species, and are not likely to destroy or adversely modify designated critical habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by Reclamation and the Corps (the Agencies) so that they become binding conditions of any permits issued or project descriptions, as appropriate, for the exemption in section 7(o)(2) to apply. The Agencies have a continuing duty to regulate the activities covered by this incidental take statement. If the Agencies fail to assume and implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Agencies must report the progress of the action and its impact on the species to NMFS as specified in this incidental take statement (50 C.F.R. §402.14(i)(3)).

A. Amount or Extent of Take

There are several aspects of the proposed action which have the potential to take listed species. The actual numbers of individuals likely to be taken can be estimated for certain aspects of the project while for others it cannot. With regards to the entrainment of fish into the irrigation canals, data is available from which to derive an estimate of take likely to occur from these activities. Data collected during Reclamation's studies and sampling efforts in lower Stony Creek (Corwin and Grant 2004, Reclamation 2005) has been

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analyzed to create an estimate of the level of entrainment that might occur due to future irrigation diversions on lower Stony Creek.

Although biologists who conducted the fish monitoring study are of the opinion that all Chinook salmon caught near the CHO were most likely members of the fall-run ESU, it is impossible to positively determine which ESU the juvenile Chinook salmon captured or entrained in Stony Creek might belong to. Therefore, a conservative approach will be taken in assuming that all entrained juvenile Chinook salmon are listed species (*i.e.,* either Central Valley spring-run or Sacramento River winter-run Chinook salmon) to insure that adequate accounting of potential take is provided should future ESU identification reveal that some or all these fish are in fact members of the listed ESUs. The highest estimate of Chinook salmon entrainment occurred in 2002 with 328 Chinook salmon entrained. Although Reclamation's monitoring efforts have not detected entrainment of Central Valley steelhead at the TCC diversion or the North Diversion, a small amount of steelhead take will be assumed to insure that any potential future take of steelhead will be accounted for, and thereby avoid jeopardizing Reclamation's future operation of these facilities due to "unauthorized take". Therefore we will assume that the maximum level of take expected at the agricultural diversions on Stony Creek will be 328 juvenile winter-run and/or spring-run Chinook salmon and 20 juvenile steelhead.

The entrainment monitoring and salvage system that is currently being used on the TCC diversion is assumed to capture a large proportion of the fish entrained into the diversion (wing-nets on the fyke traps now span the entire canal and are operated throughout the diversion period; conditions permitting). Every effort is made to insure that all fish captured in these traps are kept in good condition and are released back into the creek, below the diversion, following data collection. Through analysis of past capture and mortality rates, debris loads in the fike traps, and frequent fluctuations in diversion flows at the CHO, Reclamation has estimated that the level of lethal take for salmonids captured within the fyke traps will be approximately 49 fish during each annual monitoring/salvage period.

There are several other aspects of the proposed water management operations which can cause the incidental take of listed species through extreme flow fluctuations, insufficient releases which do not maintain suitable habitat conditions within lower Stony Creek, and the installation, operation and maintenance of diversion structures. The take associated with these activities is likely to occur in the form of dewatered redds, scoured redds, delayed or blocked migration due to low flows and/or structural impediments (diversion structures), isolation and stranding of fish due to flow fluctuations, and reduced survival and fecundity due to unfavorable habitat conditions. It is impossible to estimate the number of listed fish likely to be taken as a result of these impacts due to many unpredictable variables such as population size and timing of use by the various life stages of the listed species in Stony Creek and weather conditions/precipitation levels which will influence the frequency, timing, and magnitude of flow fluctuations as well as water temperatures and habitat availability and quality.

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Because of the unpredictable nature of the annual level of take likely to be caused by these aspects of Stony Creek water management operations, NMFS has designated specific project related ecological surrogates to represent the extent of take anticipated to be caused by Stony Creek water management operations, so that we will be able to monitor those surrogates to determine the level of take that is occurring. The three most appropriate ecological surrogates for the extent of take caused by Stony Creek water management operations are: 1) the timing and duration of rediversion activities at the TCC; 2) the minimum bypass flows that will be maintained below specific diversion points on Stony Creek; and 3) the flood control/ramping rate operations that will be implemented by the Corps.

1. Ecological Surrogates

- The analysis of the effects of the proposed project anticipates that the diversion structure for the TCC will not be installed prior to April 1 of each year and a minimum 40 cfs bypass flow will be maintained at all times while the diversion structure is in place. Additionally, a fish distribution flow of not less than 100 cfs will be released below NDD for a period of 24 hours prior to the commencement of spring time diversions at the TCC.

- The analysis of the effects of the proposed project anticipates that a minimum of 30 cfs flow will be maintained below the lowest point of diversion not withstanding the above 40cfs requirement below the active TCC diversion.

- The analysis of the effects of the proposed project anticipates that the Corps will follow the flood control/ramping rate guidelines described on pages 33 and 34 of this document.

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

B. Effect of the Take

In this biological opinion, NMFS has determined that the level of anticipated take is not likely to jeopardize the continued existence of listed Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead or result in the destruction or adverse modification of critical habitat.

C. Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize take of Sacramento winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead:

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1. Reclamation shall seek to minimize the impacts to listed species associated with the diversion of water from Stony Creek by continuing to capture and count salmonids that may become entrained into the CHO, and release them below the CHO.

2. The Corps shall implement flood release protocols to minimize the adverse effects of low flows and flow fluctuations on incubating eggs as well as juvenile and adult anadromous salmonids in Stony Creek.

3. The Corps shall develop and implement a long-term gravel augmentation program to improve the quality and quantity of salmonid spawning habitat throughout lower Stony Creek.

4. Reclamation and the Corps shall meet with NMFS each spring to determine minimum instream flows in lower Stony Creek during the spring cold-water period. The provision of increased minimum instream flows will be determined using water storage levels in the three reservoirs and projected inflow into Black Butte Reservoir on or after April 1 of each year.

D. Terms and Conditions

Reclamation and the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures listed above. These terms and conditions are non-discretionary.

1. Reclamation shall seek to minimize the impacts to listed species associated with the diversion of water from Stony Creek by continuing to capture and count salmonids that may become entrained into the CHO, and to release them below the CHO.

    A) Reclamation shall continue to implement the fish monitoring/salvage operations at the CHO during all periods that water is being diverted into the TCC during the spring diversion season (April 1-May 15). The trapping facilities shall be designed so as to sample the entire flow of the diversion by extending wing nets from the edges of the traps out to the banks of the channel. This can safely be done with flows up to 200 cfs. Wing nets or similar devices should also be employed between the two traps to insure that fish are not able to pass between the traps without being captured. When flows are above 200 cfs, Reclamation shall sample as much of the flow as can be safely sampled, with a minimum of 40% of the channel being sampled.

    B) Reclamation shall provide an annual report on the number, species, and disposition of all salmonids captured during the monitoring/salvage operations at the CHO. This report shall be provided within four months of the completion of monitoring/salvage operations each year. Take may

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not exceed 328 Chinook salmon and 20 steelhead. Lethal take for salmonids may not exceed 49 individuals during the annual monitoring/salvage operations.

The above mentioned report required by term and condition 1-B shall be submitted to:

Office Supervisor
Sacramento Area Office
National Marine Fisheries Service
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814
FAX: (916) 930-3629
Phone: (916) 930-3604

2. The Corps shall implement flood release protocols to minimize the adverse effects of flow fluctuations on incubating eggs as well as juvenile and adult anadromous salmonids in Stony Creek.

A) The Corps shall implement, to the extent possible, the ramping rate criteria provided in Table 5 for flood releases[1] from Black Butte Lake when storage elevations are encroached into the prescribed flood control space required at any particular time as determined from the updated Flood Control Diagram.

The rates of change for increasing flood releases of minimum flow to 1,000 cfs shall be as follows:

i. When storage encroaches 0 percent to 25 percent of the required flood control space, releases will be increased by no more than 250 cfs/hour.

ii. When storage encroaches 25 percent to 50 percent of the required flood control space, releases will be increased by no more than 500 cfs/hour.

iii. When storage encroaches 50 percent or more of the required flood control space, releases will be increased by no more than 1,000 cfs/hour.

When flood releases are above 1,000 cfs, releases shall be increased by no more than 1,000 cfs/hour. Exceptions to this requirement shall be allowed to insure the

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[1] *All releases are expected to be within +/- 5 percent of those targeted.*

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structural integrity of the Corps' facilities and in emergency situations, to protect human lives and property from downstream flood damages.

The rate of change for decreasing releases shall be as follows:

i When flood release is 15,000 cfs to 5,000 cfs, releases will be decreased by no more than 500 cfs/hour.

ii When flood release is 5,000 cfs to 500 cfs, releases will be decreased by no more than 250 cfs/hour.

iii. When flood release is 500 cfs to 100 cfs, releases will be decreased by no more than 250 cfs/day at a rate not greater than 30 cfs/hr.

iv. When flood release is at or below 100 cfs, releases will be decreased in approximately 10 cfs/hour increments.

Table 5. Corps Ramping Rates[1]

When Increasing Flood Releases from Minimum Flow to 1,000 cfs:	
0 % to 25 % encroachment	250 cfs/hr or less
25 % to 50 % encroachment	500 cfs/hr. or less
Above 50 % encroachment	1,000 cfs/hr or less
When Increasing Flood Releases Above 1,000 cfs[2]:	
Any encroachment	1,000 cfs/hr. or less
When Decreasing Flood Releases:	
Flood releases 15,000 to 5,000 cfs	500 cfs/hr. or less
Flood releases 5,000 to 500 cfs	250 cfs/hr. or less
Flood releases 500 to 100 cfs	250 cfs/day at a rate not greater than 30 cfs/hr
Flood releases 100 cfs or less	10 cfs/hr

[1]*All releases are expected to be within + /- 5 of percent those targeted.*

[2]*Operating experience has shown that when upward release changes are required within the range of 4,000 cfs to 6,500 cfs (depending on reservoir storage) the gates should be operated in such a way as to force a hydraulic jump below the outlet portal by temporarily increasing the release by approximately 2,000 cfs. Once the hydraulic jump is established, the 1,000 cfs per hour (or less) rate of release would resume.*

B) The Corps shall continue to implement the recently developed flood release protocols for the last 5 to 7 percent of floodwater encroachment in Black Butte Lake. The intent is to release this last increment of flood water in a manner that will maintain minimum releases of 100 cfs or

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greater for as long as possible during flood control operations. On an annual basis in the fall of each year, the Corps, NMFS, and Reclamation shall meet to develop guidelines for release patterns for the upcoming winter with the intent of providing consistently suitable conditions for successful spawning and survival of anadromous salmonids. Those alternative release patterns shall not impair the Corps' flood control abilities through Black Butte Dam. In the event that flood releases are being made when irrigation water is requested, the total release from Black Butte Dam will be irrigation demands plus the desired instream flow needed for promoting successful spawning and survival of anadromous salmonids.

3. The Corps shall develop and implement a long-term gravel augmentation program to improve the quality and quantity of salmonid spawning habitat throughout lower Stony Creek.

   A) The Corps shall work with NMFS and other willing partners (GCRCD, Reclamation, local gravel mine operators, *etc.*) to develop and implement a spawning gravel augmentation program whereby an appropriate amount of suitably sized, clean spawning gravel will be placed into the upper end of lower Stony Creek on a regular basis to improve spawning habitat in those parts of the creek that have been deprived of adequate gravel recruitment due to the existence of Black Butte Dam. Implementation of this program shall commence within five (5) years of the issuance of this biological opinion

4. Reclamation and the Corps shall meet with NMFS each spring to determine minimum instream flows in lower Stony Creek during the spring cold-water period. The provision of increased minimum instream flows will be determined using water storage levels in the three reservoirs and projected inflow into Black Butte Reservoir on or after April 1 of each year.

   A) NMFS will initiate communications in early March of each year to establish early storage and inflow conditions and to set a meeting between Reclamation, the Corps and NMFS where the agencies will determine minimum instream flows in lower Stony Creek during the spring cold-water period.

   In those years when storage in Black Butte Lake is expected to exceed 104,654 acre feet on or after April 1, and the upstream reservoirs are full (Stony Gorge with 50,300 acre-feet, and East Park with 51,000 acre-feet), Reclamation shall increase minimum flows as much as possible with the intent of maintaining these flow levels throughout the cold-water period (see below). The target instream flow level shall be maintained below the lowest active diversion (or from Black Butte Dam if no diversions are occurring) during those periods when Reclamation has control over Black

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Butte releases (non-flood control periods). These minimum flow releases will be determined by consensus between NMFS, Reclamation, and the Corps using water storage levels and anticipated inflow to the three reservoirs on or after April 1 of each year as a guideline.

When implemented, the increased minimum instream flow will be maintained as long as possible or through May 31 of that year, or until average daily water temperatures at the release point for Black Butte Dam reach 70 °F for three consecutive days, whichever occurs first, or until the time when the total system storage is less than 32.5 TAF (sum of minimum pool storage in the three reservoirs).

Failure by either agency to implement the project as described in this BO or to implement the terms and conditions set forth in this incidental take statement may cause the level of incidental take anticipated in this BO to be exceeded. If such a situation arises, the Agencies must immediately notify NMFS to provide an explanation for the deviation from the proposed project description or non adherence to the terms and conditions and review with NMFS the need for reinitiation of consultation.

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on a listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Reclamation and the Corps should support and promote habitat restoration activities on lower Stony Creek, including the local landowner based efforts to restore healthy riparian habitat along the lower creek.

2. To improve habitat conditions and allow earlier access to Stony Creek for upstream migrating salmonids, Reclamation should use excess pumping capacity at the Red Bluff Pumping Plant (RBPP) to provide flows into the TCC which would be released into Stony Creek through the CHO in the fall. These releases should be a minimum of 75 cfs (the standard capacity of a single pump at the RBPP), should begin when water temperatures in the canal cool down to the point where they would provide suitable and attractive habitat for salmonids attempting to enter Stony Creek (below 68 °F), and should continue until natural instream flows in Stony Creek reach 100 cfs at the CHO.

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

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XI. REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the proposed lower Stony Creek Water Management Operations Plan. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take authorized in the accompanying incidental take statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in this opinion; (3) the action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

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Enclosure 2

Magnuson-Stevens Fishery Conservation and Management Act (MSA)

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS[1]
U.S. Bureau of Reclamation and U.S. Army Corps of Engineers Lower Stony Creek Water Management Operations

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The geographic extent of freshwater essential fish habitat (EFH) for the Pacific salmon fishery includes waters currently or historically accessible to salmon within specific U.S. Geological Survey hydrologic units (Pacific Fishery Management Council 1999). EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of EFH, "waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

The associated biological opinion (Enclosure 1) thoroughly addresses the species of Chinook salmon listed both under the Endangered Species Act (ESA) as well as the MSA which potentially will be affected by the proposed action. These include Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley spring-run Chinook salmon (*O. tshawytscha*). Therefore, this EFH consultation will concentrate primarily on the Central Valley fall/late fall-run Chinook salmon (*O. tshawytscha*) which is covered under the MSA, although not listed under the ESA.

The Sacramento, Feather, Yuba, American, Cosumnes, Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin Rivers, and many of their tributaries, support wild populations of Central Valley fall-/late fall-run (herein "fall-run") Chinook salmon. However, 40 to 50 percent of spawning and rearing habitats once used by these fish have been lost or degraded. Fall-run Chinook salmon once were found throughout the Sacramento and San Joaquin River drainages, but have suffered declines since the mid-

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

1900s as a result of several factors, including commercial fishing, blockage of spawning and rearing habitat, water flow fluctuations, unsuitable water temperatures, loss of fish in overflow basins, loss of genetic fitness and habitat competition due to straying hatchery fish, and a reduction in habitat quality.

Chinook salmon in the Sacramento/San Joaquin basin are genetically and physically distinguishable from coastal forms (Clark 1929). Additionally, San Joaquin River populations tend to mature at an earlier age and spawn later in the year than Sacramento River populations. These differences could have been phenotypic responses to the generally warmer temperature and lower flow conditions found in the San Joaquin River basin relative to the Sacramento River basin. There is no apparent difference in the distribution of marine coded wire tag (CWT) recoveries from Sacramento and San Joaquin River hatchery populations, nor are there genetic differences between Sacramento and San Joaquin River fall-run populations (based on DNA and allozyme analysis) of a similar magnitude to that used in distinguishing other Evolutionarily Significant Units (ESUs). This apparent lack of distinguishing life-history and genetic characteristics may be due, in part, to large-scale transfers of Sacramento River fall-run Chinook salmon into the San Joaquin River basin.

The historical abundance of fall-run Chinook salmon is poorly documented (Myers *et al.* 1998) and complete estimates are not available until 1953 (U.S. Fish and Wildlife Service [FWS] 1995). From the late 1930s to the late 1950s estimates for mainstem Sacramento River fall-run fish were obtained from spawning surveys and ladder counts at the Anderson-Cottonwood Irrigation Dam. Although surveys were not consistent or complete, they did yield population estimates for fall-run Chinook salmon in the Sacramento River ranging from 102,000 to 513,000 fish (Yoshiyama *et al.* 1998). Average escapement from 1953 to 1966 was 179,000 fish and from 1967 to 1991 was 77,000 (FWS 1995). From 1992 to 1997 the estimated fall-run population in the Sacramento River has ranged from 107,300 to 381,000 fish (Yoshiyama *et al.* 1998). Over the last 6 years average escapement of fall-run spawners in the mainstem Sacramento River has been above 190,000; however, 20 to 40 percent of these natural spawners have been of hatchery origin. The increase in salmon runs in the Sacramento River since 1990 may be attributable to several factors including, increased water supplies following the 1987-1992 drought, stricter ocean harvest regulations, and fisheries restoration actions throughout the Central Valley. However, it is unclear if natural populations are self-sustaining or if the appearance of a healthy population is due to high hatchery production. Concern remains over impacts from high hatchery production and harvest levels, although ocean and freshwater harvest rates have been recently reduced.

Although little information has been documented on fall/late-fall run Chinook salmon spawning in Stony Creek since the construction of Black Butte Dam, there has been sporadic documentation of spawning and juvenile rearing within the creek. Spawning surveys conducted by the California Department of Fish and Game (DFG) in the winter of 1981-82 estimated 384 adult fall-run Chinook salmon spawning in Stony Creek (Reavis 1983). A survey conducted by DFG during the fall and winter of 2000-01

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documented successful Chinook salmon spawning in Stony Creek during a very dry year. Although no adult salmon were actually seen during this highly limited survey, redds were located and newly emergent fry were collected at several locations throughout the lower 15 miles of the creek (Charles Brown, DFG, pers. comm., March 5, 2001).

Corwin and Grant (2004) conducted limited surveys for adult Chinook salmon and redds during the fall-run spawning season from 2001 through 2004. While high stream flows and a lack of private land access limited these surveys to a very small area of the creek over short periods of time, the investigators found proof (in the form of live fish, carcasses, and/or redds) of adult escapement and spawning in each year of the study. In 2003, a groundwater monitoring study conducted by the California Department of Water Resources provided sufficient flows in lower Stony Creek to allow surface flows to reach the confluence of the Sacramento River during the early part of the fall-run Chinook salmon migration period. That fall's surveys showed the highest level of spawning activity of the 4-year study, with 27 live adults, 13 carcasses, and 18 redds documented before an increase in flows on December 10, 2003, made it impossible to conduct further surveys for the rest of the winter. The capture of newly-hatched fry Chinook salmon (30 to 40 mm fork-length) in each year of the study provided further evidence of consistently successful Chinook salmon spawning in lower Stony Creek during the study period (Corwin and Grant 2004).

A. Life History and Habitat Requirements

Central Valley fall-run Chinook salmon are "ocean-type," entering the Sacramento River from July through December, and spawning from October through January. Peak spawning occurs in October and November (Reynolds *et al.* 1993). Chinook salmon spawning generally occurs in swift, relatively shallow riffles or along the edges of fast runs at depths up to 15 feet. Preferred spawning substrate is clean loose gravel. Gravels are unsuitable for spawning when cemented with clay or fines, or when sediments settle out onto redds reducing intergravel percolation (NMFS 1997).

Egg incubation occurs from October through March, and juvenile rearing and smolt emigration occurs from January through June (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and estuary (Kjelson *et al.* 1982). The remainder of fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, tributary streams are used as rearing habitat. These non-natal rearing areas are highly productive micro-habitats providing abundant food and cover for juvenile Chinook salmon to grow to the smolt stage. Smolts are juvenile salmonids that are undergoing a physiological transformation that allows them to enter saltwater. These smolts generally spend a very short time in the Delta and estuary before entry into the ocean.

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In contrast, the majority of fry carried downstream soon after emergence are believed to reside in the Delta and estuary for several months before entering the ocean (Healey 1980, 1982; Kjelson *et al.* 1982). Principal foods of Chinook salmon while rearing in freshwater and estuarine environments are larval and adult insects and zooplankton such as *Daphnia,* flies, gnats, mosquitoes or copepods (Kjelson *et al.* 1982), stonefly nymphs or beetle larvae (Chapman and Quistdorff 1938) as well as other estuarine and freshwater invertebrates. All outmigrant Central Valley fall-run Chinook salmon depend on passage through the Sacramento-San Joaquin Delta for access to the ocean. They remain off the California coast during their ocean residence and migration.

II. DESCRIPTION OF THE PROPOSED ACTION

The proposed action is described in the *Description of the Proposed Action* section of the associated biological opinion (Enclosure 1) for the endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, and threatened Central Valley steelhead ESUs.

III. EFFECTS OF THE ACTION

The greatest adverse effect on fall-run Chinook salmon EFH associated with Stony Creek water management operations is the complete blockage of access to a large portion their historical spawning and rearing habitat above Black Butte Dam. Because this historic habitat is no longer accessible, Chinook salmon are relegated to a small reach of the creek containing only marginal habitat. This makes these fish particularly vulnerable to the water management operations of the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation (Reclamation). These Federal agencies, through the storage and release of flows, control the quantity and quality of the small amount of remaining habitat on Stony Creek. The alteration of the natural hydrologic cycle due to upstream dam operations on Stony Creek has the potential to adversely affect all life stages of fall-run Chinook salmon. The storage of fall and early winter rains in upstream reservoirs prevents the flows of lower Stony Creek from reaching the Sacramento River until December of most years, thereby excluding the vast majority of adult fall-run Chinook salmon from entering Stony Creek to spawn. Reservoir operations resulting in large scale flow fluctuations can cause adverse effects such as redd scouring or juvenile stranding. Extended periods of low flow releases can result in increased temperatures and reduced habitat availability.

Diversion of irrigation water into the Tehama Colusa Canal (TCC) through the constant head orifice (CHO) at Stony Creek is another major impact to EFH, and causes direct entrainment and loss of juvenile fall-run Chinook salmon. The diversion of water out of Stony Creek for consumptive purposes also reduces flows below those diversions which results in increased water temperatures and reduced quality and quantity of essential habitat.

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As discussed above, EFH protections apply to all ESUs of Pacific Chinook salmon, so the adverse effects that impact the habitat occupied by winter- and spring-run Chinook salmon juveniles are also considered adverse effects on EFH. Those effects are thoroughly detailed in the biological opinion for the proposed project (Enclosure 1).

IV. CONCLUSION

Upon review of the effects of lower Stony Creek water management operations, NMFS believes that some project activities will adversely affect EFH of Pacific salmon protected under the MSA.

V. EFH CONSERVATION RECOMMENDATIONS

As the habitat requirements of Central Valley fall-run Chinook salmon within the action area are similar to those of the Federally-listed species addressed in the attached biological opinion, NMFS recommends that the ESA reasonable and prudent measures and conservation recommendations included in the biological opinion prepared for the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead ESUs, be adopted as EFH conservation recommendations.

Additionally, the following conservation recommendation should be implemented to improve migrational, holding, and spawning habitat for Chinook salmon within the action area.

- To improve habitat conditions and allow earlier access to Stony Creek for upstream migrating Chinook salmon, Reclamation should use available pumping capacity at the Red Bluff Pumping Plant to provide flows into the TCC which would be released into Stony Creek through the CHO in the fall. These releases should be a minimum of 75 cfs (the standard capacity of a single pump at the RBPP), should begin when water temperatures in the canal cool down to the point where they would provide suitable and attractive habitat for salmonids attempting to enter Stony Creek (below 68 °F), and should continue until natural instream flows in Stony Creek reach 100 cfs at the CHO.

VI. ACTION AGENCY STATUTORY REQUIREMENTS

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

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recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(j)).

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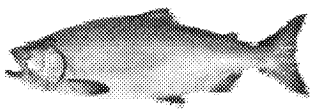
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AND
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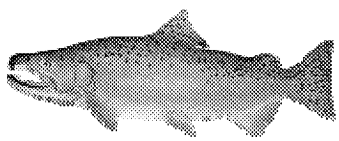
AND

THE DISTINCT POPULATION SEGMENT OF

CALIFORNIA CENTRAL VALLEY STEELHEAD



Winter-run



Spring-run



Steelhead

National Marine Fisheries Service

West Coast Region

Sacramento, California

July 2014

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DISCLAIMER

Recovery plans delineate such reasonable actions as may be necessary for the conservation and survival of listed species. Plans are published by the National Marine Fisheries Service (NMFS), sometimes prepared with the assistance of recovery teams, contractors, State agencies and others. Recovery plans do not necessarily represent the views, official positions or approval of any individuals or agencies involved in the plan formulation, other than NMFS. They represent the official position of NMFS only after they have been signed by the Assistant Administrator. Recovery plans are guidance and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any general agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions.

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Final Recovery plans can be downloaded from the NMFS website:

http://www.nmfs.noaa.gov/pr/recovery/plans.htm

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List of Acronyms

AFRP	Anadromous Fish Restoration Program
Bay/Delta	San Francisco Bay/Sacramento-San Joaquin Delta
BRT	Biological Review Team
CALFED	CALFED Bay-Delta Program
CAMP	Comprehensive Assessment and Monitoring Program
CBDA	California Bay/Delta Authority
CCWD	Contra Costa Water District
CCWMG	Cow Creek Watershed Management Group
CDFW	California Department of Fish and Wildlife
CESA	California Endangered Species Act
CMARP	Comprehensive Monitoring Assessment and Research Program
cm	centimeters
cm/sec	centimeters per second
CNFH	Coleman National Fish Hatchery
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVSEPWT	Central Valley Salmonid Escapement Project Work Team
CWT	Coded Wire Tag
Delta	Sacramento-San Joaquin Delta
DPS	Distinct Population Segment
DWR	Department of Water Resources
ERP	Ecosystem Restoration Program
ESA	Federal Endangered Species Act
ESU	Evolutionarily Significant Unit
EWA	Environmental Water Account
FERC	Federal Energy Regulatory Commission
FL	fork length
FRFH	Feather River Fish Hatchery
ft/sec	feet per second
HGMPs	Hatchery and Genetic Management Plans
IEP	Interagency Ecological Program
LSNFH	Livingston Stone National Fish Hatchery
m	meters
mi^2	square miles
m/sec	millimeters per second
mm	millimeters
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PCSRF	Pacific Coastal Salmon Recovery Fund
PRD	Protected Resources Division
PVA	Population Viability Analyses
QC	Quality Control
RBDD	Red Bluff Diversion Dam
Reclamation	Bureau of Reclamation
RM	River Mile
RST	Rotary Screw Trap
SWP	State Water Project
TRT	Technical Recovery Team
USACOE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
VSP	Viable Salmonid Population

EXECUTIVE SUMMARY

Introduction: Recovery is the process by which listed species and their ecosystems are restored and their future is safeguarded to the point that protections under the Endangered Species Act (ESA) are no longer needed. The goal of this Recovery Plan is to recover the endangered Sacramento River winter-run Chinook salmon Evolutionarily Significant Unit (ESU), the threatened Central Valley spring-run Chinook salmon ESU, and the threatened California Central Valley steelhead Distinct Population Segment (DPS). Recovering these species and the Central Valley, San Francisco Bay-Delta Estuary, and Pacific Ocean ecosystems that support them will be challenging and will require shifts in societal values. Californians must work together towards a conservation ethic and practice that ensures wild salmon and steelhead are an important part of coastal California and Central Valley culture for many generations to come.

Background: The rivers draining the Great Central Valley of California ("Central Valley") and adjacent Sierra Nevada and Cascade Range once were renowned for their production of large numbers of Pacific salmon (Clark 1929; Skinner 1962 *in* Yoshiyama *et al.* 1998). The Central Valley rivers and creeks historically have been the source of most of the Pacific salmon produced in California waters (CDFW 1950, 1955; Fry and Hughes 1951; Skinner 1962; CDWR 1984 *in* Yoshiyama *et al.* 1998). Chinook salmon *(Oncorhynchus tshawytscha)* historically were, and remain today, the only abundant salmon species in the Central Valley (Eigenmann 1890; Rutter 1908 *in* Yoshiyama *et al.* 1998), although small numbers of other salmon species also have occurred occasionally in its rivers (Collins 1892; Rutter 1904a, 1908; Hallock and Fry 1967; Moyle *et al.* 1995 *in* Yoshiyama *et al.* 1998). Steelhead (anadromous *O. mykiss)* were common in Central Valley tributaries (USFC 1876; Clark 1973; Latta 1977; Reynolds *et al.* 1993 *in* Yoshiyama *et al.* 1998), but records for them are few and fragmented, partly because they did not support commercial fisheries (Yoshiyama *et al.* 1998).

Populations of native Chinook salmon and steelhead have declined dramatically since European settlement of the Central Valley in the mid-1800s. California's salmon resources began to decline in the late 1800s, and continued to decline in the early 1900s, as reflected in the decline of Chinook salmon commercial harvest. The total commercial catch of Chinook salmon in 1880 was 11 million pounds; by 1922 it had dropped to seven million pounds, and it reached a low of less than three million pounds in 1939 (Lufkin 1996).

Another major factor affecting anadromous salmonids during this period was hydraulic gold mining, which began in the 1850s. By 1859, an estimated 5,000 miles of mining flumes and canals diverted streams used by salmonids for spawning and nursery habitat. Habitat alteration and destruction also resulted from the use of hydraulic cannons, and from hydraulic and gravel mining, which leveled hillsides and sluiced an estimated 1.5 billion cubic yards of debris into the streams and rivers of the Central Valley (Lufkin 1996).

Despite the prohibition of hydraulic mining in 1894, habitat degradation continued. Habitat quantity and quality have declined due to: construction of levees and barriers to migration, modification of natural hydrologic regimes by dams and water diversions, elevated water temperatures, and

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water pollution from agriculture and industry (Lufkin 1996).

Although the effects of habitat degradation on fish populations were evident by the 1930s, rates of decline for most anadromous fish species increased following construction of major water project facilities (USFWS 2001), which primarily occurred around the mid- 1900s. Many of these water development projects completely blocked the upstream migration of Chinook salmon and steelhead to spawning and rearing habitats, and altered flow and water temperature regimes downstream from terminal dams. As urban and agricultural development of the Central Valley continued, numerous other stressors to anadromous salmonids emerged and continue to affect the viability of these fish today. Some of the more important stressors include: the high demand for limited water supply resulting in reduced instream flows, increased water temperatures, and highly altered hydrology in the Sacramento-San Joaquin Delta, barriers to historic habitat, widespread loss of tidal marsh, riparian and floodplain habitat, poor water quality, commercial and/or recreational harvest, and predation from introduced species such as striped bass.

Recovery Strategy: Recovery of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead across such a vast and altered ecosystem as the Central Valley will require a broadly focused, science-based strategy. The scientific rationale for the strategy in this plan focuses on two key salmonid conservation principles. The first is that functioning, diverse, and interconnected habitats are necessary for a species to be viable. That is, salmon and steelhead recovery cannot be achieved without providing sufficient habitat. Anadromous salmonids persisted in the Central Valley for thousands of years because the available habitat capacity and diversity allowed species to withstand and adapt to environmental changes including catastrophes such as prolonged droughts, large wildfires, and volcanic eruptions.

To help return the habitat capacity and diversity in the Central Valley to a level that will support viable salmon and steelhead, we have identified and prioritized recovery actions based on a comprehensive life stage-specific threats assessment. Minimizing or eliminating stressors to the fish and their habitat in an efficient and structured way is a key aspect of the recovery strategy.

The second salmonid conservation principle guiding the recovery strategy is that a species' viability is determined by its spatial structure, diversity, productivity, and abundance (McElhany *et al.* 2000). Abundance and population growth rate are self-explanatory parameters that are clearly important to species and population viability, while spatial structure and diversity are just as important, but less intuitive. Spatial structure refers to the arrangement of populations across the landscape, the distribution of spawners within a population, and the processes that produce these patterns. Species with a restricted spatial distribution and few spawning areas are at a higher risk of extinction from catastrophic environmental events (e.g., a single landslide) than are species with more widespread and complex spatial structure. Species or population diversity concerns the phenotypic (morphology, behavior, and life-history traits) and genetic characteristics of populations. Phenotypic diversity allows more populations to use a wider array of environments and protects populations against short-term temporal and spatial environmental changes. Genetic diversity,

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on the other hand, provides populations with the ability to survive long-term changes in the environment. It is the combination of phenotypic and genetic diversity expressed in a natural setting that provides populations with the ability to adapt to long-term changes (McElhany *et al.* 2000).

Bridging the gap between the species and population levels are population groups or salmonid ecoregions, which are delineated based on climatological, hydrological, and geological characteristics. The Central Valley Technical Recovery Team (TRT) identified four population groups (hereafter referred to as diversity groups) that Chinook salmon historically inhabited in the Central Valley:

- The basalt and porous lava diversity group composed of the upper Sacramento River, McCloud River, Pit River and Battle Creek watersheds;
- The northwestern California diversity group composed of streams that enter the mainstem Sacramento River from the northwest;
- The northern Sierra Nevada diversity group composed of streams tributary to the Sacramento River from the east, and including the Mokelumne River; and
- The southern Sierra Nevada diversity group composed of streams tributary to the San Joaquin River from the east.

Based on the two scientific principles described above and on a comparison of current species viability, relative to historic viability, the basic strategy put forth in this recovery plan is to secure all extant populations and to reintroduce populations to historic habitat such that each salmonid diversity group in the Central Valley supports viable populations. The TRT concluded that recovery of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead would require that no more populations are allowed to become extirpated and that habitat must be expanded to allow for the establishment of additional populations (Lindley *et al.* 2007).

The primary means of securing existing populations is to reduce or eliminate threats to those populations and their habitats. To help guide threat abatement efforts, watersheds and recovery actions have been prioritized. Watersheds that are currently occupied by at least one of the listed Chinook salmon and steelhead species have been prioritized among three levels. Of highest priority are core 1 populations, which have been identified, based on their known ability or potential to support independent viable populations. Core 1 populations form the foundation of the recovery strategy and must meet the population-level biological recovery criteria for low risk of extinction set out in Table 5-1. NMFS believes that core 1 populations should be the first focus of an overall recovery effort. Core 2 populations are assumed to have the potential to meet the moderate risk of extinction criteria set out in Table 5-1. These dependent populations are of secondary importance for recovery efforts. Core 3 populations are present on an intermittent basis and are characterized as being dependent on other nearby populations for their existence. The presence of these populations provides increased life history diversity to the ESU/DPS and is likely to buffer against local catastrophic occurrences that could affect other nearby populations. Connectivity between populations and genetic diversity may be enhanced by

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working to recover smaller core 3 populations that serve as stepping stones for dispersal. General guidance for how this watershed prioritization should be applied is that if a core 1 watershed and a core 2 (or 3) watershed had a similar problem affecting salmon and/or steelhead, then efforts should be directed at fixing the problem in the core 1 watershed first.

Unoccupied habitats that historically supported winter-run Chinook salmon, spring-run Chinook salmon, or steelhead have been prioritized regarding fish reintroductions. These unoccupied habitats have been prioritized as primary areas, candidates, or have been ruled out as places to reintroduce one or more of the species. Primary areas for reintroductions are areas where there is a known high likelihood of success based on species-specific life history needs, and available habitat quality and quantity. Specific primary reintroduction areas include the McCloud River, Battle Creek, the Yuba River, and the San Joaquin River. Candidate areas for reintroduction are unoccupied habitats that require further study of their potential for successful reintroductions. Some areas that were historically accessible to anadromous salmonids, but are no longer because of dams, have been excluded from consideration for reintroductions because they are so critically impaired by hydroelectric development and channel inundation that we felt efforts should be focused on areas with a higher potential for success.

Because recovery of winter- and spring-run Chinook salmon and steelhead will require implementation over a large landscape and over an extended period of time, a stepwise strategy has been adopted, based on the prioritization of watersheds and recovery actions. As this Recovery Plan is implemented over time, additional information will become available to help determine the degree to which the threats have been abated, to further develop understanding of the linkages between threats and population responses, to identify any additional threats, and to evaluate the viability of Chinook salmon and steelhead in the Central Valley.

Recovery Goals, Objectives, and Criteria: The overarching goal of this Recovery Plan is the removal of the Sacramento River winter-run Chinook salmon ESU, Central Valley spring-run Chinook salmon ESU, and California Central Valley steelhead DPS from the Federal List of Endangered and Threatened Wildlife (50 C.F.R. 17.11). The objectives and criteria to accomplish this goal builds upon the technical input and guidance provided by the TRT, and much of the following discussion is taken directly from information developed by the TRT (Lindley *et al.* 2004; 2006; 2007).

In order for the Chinook salmon ESUs and the steelhead DPS to achieve recovery, each diversity group must be represented, and population redundancy within the groups must be met to achieve diversity group recovery. Therefore, ESU-level recovery criteria include the following:

Winter-run Chinook salmon ESU:

- Three populations in the Basalt and Porous Lava Diversity Group at low risk of extinction

Spring-run Chinook salmon ESU and **Central Valley steelhead DPS**:

- One population in the Northwestern California Diversity Group at low risk of extinction

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- Two populations in the Basalt and Porous Lava Diversity Group at low risk of extinction
- Four populations in the Northern Sierra Nevada Diversity Group at low risk of extinction
- Two populations in the Southern Sierra Nevada Diversity Group at low risk of extinction
- Maintain all Core 2 populations at moderate risk of extinction.

Recovery criteria at the population level were established by the Central Valley TRT and are included in this recovery plan (and apply to all three species), as described in Lindley *et al.* (2007). The TRT incorporated the four viable salmonid population parameters (McElhany *et al.* 2000) into assessments of population viability, and two sets of population viability criteria were developed, expressed in terms of extinction risk. The first set of criteria deal with direct estimates of extinction risk from population viability models. If data are available and such analyses exist and are deemed reasonable for individual populations, such assessments may be efficient for assessing extinction risk. In addition, the TRT also provided simpler criteria. The simpler criteria include population size (and effective population size), population decline, catastrophic rate and effect, and hatchery influence. For a population to be considered at low risk of extinction (i.e., < 5 percent chance of extinction within 100 years), the population viability assessment must demonstrate that risk level or all of the following criteria must be met:

- Census population size is >2,500 adults -or- Effective population size is >500
- No productivity decline is apparent
- No catastrophic events occurring or apparent within the past 10 years
- Hatchery influence is low (see Figure 4-1).

Additionally, threat abatement criteria must be met demonstrating that specific threats have been alleviated. The following threat abatement criteria have been established to ensure that each of the five ESA listing factors are addressed before a species can be delisted:

- Populations have unobstructed access to Core 1, 2, and 3 watersheds and assisted access to primary watersheds for reintroduction that are obstructed. Man-made structures (e.g., bridges and water diversions) affecting these watersheds and in migratory habitat must meet NMFS salmonid passage guidelines for stream crossings and screening criteria for anadromous salmonids (Listing Factors 1, 4, and 5)
- Utilization for commercial, recreational, scientific, and educational purposes is managed, such that all Core 1 populations meet the low extinction risk category for abundance (see Table 5-1) (Listing Factor 2)
- Hatchery programs are operated so that all Core 1 populations meet the low extinction risk criteria for hatchery influence (see Table 5-1) (Listing Factors 3 and 5)
- Migration and rearing corridors meet the life-history, water quality and habitat requirements of the listed species, such that the corridor

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supports multiple viable populations (Listing Factors 1, 3, 4, and 5)

Recovery Actions: This Recovery Plan establishes a strategic approach to recovery, which identifies and prioritizes recovery actions at the Statewide, Central Valley wide, and site-specific levels. Three steps were taken to prioritize recovery actions as they are presented in this plan. First, results from the threats assessment and prioritization process (described in Appendix B) were used to guide the identification of watershed- and site-specific recovery actions for each diversity group and population. This step prioritized recovery actions separately for each species. The second step to prioritize recovery actions was undertaken through consideration of specific actions that benefit multiple species and populations. Results from the second step included tables of recovery actions listed in descending order of priority by geographic region (e.g., Delta, mainstem Sacramento River, Diversity Group) based on multiple species benefits. These first two steps were the only steps taken to prioritize recovery actions that were presented in the Co-Manager Review Draft Recovery Plan. Based on feedback from co-managers, it was apparent that the priority with which recovery actions should be undertaken was not clear. To address this, we implemented a third step and prioritized each of the region-specific recovery actions according to three categories. Priority 1 actions are those critical actions that address threats that generally ranked among the most important threats to one or more of the species; priority 2 actions address threats of moderate importance, and priority 3 actions are among the least important to implement. Actions were identified as priority 1, 2, or 3 based on the first two prioritization steps and on the best professional judgment of agency co-managers, including biologists from CDFW, USFWS, USFS, and NMFS.

Prioritized recovery actions for each of the following scales or regions are described in chapter 6 in the form of implementation tables: California-wide, Central Valley-wide, Pacific Ocean, San Francisco Bay, Delta, mainstem Sacramento River, mainstem San Joaquin River, and each of the four diversity groups. These implementation tables describe each action, the time frames and, if possible, the costs associated with it. Cost estimates have been provided wherever practicable, but in some cases where the uncertainties regarding the exact nature or extent of the recovery actions is unknown, these costs estimates can only be provided after site-specific investigations are completed.

Investment in recovery of salmon and steelhead will result in economic, societal and ecosystem benefits. Monetary investments in watershed restoration projects can promote the economy in a myriad of ways. These include stimulating the economy directly through the employment of workers, contractors and consultants, and the expenditure of wages and restoration dollars for the purchase of goods and services. Habitat restoration projects have been found to stimulate job creation at a level comparable to traditional infrastructure investments such as mass transit, roads, or water projects (Oregon Watershed Enhancement Board 2010). In addition, viable salmonid populations provide ongoing direct and indirect economic benefits as a resource for fish, recreation, and tourist related activities. Dollars spent on salmon and steelhead recovery will promote local, state, Federal and tribal economies, and should be viewed as an investment with both societal (clean

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rivers, healthy ecosystems) and economic returns.

The largest direct economic returns resulting from recovered salmon and steelhead are associated with sport and commercial fishing. On average 1.6 million anglers fish the Pacific region annually (Oregon, Washington and California) and 6 million fishing trips were taken annually between 2004 and 2006 (NMFS 2010a). Most of these trips were taken in California and most of the anglers lived in California. The California salmon fishery is estimated to generate $118 to $279 million in income annually, and provide roughly two to three thousand jobs (Michael 2010). With a revived sport and commercial fishery, these substantial economic gains and the creation of jobs would be realized across California, but most notably for river communities and rural coastal counties.

Many of the actions identified in this Recovery Plan are designed to improve watershed-wide processes which will benefit many native species of plants and animals (including other state and federally listed species) by restoring natural ecosystem functions. In addition, restoration of habitat in watersheds will provide substantial benefits for human communities. Some of these benefits are: improving and protecting the quality of important surface and ground water supplies; reducing damage from flooding resulting from floodplain development; and controlling invasive exotic animal and plant species which can threaten water supplies and increase flooding risk. Restoring and maintaining healthy watersheds also enhances important human uses of aquatic habitats, including outdoor recreation, ecological education, field based research, aesthetic benefits, and the preservation of tribal and cultural heritage.

The final category of benefits accruing to recovered salmon and steelhead populations are even more difficult to quantify and are related to the ongoing costs associated with maintaining populations that are at risk of extinction. Significant funding is spent annually by entities (Federal, State, local, private) in order to comply with the regulatory obligations that accompany populations that are listed under the ESA.

Important activities, such as water management for agriculture and urban use, are now constrained to protect ESA listed populations of salmon and steelhead. Examples of these types of obligations include such requirements as: ESA section 7 consultations, development and implementation of Habitat Conservation Plans, the provision of fish passage at impassible barriers, and a high degree of uncertainty for the regulated entities. Recovering the salmonid populations so the protections of the ESA are no longer necessary will also result in elimination of the regulatory requirements imposed by the ESA, and allow greater flexibility for land and water managers to optimize their activities and reduce costs related to ESA protections. Salmon recovery is best viewed as an opportunity to diversify and strengthen the economy while enhancing the quality of life for present and future generations.

Implementation: It is a challenging undertaking to facilitate a change in practice and policy that reverses the path towards extinction of a species to one of recovery. This change can only be accomplished with effective outreach and education, strong partnerships, focused recovery strategies and solution-oriented thinking that can shift agency and societal attitudes, practices and understanding. Implementation of the recovery plan by NMFS will take many forms and is described in the NMFS

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Protected Resources Division (PRD) Strategic Plan 2006 (NMFS 2006). The Recovery Planning Guidance (NMFS 2010b) also outlines how NMFS shall cooperate with other agencies regarding plan implementation. These documents, in addition to the ESA, shall be used by NMFS to set the framework and environment for plan implementation. The PRD Strategic Plan asserts that species conservation (in implementing recovery plans) by NMFS will be more strategic and proactive, rather than reactive. To maximize existing resources with workload issues and limited budgets, the PRD Strategic Plan champions organizational changes and shifts in workload priorities to focus efforts towards "*…those activities or areas that have biologically significant beneficial or adverse impacts on species and ecosystem recovery* (NMFS 2006)." The resultant shift will reduce NMFS engagement on those activities or projects not significant to species and ecosystem recovery.

NMFS actions to promote and implement recovery planning shall include:

- Coordinating priorities and actions with the Anadromous Fish Restoration Program, the Ecosystem Restoration Program, and other key funding sources.
- Creating and maintaining partnerships with fish and water stakeholder groups, including Federal, State, and local governments, water agencies, fishing groups, and watershed conservation groups.
- Formalizing recovery planning goals on a program-wide basis to prioritize work load allocation and decision-making (to include developing the mechanisms to make implementation (e.g., restoration) possible).
- Supporting outreach and education programs.
- Facilitating a consistent framework for research, monitoring, and adaptive management that can directly inform recovery objectives and goals.
- Establishing an implementation tracking system that is adaptive, web-based, and pertinent to support the annual reporting for the Government Performance and Results Act, Biennial Recovery Reports to Congress and the 5-Year Status Reviews.

NMFS' efforts must be as far-reaching (beyond those under the direct regulatory jurisdiction of NMFS) as the issues adversely affecting the species. Thus, to achieve recovery, NMFS will need to promote the recovery plan and provide needed technical information and assistance to other entities that implement actions that may impact the species' recovery. For example, NMFS will work with key partners on high priorities such as facilitating passage assessment and working with Counties to ensure protective measures consistent with recovery objectives are included in their General Plans.

Many complex and inter-related biological, economic, social, and technological issues must be addressed in order to recover anadromous salmonids in the Central Valley. Policy changes at the Federal, State and local levels will be necessary to implement many of the recovery actions identified in this Recovery Plan. For example, without substantial strides in

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habitat restoration, fish passage, and changes in water use, recovery will be difficult if not impossible. In some cases, conflicting regulatory mandates that influence water and aquatic resources management will need to be resolved. Most importantly, recovering winter-run Chinook salmon, spring-run Chinook salmon, and steelhead will require a focused effort that secures existing populations, re-establishes populations in watersheds that historically supported them, and restores the ecological function of the habitats upon which the species depend for their long-term survival.

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1.0 Introduction

"Salmon was now abundant in the Sacramento. Those which we obtained were generally between three and four feet in length, and appeared to be of two distinct kinds. It is said that as many as four different kinds ascend the river at different periods. The great abundance in which this fish is found gives it an important place among the resources of the country."

- Captain John C. Frémont, memoirs for 30 March-5 April 1846 *in* Yoshiyama et al. 1998

The rivers draining the Great Central Valley of California ("Central Valley") and adjacent Sierra Nevada and Cascade Range once were renowned for their production of large numbers of Pacific salmon (Clark 1929; Skinner 1962 *in* Yoshiyama *et al.* 1998). The Central Valley system historically has been the source of most of the Pacific salmon produced in California waters (CDFW 1950, 1955; Fry and Hughes 1951; Skinner 1962; CDWR 1984 *in* Yoshiyama *et al.* 1998).

Chinook salmon *(Oncorhynchus tshawytscha)* historically were, and remain today, the only abundant salmon species in the Central Valley system (Eigenmann 1890; Rutter 1908 *in* Yoshiyama *et al.* 1998), although small numbers of other salmon species also have occurred occasionally in its rivers (Collins 1892; Rutter 1904a, 1908; Hallock and Fry 1967; Moyle *et al.* 1995 *in* Yoshiyama *et al.* 1998). Steelhead (anadromous *O. mykiss)* apparently were common in Central Valley tributaries (USFC 1876; Clark 1973; Latta 1977; Reynolds *et al.* 1993 *in* Yoshiyama *et al.* 1998), but records for them are few and fragmented, partly because they did not support commercial fisheries (Yoshiyama *et al.* 1998).

Anadromous salmonids, in particular Chinook salmon, have and continue to be an important resource, both revered and harvested by humans. The Native American people depended upon these fishes for subsistence, ceremonial, and trade purposes. Prior to Euro-American settlement, Native Americans within the Central Valley drainage harvested Chinook salmon at estimated levels that reached 8.5 million pounds or more annually (Yoshiyama *et al.* 1998). With the advent of the California gold rush in the mid-1800s, a commercial Chinook salmon fishery developed in the San Francisco Bay and Sacramento-San Joaquin Delta ("Delta") region. Annual catches by the early in-river fisheries commonly reached 4-10 million pounds. The first west coast salmon cannery opened on a scow moored near Sacramento in 1864. Within 20 years, 19 canneries were operating in the Delta region, and processed a peak of 200,000 cases (each case comprised of 48, 1-pound cans) in 1882 (Lufkin 1996). The salmon fishery remained centered in the Delta region until the early 1900s, when ocean salmon fishing began to expand and eventually came to dominate the fishery.

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1.1 The Great Central Valley of California

The northern half of the Central Valley is comprised of the Sacramento River Basin (covering approximately 24,000 square miles [mi^2]), with the southern half (covering approximately 13,540 mi^2) primarily composed of the San Joaquin River Basin (**Figure 1-1**). The broad expanse of the Central Valley region of California once encompassed numerous salmon-producing streams that drained the Sierra Nevada and Cascade mountains on the east and north and, to a lesser degree, the lower-elevation Coast Range on the west. The large areal extent of the Sierra Nevada and Cascades watersheds, coupled with regular, heavy snowfalls in those regions, provided year-round streamflows for a number of large rivers which supported substantial runs of Chinook salmon (Yoshiyama *et al.* 1998).

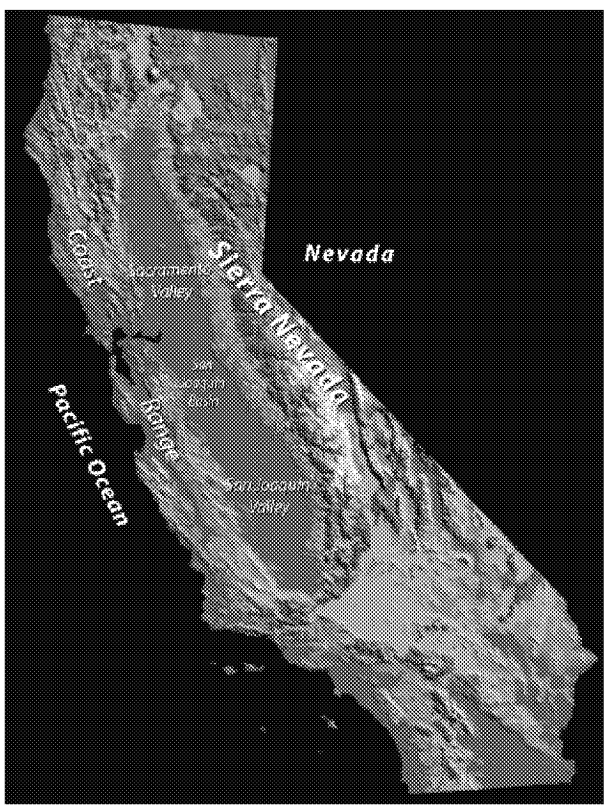


Figure 1-1. Central Valley Region of California

In the Sacramento River Basin, most Coast Range streams historically supported regular salmon runs, although their runs were limited by the volume and seasonal availability of streamflows due to the lesser amount of snowfall west of the valley (Yoshiyama *et al.* 1998). In the San Joaquin River Basin, a number of major streams (e.g., the Merced, Tuolumne, and upper San Joaquin rivers) sustained very large salmon populations, while other streams with less regular streamflows had intermittent salmon runs in years when rainfall provided sufficient flows. All of the west side San Joaquin River Basin streams flowing from the Coast Range were highly intermittent (Elliott 1882) and none are known to have supported anadromous salmonids (Yoshiyama *et al.* 1998).

1.2 Salmon & Steelhead at Risk

Since settlement of the Central Valley in the mid-1800s, populations of native Chinook salmon and steelhead have declined dramatically. California's salmon resources began to decline in the late 1800s, and continued to decline in the early 1900s, as reflected in the decline of commercial harvest. The total commercial catch of Chinook salmon in 1880 was 11 million pounds, by 1922 it had dropped to 7 million pounds, and reached a low of less than 3 million pounds in 1939 (Lufkin 1996).

History and Current Status of Commercial Harvest

Although Chinook salmon remain an important resource, fishing for salmon has changed, most notably, in the last 20 years. 28 evolutionarily significant units (ESU'S) and distinct population segments (DPS's) of salmonids have been listed under the List of Endangered and Threatened Wildlife by the National Marine Fisheries Service (NMFS) on

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the West Coast of the United States since 1989. This is significant because commercial ocean harvest and sport fishing for salmon has undergone dramatic management and regulatory implementations in order to continue with the commercial fishery while at the same time finding and implementing an exploitation rate that enables sustained Chinook populations into the future. It is also now possible for the ocean fishery to be managed for specific river fisheries through genetic sampling of the ocean harvest along the Pacific Coast. This change has altered the way ocean harvest is regulated, and further protects critical species in that life stage.

New matrixes developed by the National Oceanic and Atmospheric Administration (NOAA) Pacific Northwest Region emphasize that commercial fishing or ocean harvest is a critical parameter in the decisions used to manage sustainable fisheries or to reestablish adequate escapement levels.

Commercial and recreational ocean salmon fisheries in the U.S. Exclusive Economic Zone off the coasts of Washington, Oregon, and California are authorized by NMFS under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). Specifically, these fisheries are managed under the Federal Pacific Coast Salmon Fishery Management Plan (FMP) (PFMC 2003). Consistent with the FMP, detailed management regulations are developed annually, designed to respond to new information and the current status of each salmon stock. Pursuant to the MSA, the Pacific Fishery Management Council (PFMC) develops recommendations for the development of the FMP, FMP amendments, and annual management measures and provides those recommendations to the Secretary of Commerce, through NMFS, for review and approval. The Secretary may approve the PFMC's recommendations for implementation as federal regulation if found to be consistent with the MSA and other applicable law, including the ESA.

The number of Chinook salmon harvested in the California commercial salmon fishery dramatically declined starting in 2006. From 1978 to 2005, the annual salmon harvest for the California commercial fishery exceeded 300,000 in all but one year (2001). In 2006 the fishery collapsed resulting in complete fishery closures in 2008 and 2009, and a heavily restricted fishery in 2010. The average Chinook salmon harvest in the fishery in 2006, 2007, and 2011 was approximately 85,000 (PFMC 2012).

Sources of Habitat Decline

A major factor affecting Chinook salmon and steelhead was hydraulic gold mining, which began in the 1850s. By 1859, an estimated 5,000 miles of mining flumes and canals diverted streams used by salmonids for spawning and nursery habitat. Habitat alteration and destruction also resulted from the use of hydraulic cannons, which leveled hillsides and sluiced an estimated 1.5 billion cubic yards of debris into the streams and rivers of the Central Valley (Lufkin 1996).

Evan though hydraulic mining was prohibited in 1894, other habitat degradation continued. Habitat quantity and quality have declined due to construction of levees and barriers to migration, modification of natural hydrologic regimes by dams and water diversions, elevated water temperatures, and water pollution (Lufkin 1996). Although the effects of habitat degradation on fish populations were evident by the 1930s, rates of decline for most anadromous fish species increased following completion of major water project facilities (USFWS 2001) which primarily occurred around the mid- 1900s.

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Numerous water development projects blocked the upstream migration of Chinook salmon and steelhead, and altered flow and water temperature regimes downstream from terminal dams. An extensive network of reservoirs and aqueducts has been developed throughout much of California to provide water to major urban and agricultural areas. The two largest water projects in California are the State Water Project (SWP) and the Federal Central Valley Project (CVP). The CVP delivers on average over 7 million acre-feet per year. CVP water is used to irrigate 3 million acres of farmland in the San Joaquin Valley, as well as provide water for urban use in Contra Costa, Santa Clara, and Sacramento counties. The largest state-built water and power project in the United States, the SWP spans 600 miles from Northern California to Southern California, providing drinking water for 23 million people and irrigation water for 750,000 acres of farmland (see www.aquafornia.com for more information about California water management).

An estimated 1,126 miles of stream remain of the more than 2,183 miles of Central Valley streams that were historically accessible by Chinook salmon – indicating an overall loss of at least 1,057 miles (48 percent) of the original total (Yoshiyama *et al.* 2001). The estimated habitat loss includes the lengths of stream used by salmon mainly as migration corridors, in addition to holding and spawning habitat. This estimated loss of habitat does not include the Delta, comprising about 700 miles of river channels and sloughs (USFWS 1995), available to various degrees as migration corridors or rearing areas for Chinook salmon and steelhead.

It is likely that the lower reaches of the Sacramento and San Joaquin rivers historically were used as rearing areas (at least during some flow regimes) as the juveniles moved downstream, but recently they have been less suitable for rearing due to alterations in channel morphology and other degraded environmental conditions. In terms of only spawning and holding habitat, the proportionate loss of historically available habitat far exceeds 48 percent, much of which was located in upper stream reaches that have been rendered inaccessible by terminal dams (Yoshiyama *et al.* 2001). Excluding the lower stream reaches that were used as adult migration corridors (and, to a lesser degree, for juvenile rearing), it has been estimated that at least 72 percent of the original Chinook salmon spawning and holding habitat in the Central Valley drainage is no longer available (Yoshiyama *et al.* 2001).

The amount of steelhead habitat lost most likely is much higher than that for Chinook salmon, because steelhead were undoubtedly more extensively distributed. Due to their superior leaping and swimming ability and the timing of their upstream migration, which coincided with the winter rainy season, steelhead likely used at least hundreds of miles of smaller tributaries not accessible to even the highest migrating winter-run and spring-run Chinook salmon (Yoshiyama *et al.* 2001).

In addition to commercial exploitation, large-scale habitat degradation, blockage of historically available habitat and altered flow and water temperature regimes, other factors that may have adversely affected natural stocks of Chinook salmon and steelhead include overharvest, illegal harvest, hatchery production, entrainment, and introduction of competitors, predators and diseases. Fish populations also vary due to natural events, such as droughts and poor ocean conditions (e.g., El Niño). However, populations in healthy habitats typically recover within a few years after natural events. In the Central Valley, the decline of fish populations has continued through cycles of beneficial and adverse natural conditions, indicating the need to improve habitat (USFWS 2001).

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1.3 The Recovery Planning Process

The Federal Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 *et seq.*) mandates the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) to develop and implement plans (i.e., recovery plans) for the conservation and survival of NMFS listed species. Winter-run Chinook salmon are listed as endangered under the Federal ESA, and spring-run Chinook salmon and steelhead are listed as threatened. Implementation of the Recovery Plan for the Sacramento River winter-run Chinook salmon Evolutionarily Significant Unit (ESU), Central Valley spring-run Chinook salmon ESU, and California Central Valley steelhead Distinct Population Segment[1] (DPS) is vital to the continued persistence and recovery of these populations.

The recovery plan is a comprehensive plan that serves as a road map for species recovery – it lays out where we need to go and how best to get there. A recovery plan is one of the most important tools to ensure sound scientific and logistical decision-making throughout the recovery process. Primarily, a recovery plan should do the following:

- Delineate those aspects of the species' biology, life history, and threats that are pertinent to its endangerment and recovery;
- Outline and justify a strategy to achieve recovery;
- Identify the actions necessary to achieve recovery of the species; and
- Identify goals and criteria by which to measure the species' achievement of recovery (NMFS 2010b).

Although recovery plans provide guidance, they do not have the force of law. The success of this Recovery Plan depends upon the cooperation of all stakeholders and regulatory entities to ensure appropriate implementation.

Pursuant to Section 4(f) of the ESA, a recovery plan must be developed and implemented for the conservation and survival of species listed as threatened or endangered unless it finds that a recovery plan will not promote the conservation of the species. A recovery plan must, to the maximum extent practicable, include the following:

- A description of site-specific management actions necessary for recovery;
- Objective, measurable criteria, which when met, will allow delisting of the species; and
- Estimates of the time and cost to carry out the recovery measures.

The purpose of this Recovery Plan is to guide implementation of recovery of the species by resolving the threats to the species and thereby ensuring viable Chinook salmon ESUs and the steelhead DPS. This Recovery Plan may be used to inform all stakeholders including Federal, State, Tribal, and local agencies and land use actions, but it does not place regulatory requirements on such entities.

Past recovery plans generally have focused on the abundance, productivity, habitat and other life history characteristics of a species. While knowledge of these characteristics is certainly important for making sound conservation management decisions, the long-term

[1] On January 5, 2006, NMFS departed from their previous practice of applying the ESU policy to steelhead. NMFS concluded that within a discrete group of steelhead populations, the resident and anadromous life forms of steelhead remain "markedly separated" as a consequence of physical, ecological and behavioral factors, and may therefore warrant delineation as a separate DPS (71 FR 834).

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sustainability of a species in need of recovery can only be ensured by alleviating the threats that are contributing to the status of the species as threatened or endangered. Therefore, the identification of the threats to the species is a key component of this Recovery Plan.

To be most useful for recovery planning, a threats assessment should be used to determine the relative importance of various threats to a species. A threats assessment includes: (1) identifying threats and their sources; (2) evaluating the effects of threats; and (3) ranking each threat based on relative effects. The Interim Endangered and Threatened Species Recovery Planning Guidance (NMFS 2010b) recommends "*…using a threats assessment for species with multiple threats to help identify the relative importance of each threat to the species' status, and, therefore, to prioritize recovery actions in a manner most likely to be effective for the species' recovery*." This Recovery Plan uses this recommended approach to identify and prioritize threats to the Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon ESUs, and the California Central Valley steelhead DPS. The prioritized threats are then used to guide the identification of specific recovery actions.

The methodology used in the threats assessment for this Recovery Plan is generally described in the next chapter (Background) and is fully described in Appendix B.

1.3.1 A Collaborative Effort

Central Valley Technical Recovery Team

As part of its recovery planning efforts, the NMFS Southwest Region (now part of the West Coast Region) designated the Central Valley as a "Recovery Domain." The NMFS Southwest Region established the Central Valley Technical Recovery Team (TRT) to provide technical assistance to the recovery planning process for the Central Valley Domain. The NMFS' intent in establishing the Central Valley TRT was to seek unique geographic and species expertise, and to develop a solid scientific foundation for the Recovery Plan. The Central Valley TRT identified unique habitat and biological characteristics of the three species, made technical findings regarding limiting factors and stressors for each ESU and DPS and its component populations, recommended biological viability criteria at the ESU/DPS- and population-level, and provided scientific review of local and regional recovery planning efforts.

The Central Valley TRT, a collaborative body of biologists that were selected based on their expertise and local knowledge, produced three documents heavily relied upon in preparation of the Recovery Plan: (1) *Population Structure of Threatened and Endangered Chinook Salmon ESUs in California's Central Valley Basin* (Lindley *et al.* 2004); (2) *Historical Population Structure of Central Valley Steelhead and its Alteration by Dams* (Lindley *et al.* 2006); and (3) *Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin* (Lindley *et al.* 2007).

Public Participation

NMFS conducted a series of Recovery Planning Workshops, designed as round-table discussions, to solicit information and promote dialogue as part of the development of the Federal Recovery Plan for winter-run Chinook salmon, spring-run Chinook salmon and steelhead in the Central Valley Domain. Public workshops were held in Sacramento, California on July 20, 2006, in Redding, California on August 15, 2006, and in

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Stockton, California on August 17, 2006. At these workshops, NMFS provided a general overview of: (1) the Federal recovery planning process; (2) the timeline for NMFS recovery plan development; (3) the current understanding of Chinook salmon and steelhead populations and their habitats; and (4) threats identified in original ESA listing documents.

Following the overviews, workshop participants were separated into smaller facilitated discussion groups to generate more in-depth dialogue and identify threats to specific Chinook salmon and steelhead populations and their habitats.

Information obtained at the initial series of workshops also was used in additional workshops to develop recovery actions that reduce or eliminate identified threats. These additional workshops were held in Sacramento, California on May 22, 2007 and in Redding, California on May 24, 2007.

In October of 2009, NMFS released a Public Draft Recovery Plan for Central Valley salmon and steelhead, commencing a 60-day public review and comment period (74 FR 51553; October 7, 2009). Based on requests from the public for additional review time, this comment period was extended an additional 60 days (74 FR 61329; November 24, 2009). NMFS received 78 written comment submissions from the public as well as several verbal comments. Many of the public comments and suggested edits have strengthened this Recovery Plan. Following release of the Public Draft Recovery Plan, a total of eight public workshops were held in Sacramento (three workshops), Chico (three workshops), Salida, and Mt. Shasta to help establish working relationships with local communities and to obtain stakeholder input.

Existing Efforts

Local water agencies and irrigation districts, municipal and county governmental agencies, watershed groups, and State and Federal agencies have undertaken major habitat restoration efforts in many parts of the Central Valley and Delta. These actions include the addition of gravel below dams, removal of small dams, screening water diversions, fish passage improvements, riparian revegetation, bank protection, structural habitat enhancement, restoration of floodplain and tidal wetlands, development and implementation of new flow and water temperature requirements below dams, and operational constraints in the Delta. Major restoration efforts that impact salmon and steelhead recovery throughout the Central Valley include the programs established under the Anadromous Fish Restoration Program (AFRP) of the Central Valley Project Improvement Act (CVPIA) and the Ecosystem Restoration Program (ERP). Shared purposes of the AFRP and the ERP are to protect and restore diversity within and among the various naturally-producing populations of Chinook salmon and steelhead in the Central Valley, and to restore the habitats upon which the populations depend.

The AFRP promotes collaboration between the Department of Interior (USFWS and the Bureau of Reclamation [Reclamation]) with other agencies, organizations and the public to increase natural production of anadromous fish in the Central Valley by augmenting and assisting restoration efforts presently conducted by local watershed workgroups, the California Department of Fish and Wildlife (CDFW), and others. Purposes of the CVPIA (Section 3402) relevant to the AFRP are: (1) to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley; (2) to address impacts of the CVP on fish, wildlife, and associated habitats; (3) to improve the operational flexibility of the

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CVP; (4) to contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay and Sacramento-San Joaquin Delta Estuary; and (5) to achieve a reasonable balance among competing demands for the use of CVP water, including the requirements of fish and wildlife, agricultural, municipal and industrial, and power contractors (USFWS 2001).

The ERP is CDFW's principal program designed to restore the ecological health of the Bay/Delta ecosystem. The ERP includes actions throughout the Bay/Delta watershed and focuses on the restoration of ecological processes and important habitats. In addition, the ERP aims to reduce the effects of stressors that inhibit ecological processes, habitats and species (CALFED 1999b).

Another major effort that could impact Central Valley salmon and steelhead recovery, if implemented, is the Bay Delta Conservation Plan (BDCP). The dual goals of the BDCP are to provide a comprehensive ecosystem restoration program for the delta and a reliable water supply. Further information is available at the BDCP website: http://baydeltaconservationplan.com/.

1.4 Recovery Plan Content

This introductory chapter provides an overview of many important facets of this Recovery Plan, and in particular describes the collaborative processes of the plan. The remainder of this Recovery Plan for the Sacramento River winter-run Chinook salmon ESU, the Central Valley spring-run Chinook salmon ESU and the California Central Valley steelhead DPS is presented in several chapters.

The second chapter provides background including the current regulatory status, a description of the population trends and distribution of each species, and a description of the life history and habitat requirements for each species. A brief description of the reasons for listing and a current threats assessment is then presented (a detailed threats assessment is presented in Appendix B). Finally, current conservation efforts and biological constraints are discussed, including limiting factors that should be considered for the species recovery.

Next, the Recovery Strategy Chapter presents and justifies the recommended recovery program for each species. This chapter also describes the key facts, concepts and assumptions upon which the recovery program is based.

The following chapter describes the recovery goals, objectives, and criteria. The ultimate goal of the Recovery Plan is delisting of the Chinook salmon ESUs and the steelhead DPS. The recovery objectives basically subdivide the goal into discrete components which collectively describe the conditions necessary for delisting. Recovery criteria are the objective and measurable standards upon which decisions to delist the ESUs and DPS are based.

Next, the specific actions that should be implemented to achieve recovery are presented in the Recovery Actions Chapter. That chapter is intended to satisfy the requirement under the ESA (Section 4 (f)(1)(B)(iii)) that Recovery Plans must contain to the maximum extent practicable "*…estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.*" Recovery actions are linked to the identified threats (or stressors) individually for specific populations of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead within the Central Valley Domain, and are prioritized according to the priority of threats addressed.

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This Recovery Plan includes a chapter discussing the impacts of climate change on Central Valley salmonids, including how those impacts are expected to affect recovery efforts in the coming decades.

Lastly, a chapter on how this plan will be implemented is provided. The chapter discusses the time and cost to recovery, the benefits of recovery, and the various tools under the ESA that can be used to implement anadromous salmonid recovery in the Central Valley.

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2.0 Background

"The requirement for determining that a species no longer requires the protection of the ESA is that the species no longer be in danger of extinction or likely to become endangered in the foreseeable future based on evaluation of the listing factors specified in ESA Section 4(a)(1). Any new factors identified since listing must also be addressed in this analysis to ensure that the species no longer requires protection."

- NMFS Supplement to the Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan 2005

The Central Valley Domain encompasses the Sacramento River winter-run Chinook salmon ESU, Central Valley spring-run Chinook salmon ESU, and California Central Valley steelhead DPS. Following are descriptions of the current regulatory status, life histories, population trends and distribution, and the habitat requirements for winter- and spring-run Chinook salmon, and steelhead in the Central Valley. A brief description of the reasons for listing and a current threats assessment is then presented (a detailed threats assessment is presented in Appendix B). Finally, current conservation efforts and biological constraints are discussed, including limiting factors that should be considered for recovery of winter-run and spring-run Chinook salmon, and steelhead within the Central Valley Domain.

2.1 Winter-run Chinook Salmon

2.1.1 ESA Listing Status

The Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) ESU, currently listed as endangered, was listed as a threatened species under emergency provisions of the ESA in August 1989 (54 FR 32085: August 4, 1989) and listed as a threatened species in a final rule in November 1990 (55 FR 46515; November 5, 1990). In June 1992, NMFS proposed that winter-run Chinook salmon be reclassified as an "endangered"[2] species (57 FR 27416; June 19, 1992). NMFS finalized its proposed rule and re-classified winter-run Chinook salmon as an endangered species on January 4, 1994 (59 FR 440). NMFS concluded that winter-run Chinook salmon in the Sacramento River warranted listing as an endangered species due to several factors, including: (1) the continued decline and increased variability of run sizes since its first listing as a threatened species in 1989; (2) the expectation of weak returns in future years as the result of two small year classes (1991 and 1993); and (3) continued threats to the winter-run Chinook salmon.

[2] Under the ESA, an "endangered species" is, with the exception of insects determined to be pests, "...any species which is in danger of extinction throughout all or a significant portion of its range..." (16 USC § 1532(6)).

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On June 14, 2004, NMFS issued a proposed rule to reclassify the listing status of winter-run Chinook salmon from endangered to threatened (69 FR 33102). To prevent further decline of the ESU by preventing take of this species from activities that harm fish and fish habitat, NMFS proposed to apply the ESA Section 9(a) take prohibitions with specific limitations to winter-run Chinook salmon under ESA Section 4(d) (69 FR 33102).

Following a series of extensions to the public comment period on the proposed listing determinations, the public comment period closed during November 2004 (69 FR 61348; October 18, 2004). On June 28, 2005, NMFS issued a final listing determination for the Sacramento River winter-run Chinook salmon ESU, which concluded that the Sacramento River winter-run Chinook salmon ESU is "in danger of extinction" due to risks to the ESU's diversity and spatial structure and, therefore, continues to warrant listing as an endangered species under the ESA (70 FR 37160). Additionally, the Sacramento River Winter-run Chinook salmon was listed as endangered under the California ESA in 1989.

The Sacramento River winter-run Chinook salmon ESU includes winter-run Chinook salmon spawning naturally in the Sacramento River and its tributaries, as well as winter-run Chinook salmon that are part of the conservation hatchery program at the Livingston Stone National Fish Hatchery (LSNFH) (70 FR 37160). The Sacramento River winter-run Chinook salmon ESU is depicted in **Figure 2-1**.

2.1.2 Species Description and Taxonomy

Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. The following physical description of the species is provided by Moyle (2002). Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. There are numerous small black spots in both sexes on the back, dorsal fins, and both lobes of the tail. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw. Parr have 6 to 12 parr marks, each equal to or wider than the spaces between them and most centered on the lateral line. The adipose fin of parr is pigmented on the upper edge, but clear at its base. The dorsal fin occasionally has one or more spots on it but the other fins are clear.

2.1.3 Life History/Habitat Requirements

Chinook salmon is the most important commercial species of anadromous fish in California. Chinook salmon have evolved a broad array of life history patterns that allow them to take advantage of diverse riverine conditions throughout the year. Four principal life history variants are recognized and are named for the timing of their upstream migration: fall-run, late fall-run, winter-run, and spring-run. The Sacramento River supports all four runs of Chinook salmon. The larger tributaries to the Sacramento River (American, Yuba, and Feather rivers) and rivers in the San Joaquin Basin also provide habitat for one or more of these runs.

Winter-run Chinook salmon are unique because they spawn during summer months when air temperatures usually approach their yearly maximum. As a result, winter-run Chinook salmon require stream reaches with cold water sources that will protect embryos and juveniles from the warm ambient conditions in summer.

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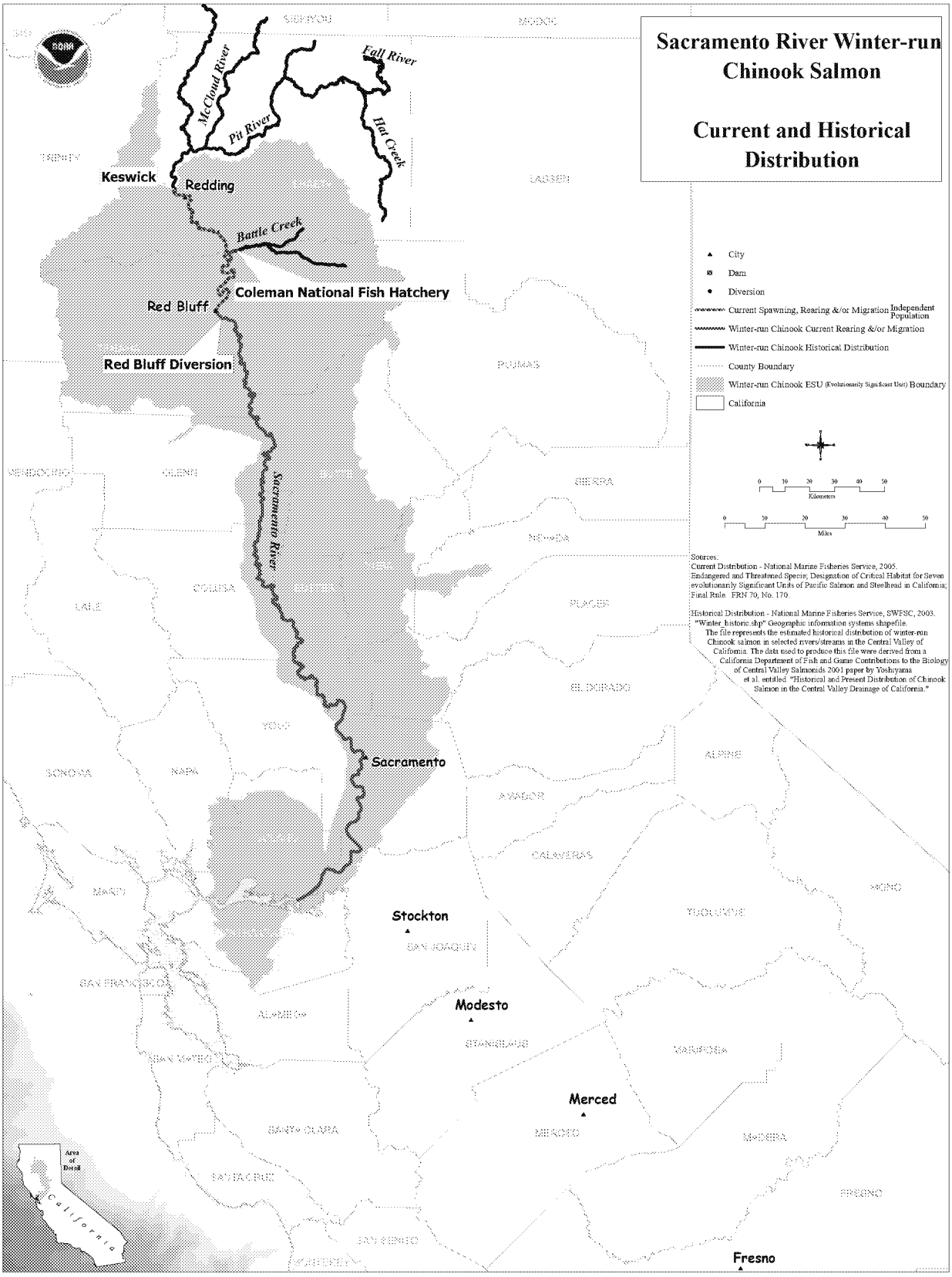


Figure 2-1. Current and Historical Sacramento River Winter-run Chinook Salmon Distribution.

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Table 2-1 depicts the temporal occurrence of winter-run Chinook salmon life stages in the Sacramento River. Adult winter-run Chinook salmon immigration and holding (upstream spawning migration) through the Delta and into the lower Sacramento River occurs from December through July, with a peak during the period extending from January through April (USFWS 1995). Winter-run Chinook salmon are sexually immature when upstream migration begins, and they must hold for several months in suitable habitat prior to spawning. Winter-run Chinook salmon primarily spawn in the mainstem Sacramento River between Keswick Dam (River Mile [RM] 302) and the Red Bluff Diversion Dam (RBDD) (RM 243). Spawning occurs between late-April and mid-August, with a peak in June and July as reported by CDFW annual escapement surveys (2000-2006). Winter-run Chinook salmon embryo incubation in the Sacramento River can extend into October (Vogel and Marine 1991).

Winter-run Chinook salmon fry rearing in the upper Sacramento River exhibit peak abundance during September, with fry and juvenile emigration past RBDD primarily occurring from July through November (Poytress and Carillo 2010, 2011, 2012). Emigration of winter-run Chinook salmon juveniles past Knights Landing, located approximately 155.5 river miles downstream of the RBDD, reportedly occurs between November and March, peaking in December, with some emigration continuing through May in some years (Snider and Titus 2000a; Snider and Titus 2000c).

A description of freshwater habitat requirements for winter-run Chinook salmon is presented in the following sections. Habitat requirements are organized by life stage.

Adult Immigration and Holding

Suitable water temperatures for adult winter-run Chinook salmon migrating upstream to spawning grounds range from 57°F to 67°F (NMFS 1997). However, winter-run Chinook salmon are immature when upstream migration begins, and need to hold in suitable habitat for several months prior to spawning. The maximum suitable water temperature reported for holding is 59°F to 60°F (NMFS 1997). Because water temperatures in the lower Sacramento River below the RBDD generally begin exceeding 60 degrees Fahrenheit (°F) in April, it is likely that little, if any, suitable holding habitat exists in the lower Sacramento River. It most likely is only used by adults as a migration corridor. Following installation of the water temperature control device on Shasta Dam in 1997, it is possible that some deep water pool habitat may exist for a short distance downstream of the RBDD with suitable cold water temperatures for adult holding.

Adult Chinook salmon reportedly require water deeper than 0.8 feet and water velocities less than 8 feet per second (ft/sec) for successful upstream migration (Thompson 1972). Adult Chinook salmon are less capable of negotiating fish ladders, culverts, and waterfalls during upstream migration than steelhead, due in part to slower swimming speeds and inferior jumping ability (Bell 1986; Reiser *et al.* 2006).

Chinook salmon generally hold in pools with deep, cool, well-oxygenated water. Holding pools for adult Chinook salmon have reportedly been characterized as having moderate water velocities ranging from 0.5 to 1.3 ft/sec (DWR 2000).

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Table 2-1. The Temporal Occurrence of Adult and Juvenile Sacramento River Winter-run Chinook Salmon in the Sacramento River

Winter run relative abundance	High				Medium				Low			
a) Adult freshwater												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin[a,b]												
Sacramento River spawning[c]												
b) Juvenile migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River@ Red Bluff[d]												
Sacramento River @ Knights Landing[e]												
Sacramento trawl @ Sherwood Harbor[f]												
Midwater trawl @Chipps Island[g]												

Sources: [a] (Yoshiyama *et al.* 1998); (Moyle 2002); [b](Myers *et al.* 1998) ; [c] (Williams 2006) ; [d] (Martin *et al.* 2001); [e] Knights Landing Rotary Screw Trap Data, CDFW (1999-2011)); [f,g] Delta Juvenile Fish Monitoring Program(DJFMP), USFWS (1995-2012)

Spawning

Spawning occurs from mid-April to mid-August, peaking in June and July, in the Sacramento River reach between Keswick Dam and RBDD (Vogel and Marine 1991; CDFW Annual escapement survey reports, 2000-2006). Chinook salmon spawn in clean, loose gravel, in swift, relatively shallow riffles, or along the margins of deeper river reaches where suitable water temperatures, depths, and velocities favor redd construction and oxygenation of incubating eggs. Winter-run Chinook salmon were adapted for spawning and rearing in the clear, spring-fed rivers of the upper Sacramento River Basin, where summer water temperatures were typically 50°F to 59°F. Water temperature conditions were created by glacial and snowmelt water percolating through porous volcanic formations that surround Mt. Shasta and Lassen Peak, which cover much of northeastern California. Chinook salmon require clean loose gravel from 0.75 to 4.0 inches in diameter for successful spawning (NMFS 1997). The construction of dams in the upper Sacramento River has eliminated the major source of suitable gravel recruitment to reaches of the river below Keswick Dam. Gravel sources from the banks of the river and floodplain have also been substantially reduced by levee and bank protection measures. Levee and bank protection measures restrict the meandering of the river, which would normally release gravel into the river through natural erosion and deposition processes. Moyle (2002) reported that water velocity preferences (i.e., suitability greater than 0.5) for Chinook salmon spawning range from 0.98 ft/sec to 2.6 ft/sec (0.3 to 0.8 meters per second (m/sec)) at a depth of a few

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centimeters (cm) to several meters (m), whereas USFWS (2003) reported that winter-run Chinook salmon prefer water velocities range from 1.54 ft/sec to 4.10 ft/sec (0.47 to 1.25 meters per second) at a depth of 1.4 to 10.1 feet (0.4 to 3.1 m).

Today, Shasta Dam denies access to historical winter-run Chinook salmon spawning habitats and they persist mainly because water released from Shasta Reservoir during the summer has been, for the most part, sufficiently cold. Spawning habitat for Sacramento River winter-run Chinook salmon is restricted to the Sacramento River primarily between RBDD and Keswick Dam.

Embryo Incubation

In the Sacramento River, winter-run Chinook salmon spawning occurs from late April through mid-August. Because the embryo incubation life stage begins with fertilized egg deposition and ends with fry emergence from the gravel, embryo incubation occurs from late April through mid-October. Fry emergence occurs from mid-June through mid-October (NMFS 1997). Within the appropriate water temperature range, eggs normally hatch in 40 to 60 days. Newly hatched fish (alevins) normally remain in the gravel for an additional four to six weeks until the yolk sac has been absorbed (NMFS 1997).

Physical habitat requirements for embryo incubation are the same as the requirements discussed above for spawning. However, it is also important that flow regimes remain relatively constant or at least not decrease significantly during the embryo incubation life stage.

Juvenile Rearing and Outmigration

Upon emergence from the gravel, fry swim or are displaced downstream (Healey 1991). Fry seek streamside habitats containing beneficial aspects such as riparian vegetation and associated substrates that provide aquatic and terrestrial invertebrates for food, predator avoidance cover, and slower water velocities for resting (NMFS 1996a). These shallow water habitats have been described as more productive juvenile salmon rearing habitat than the deeper main river channels. Higher juvenile salmon growth rates, partially due to greater prey consumption rates, as well as favorable environmental temperatures have been associated with shallow water habitats (Sommer *et al.* 2001b). Similar to adult salmon upstream movement, juvenile salmon downstream movement is primarily crepuscular. Once downstream movement has commenced, salmon fry continue this movement until reaching the estuary or they might reside in the stream for a time period that varies from weeks to a year (Healey 1991). Juvenile Chinook salmon migration rates vary considerably, presumably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al.* (1981) found Chinook salmon fry traveled as fast as 30 kilometers (km) per day in the Sacramento River. Sommer *et al.* (2001b) found travel rates ranging from approximately 0.8 km (0.5 miles) per day, up to more than 9.7 km (6 miles) per day in the Yolo Bypass.

As juvenile Chinook salmon grow they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures (Healey 1991). Catches of juvenile salmon in the Sacramento River near West Sacramento by the USFWS (USFWS 1997) exhibited larger juvenile captures in the main channel and smaller-sized fry along the margins. Where the river channel is greater than nine to ten feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1979). Streamflow and/or turbidity increases in the

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upper Sacramento River basin are thought to stimulate emigration (Poytress 2007).

Emigration of juvenile Sacramento River winter-run Chinook salmon past RBDD may begin after almost one year in the river. They begin to move down river as early as mid-July, typically peaking numbers in September, and can continue through March in dry years (NMFS 1997; Vogel and Marine 1991). From 1995 to 1999, all Sacramento River winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001).

As Chinook salmon begin the smoltification stage, they are found rearing further downstream where ambient salinity reaches 1.5 to 2.5 parts per thousand (Healey 1979). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey 1979). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1981; MacFarlane and Norton 2002; Sommer *et al.* 2001a).

Juvenile Chinook salmon movements within the estuarine habitat are dictated by the interaction between tidally-driven salt water intrusions through the San Francisco Bay and fresh water outflow from the Sacramento and San Joaquin rivers. Juvenile Chinook salmon follow rising tides into shallow water habitats from the deeper main channels and return to the main channels when the tides recede (Healey 1991). Kjelson *et al.* (1981) 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 three meters of the water column. 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 Farallon Islands (MacFarlane and Norton 2002).

Juvenile Sacramento River winter-run Chinook salmon occur in the Delta primarily from November through early May, using size-at-date criteria from trawl data in the Sacramento River at West Sacramento (RM 57) (USFWS 2001). The timing of migration varies somewhat due to changes in river flows, dam operations, and water year type. Winter-run Chinook salmon juveniles remain in the Delta until they reach a fork length (FL) of approximately 118 millimeters (mm) and are from five to 10 months of age. Emigration to the ocean begins as early as November and continues through May (Fisher 1994; Myers *et al.* 1998). The importance of the Delta in the life history of Sacramento River winter-run Chinook salmon is not well understood.

Central Valley Chinook salmon begin their ocean life in the Gulf of the Farallones, then they distribute north and south along the continental shelf primarily between Point Conception and Point Arena, although some winter-run Chinook salmon migrate up and beyond Washington State. Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability (Healey 1991).

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2.1.4 Abundance Trends and Distribution

One of the main threats to the Sacramento River winter-run Chinook salmon ESU is that it consists of only one population. Furthermore the one population is small (Good *et al.* 2005). The population declined from an escapement of near 100,000 in the late 1960s to fewer than 200 in the early 1990s (Good *et al.* 2005). More recent population estimates of 8,218 (2004), 15,730 (2005), and 17,153 (2006) show a three-year average of 13,700 returning winter-run Chinook salmon (CDFW Website 2007). However, the run size decreased to 2,542 in 2007 and 2,850 in 2008. **Figure 2-2** depicts the estimated run sizes of Sacramento River winter-run Chinook salmon from 1967 through 2012.

The LSNFH winter-run Chinook salmon conservation program on the upper Sacramento River is one of the most important reasons that Sacramento River winter-run Chinook salmon still persist. The LSNFH has been producing and releasing winter-run Chinook salmon since 1998. This conservation program has apparently resulted in a net increase in the numbers of returning adult winter-run Chinook salmon, although hatchery fish make up a significant portion of the population (Brown and Nichols 2003). Since 2003, LSNFH winter-run program has exceeded best management practices for conservation and recovery of natural salmonid populations.

Table 2-2 shows the annual number of winter-run Chinook salmon released from the facility from 1998 through 2012. The fish are marked with coded wire tags (CWT), adipose fin clipped and released as smolts each winter in late January or early February. The table also provides information based on data acquired during mark-recapture studies on the amount of time required by the smolts to migrate through the Delta.

Winter-run Chinook salmon originally spawned in the upper Sacramento River system (Little Sacramento, Pit, McCloud and Fall rivers) and in Battle Creek (Yoshiyama *et al.* 1996). There is no evidence that the winter-run existed in any of the other drainages prior to watershed development (Yoshiyama *et al.* 1996). The unique life history timing pattern of winter-run Chinook salmon, requiring cold summer flows, argues against this run occurring in drainages other than the upper Sacramento system and Battle Creek. Watershed development has eliminated all historical spawning habitats above Keswick Dam (approximately 200 river miles) and approximately 47 of the 53 miles of potential habitat in Battle Creek (Yoshiyama *et al.* 1996). Figure 2-1 depicts the current and historical distribution of Sacramento River winter-run Chinook salmon.

Currently, winter-run Chinook salmon spawning habitat is likely limited to the reach of the Sacramento River extending from Keswick Dam downstream to the RBDD. Prior to construction of Shasta and Keswick dams, the mainstem Sacramento River primarily functioned as a rearing and migration corridor because warm water temperatures likely precluded spawning. Winter-run Chinook salmon still have access to Battle Creek throughout the duration of their migration period by either passing through the Coleman National Fish Hatchery (CNFH) (December through February) or by ascending the fish ladder located at the CNFH weir (March through July).

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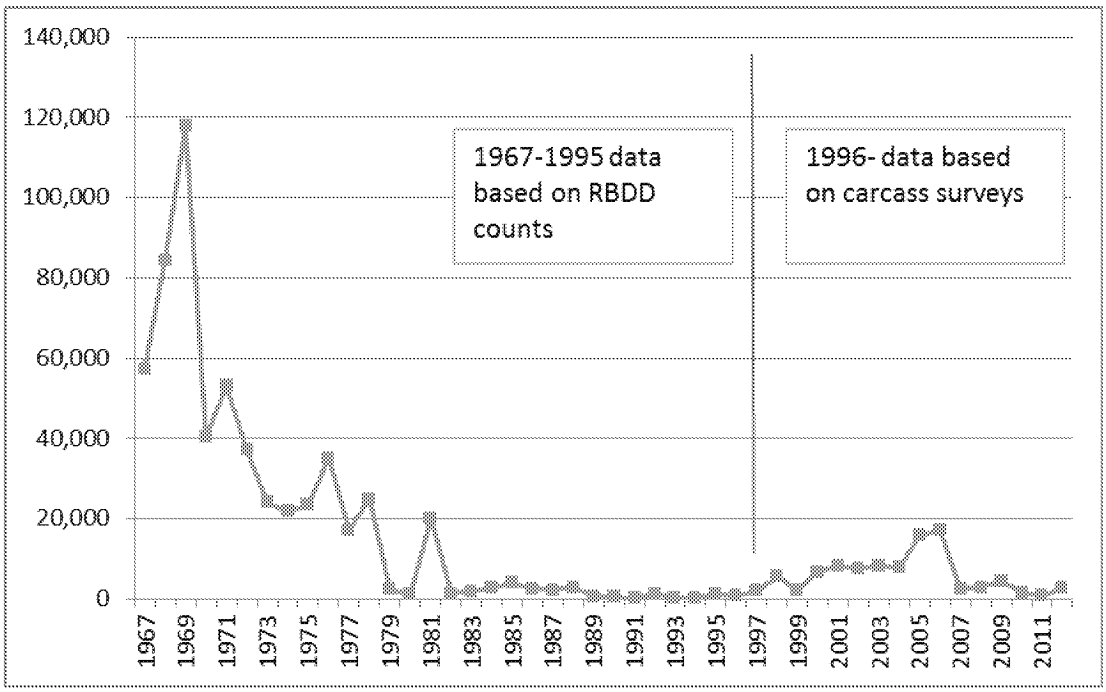


Figure 2-2. Estimated Sacramento River Winter-run Chinook Salmon Run Size (1967 – 2012).
Source: **http://www.fws.gov/stockton/afrp/**

Table 2-2. Winter-run Chinook Salmon Juvenile Releases from LSNFH (Broodyears 1998-2012) and Date of Initial Recapture at Chipps Island.

Brood Year	Upper Sacramento River Release Date	Number of Pre-Smolts Released[1]	Initial Date[2] of Recapture at Chipps Island
1998	1/28/1999	153,908	3/15/1999
1999	1/27/2000	30,840	3/18/2000
2000	2/01/2001	166,206	3/09/2001
2001	1/30/2002	252,684	3/20/2002
2002	1/30/2003	233,613	2/14/2003
2003	2/05/2004	218,617	2/20/2004
2004	2/03/2005	168,261	2/22/2005
2005	2/02/2006	173,344	2/17/2006
2006	2/08/2007	196,288	2/17/2007
2007	1/31/2008	71,883	3/12/2008
2008	1/29/2009	146,211	2/20/2009
2009	2/10-11/2010	198,582	2/26/2010
2010	2/3/2011	123,859	3/21/2011
2011	2/9/2012	194,264	3/23/2012
2012	2/7/2013	181,857	
Source: ([1]USFWS Red Bluff; [2] Redler 2013)			

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Winter-run Chinook salmon are believed to have historically occurred in Battle Creek as one of four independent Central Valley populations (Lindley *et al.* 2004). Hydroelectric facilities and operations likely caused the extirpation of winter-run Chinook salmon from the Battle Creek watershed in the early 1900s (Reynolds *et al.* 1993). Watershed restoration actions associated with the Battle Creek Salmon and Steelhead Restoration Project are expected to restore conditions that will allow for successful reintroduction of winter-run Chinook salmon to Battle Creek.

The USFWS initiated the winter-run Chinook salmon propagation program at the CNFH in 1989. Although the winter-run Chinook salmon propagation program was located on Battle Creek, the program had the goal of supplementing natural spawning in the mainstem of the upper Sacramento River. To encourage adults to return to the Sacramento River rather than the location of the hatchery on Battle Creek, hatchery-produced juvenile winter-run Chinook salmon were released into the mainstem Sacramento River at the pre-smolt life stage. Unfortunately, this strategy was not successful at achieving a successful imprint to the upper Sacramento River and adults instead returned to the location of the hatchery on Battle Creek. To improve imprinting to the upper Sacramento River, the winter-run Chinook salmon propagation program was moved in 1997 to a new facility, the LSNFH, located immediately downstream of Shasta Dam. Within a few years of relocating the winter-run Chinook salmon propagation program, returns of adult winter-run Chinook salmon to Battle Creek declined to zero. During recent years, a few winter-run Chinook salmon adults have been observed in Battle Creek; these fish are likely strays from the mainstem Sacramento River.

A winter-run Chinook salmon migration to the Calaveras River may have occurred between 1972 and 1984, but this population appears to have been extirpated by drought conditions, which were exacerbated by irrigation diversions (NMFS 1997; NMFS 1999; NMFS 2003). This Calaveras River population is also thought to have been late fall-run or fall-run Chinook salmon that were mistakenly identified as winter-run Chinook salmon (Yoshiyama *et al.* 2000). Winter-run Chinook salmon did not historically occur in the Calaveras River because the natural river conditions were not suitable to support the species life history requirements (e.g., cold water during the spring and summer for holding, spawning, and embryo incubation).

The Sacramento River winter-run Chinook salmon population is dependent upon the provision of suitably cool water temperatures during the spawning, embryo incubation, and juvenile rearing period. Water temperatures in the upper Sacramento River are the result of interaction among: (1) ambient air temperature; (2) volume of water; (3) water temperature at release from Shasta and Trinity dams; (4) total reservoir storage; (5) location of reservoir thermocline; (6) ratio of Spring Creek Power Plant release to Shasta Dam release; (7) operation of Temperature Control Device (TCD) on Shasta Dam; and (8) tributary inflows (NMFS 1997). Water temperature varies with location and distance downstream of Keswick Dam, and depends upon the annual hydrologic conditions and annual operation of the Shasta-Trinity Division of the CVP (NMFS 1997). In general, water released from Keswick Dam warms as it moves downstream during the summer and early fall months at a critical time for the successful development and survival of juvenile winter-run Chinook salmon (NMFS 1997).

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2.1.5 Critical Habitat

Critical habitat for listed salmonids is comprised of physical and biological features essential to the conservation of the species including: space for the individual and population growth and for normal behavior; cover; sites for breeding, reproduction and rearing of offspring; and habitats protected from disturbance or are representative of the historical geographical and ecological distribution of the species. Physical and biological features that are essential for the conservation of winter-run Chinook salmon, based on the best available information, include (1) access from the Pacific Ocean to appropriate spawning areas in the upper Sacramento River; (2) the availability of clean gravel for spawning substrate; (3) adequate river flows for successful spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles; (4) water temperatures between 42.5 and 57.5 °F (5.8 and 14.1 degrees Celsius (°C)) for successful spawning, egg incubation, and fry development; (5) habitat and adequate prey free of contaminants; (6) riparian habitat that provides for successful juvenile development and survival; and (7) access of juveniles downstream from the spawning grounds to San Francisco Bay and the Pacific Ocean (58 FR 33212, 33216-17; June 16, 1993).

On August 14, 1992, NMFS published a proposed critical habitat designation for winter-run Chinook salmon (57 FR 36626). The habitat proposed for designation included: (1) the Sacramento River from Keswick Dam, Shasta County (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta; (2) all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; (3) all waters of San Pablo Bay westward of the Carquinez Bridge; and (4) all waters of San Francisco Bay to the Golden Gate Bridge (NMFS 1997).

On June 16, 1993, NMFS issued the final rule designating critical habitat for winter-run Chinook salmon (58 FR 33212). The habitat identified in the final designation is identical to that in the proposed ruling except that critical habitat in San Francisco Bay is limited to those waters north of the San Francisco-Oakland Bay Bridge. **Figure 2-3** depicts the designated critical habitat and distribution for Sacramento River winter-run Chinook salmon.

2.1.6 Reasons for Listing

Section 4 of the ESA requires the Secretary of the Interior or Commerce, depending upon the species involved, to determine if any species is an endangered or threatened species for any of the following factors: (1) present or threatened destruction, modification or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) other natural or manmade factors affecting its continued existence. Each of these factors with respect to winter-run Chinook salmon are discussed in detail in past status reviews (52 FR 6041, February 27, 1987; Good *et al.* 2005; NMFS 2011) and are summarized below.

The Present or Threatened Destruction, Modification, or Curtailment of Winter-run Chinook Salmon's Habitat or Range.

Habitat Loss and Degradation

Key reasons why winter-run Chinook salmon were listed under the ESA in 1989 include blockage of historical habitat by Shasta and Keswick dams, warm water releases from

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Shasta Dam, juvenile and adult passage constraints at RBDD and Anderson-Cottonwood Irrigation District's (ACID) diversion dam, water exports in the southern Delta, loss of rearing habitat, heavy metal contamination from Iron Mountain Mine, and entrainment in a large number of unscreened or poorly screened water diversions (NMFS 1997). Since winter-run Chinook salmon were listed, the passage problems at RBDD and ACID's dam have been addressed and contamination from Iron Mountain Mine has been contained. Additionally, water temperature management has improved since the time when the ESU was listed, although warm water temperatures in the Sacramento River downstream of Keswick Dam remain a concern, particularly in drier years.

A Single Population

The range of winter-run Chinook salmon has been greatly reduced by Keswick and Shasta dams on the Sacramento River and by hydroelectric development on Battle Creek. Currently, winter-run Chinook salmon spawning is limited to the mainstem Sacramento River downstream of Shasta and Keswick dams where the naturally-spawning population is artificially maintained by cool water releases from the dams. Within the Sacramento River, the spatial distribution of spawners is largely governed by water year type and the ability of the CVP to manage water temperatures.

The fact that this ESU is comprised of a single population with very limited spawning and rearing habitat increases its risk of extinction due to local catastrophe or poor environmental conditions. There are no other natural populations in the ESU to buffer it from natural fluctuations. A single catastrophe with effects persisting for four or more years could result in extinction of the Sacramento River winter-run Chinook salmon ESU (Lindley *et al.* 2007). Such potential catastrophes include volcanic eruption of Lassen Peak, prolonged drought which depletes the cold water pool in Shasta Reservoir or some related failure to manage cold water storage, a spill of toxic materials with effects that persist for four years, or a disease outbreak.

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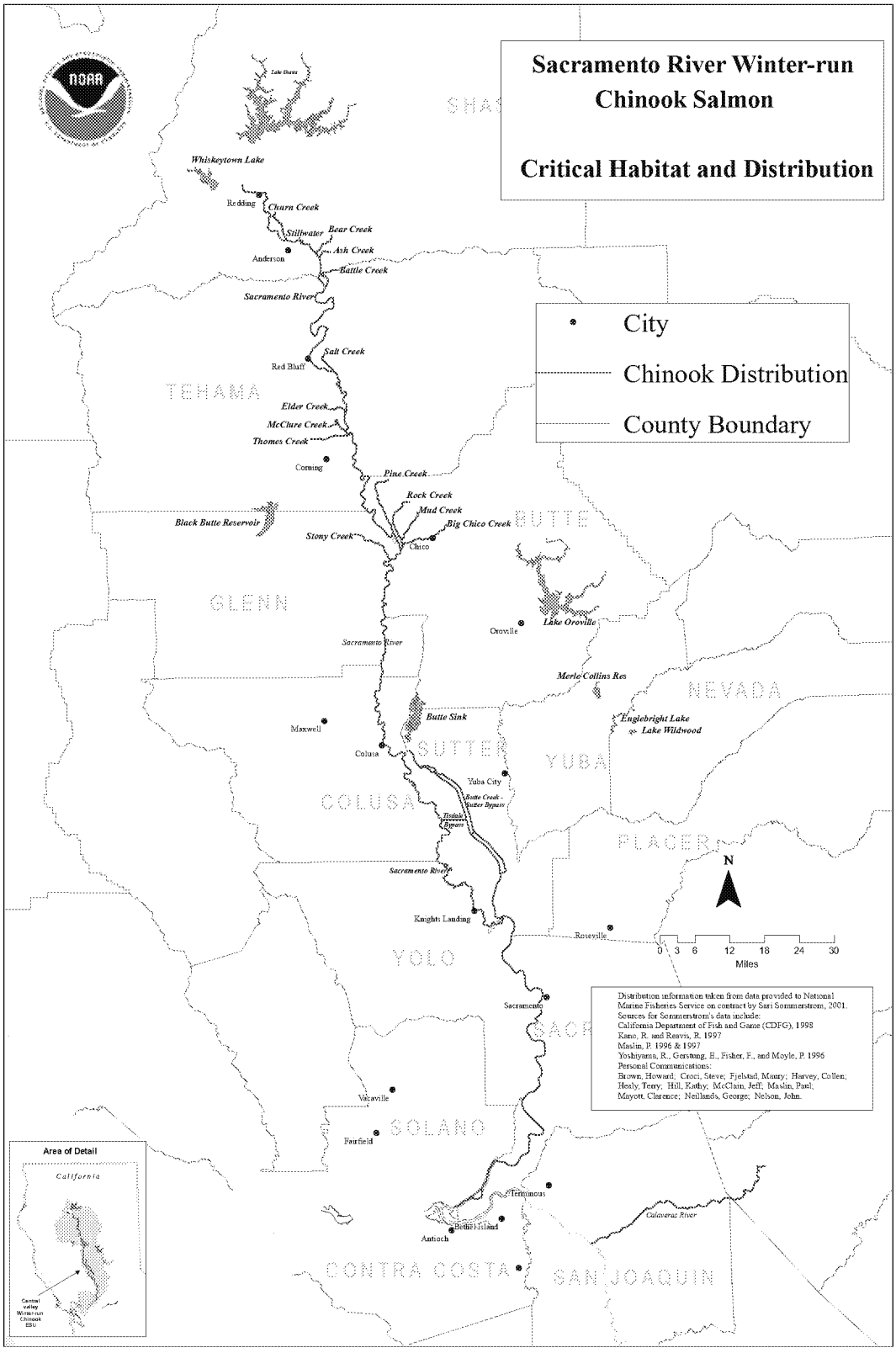


Figure 2-3. Sacramento River Winter-run Chinook Salmon Designated Critical Habitat and Distribution

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After two years of drought, Shasta Reservoir storage would be insufficient to provide cold water throughout the winter-run Chinook salmon spawning and embryo incubation season, resulting in partial or complete year-class failure. A severe drought lasting more than 3 years would likely result in the extinction of winter-run Chinook salmon. The probability of extended droughts is increasing as the effects of climate change continue (see Chapter 6).

An ESU that is represented by a single population is less able to withstand environmental variation than an ESU with multiple populations because of reduced life history and genetic diversity. The genetic integrity of winter-run Chinook salmon has been compromised due to having passed through several "bottlenecks" in the 20th century. Construction of Shasta Dam merged at least three independent winter-run Chinook populations into a single population, representing a substantial loss of genetic diversity, life history variability, and local adaptation. Episodes of critically low abundance, particularly in the early 1990s, for the single remaining population imposed ''bottlenecks'' that further reduced genetic diversity (Good *et al.* 2005).

Small Population Size

Chief among the threats facing winter-run Chinook salmon is small population size—escapement fell below 200 fish in the 1990s. In 1989, the CDFW estimated that the winter-run Chinook salmon size was only 547 fish. This unexpectedly small return represented nearly a 75 percent decline from the consistent, but low, run size of 2,000 to 3,000 fish that had occurred since 1982. The run size estimate made by the CDFW for 1991 was 191 fish. Population size declined from highs of near 100,000 fish in the late 1960s, indicating a sustained period of poor survival (Good *et al.* 2005).

Overutilization of Winter-Run Chinook Salmon for Commercial, Recreational, Scientific, or Educational Purposes

Commercial and Recreational Fisheries

When the winter-run Chinook salmon ESU was being evaluated by NMFS for listing under the ESA in the late 1980s, overutilization was not considered to be an important factor in the species decline. A winter-run Chinook salmon status review published in 1987 stated: "NMFS believes that any stock (even marginally healthy one) should be able to maintain stable population levels at the moderate harvest levels to which winter-run chinook are subjected and that harvests have not been instrumental in the decline of winter-run chinook in the Sacramento River" (52 FR 6041, 6045; February 27, 1987). Two years later when the emergency rule to list winter-run Chinook salmon was published, overutilization was still considered unimportant; the primary reasons for the species decline were identified as the construction and operation of RBDD and other human activities that had degraded spawning and rearing habitat in the Sacramento River (54 FR 32085; August 4, 1989).

In the years following the ESA listing of winter-run Chinook salmon, more information on the impacts of the ocean fisheries on the ESU became available, and it was recognized that the fisheries may play a greater role in the viability of the ESU than previously thought. In 1996 and 1997 NMFS issued a biological opinion and amendment which considered the effects of ocean salmon fisheries on winter Chinook salmon. Those documents determined that the ocean fisheries jeopardize

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winter-run Chinook salmon and, as part of the reasonable and prudent alternative, fishery restrictions were adopted to protect the ESU.

There have been five biological opinions issued for the ocean salmon fishery's effects on winter-run (1991, 1996/1997, 2002, 2004, and 2010). Similar to the 1996/1997 biological opinion, the 2010 biological opinion determined that the fisheries jeopardized the species. To avoid jeopardy, the action agency (NMFS Sustainable Fisheries Division) continues to implement the reasonable and prudent alternative, which: (1) specifies that the previous consultation standards for winter-run Chinook salmon regarding minimum size limits and seasonal windows south of Point Arena for both the commercial and recreational fisheries will continue to remain in effect at all times regardless of abundance estimates or impact rate limit; and (2) establishes an abundance-based management framework where, during periods of relatively low abundance, the fisheries are restricted in order to lower the impact rate on winter-run Chinook salmon.

Based on data from 1968-73 and 1975, Hallock and Fisher (1985) reported that the freshwater sport fishery harvested an average of 8.5 percent of the in-river run. Freshwater harvest of winter-run Chinook salmon was largely eliminated in 2002 when the opening of the Sacramento River recreational fishing season was adjusted so that the fishery would have only limited overlap with the adult immigration and spawning life stages.

Disease or Predation

Disease

Disease was not an important factor in the listing of winter-run Chinook salmon (52 FR 6041, 6045; February 27, 1987) and the impact of disease has probably been negligible since then. There is no evidence that winter-run Chinook salmon experience unusual levels of disease. Winter-run Chinook salmon juveniles from LSNFH have been notably healthy and free of disease problems. There have been no outbreaks of Infectious Hematopoietic Necrosis Virus or Bacterial Kidney Disease at LSNFH (USFWS 2011).

Predation

Predation is an ongoing threat to this ESU, especially in the lower Sacramento River and Delta where there are high densities of non-native (i.e., striped bass, smallmouth bass, and largemouth bass) and native species (e.g., pikeminnow) that prey on outmigrating juvenile salmon. The presence of man-made structures in the freshwater habitat likely contributes to increased predation levels. Since the 1970s, RBDD has been an area of high salmon predation, primarily by pikeminnow (Vogel 2011). Numerous corrective measures at RBDD have been taken over the last few decades to reduce predation. Since 2012, the dam is no longer operated with the gates in. This operational change should greatly reduce predation on juvenile salmon at RBDD.

Degraded conditions in the lower Sacramento River and Delta are a significant source of mortality for Chinook salmon (Cummins *et al.* 2009; Vogel 2011). Predation is hypothesized to be an important source of this mortality (Cummins *et al.* 2009; Vogel 2011; Moyle 2002). Moyle (2002) states, "*What we do not know is whether these species [native species], now mostly depleted, can recover their populations in the presence of a large population of striped bass…A large population of striped bass, for example, could devastate a small population of salmon.*" Consistent with Moyle (2002), a predation model developed by Lindley and Mohr (2003)

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found that a large striped bass population may impede winter-run Chinook salmon recovery.

The Inadequacy of Existing Regulatory Mechanisms

Laws relevant to the protection and restoration of winter-run Chinook salmon are the ESA, the Magnuson-Stevens Fishery Conservation and Management Act, the CVPIA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Clean Water Act, the National Environmental Policy Act, and numerous State laws administered by CDFW, DWR, or the SWRCB. These laws and associated regulations generally provide adequate mechanisms for recovering winter-run Chinook salmon (52 FR 6041, 6046; February 27, 1987); however some of the goals of these existing mechanisms have not yet been achieved.

Other Natural or Manmade Factors Affecting the Continued Existence of Winter-Run Chinook Salmon

Hatchery Production

Although the LSNFH winter-run Chinook salmon program is one of the most important reasons that the species still persists, the use of a hatchery program to supplement the population raises concerns about the genetic integrity and fitness of the population. There is a strong perception that hatchery fish may negatively affect the genetic constitution of wild fish (Allendorf *et al.* 1997; Hindar *et al.* 1991; Waples 1991). One of the main factors contributing to this perception is the observation of a reduction in wild fish populations following the initiation of a hatchery release program (Hilborn 1992; Washington and Koziol 1993). An explanation offered for this observation is that hatchery fish are adapted to the hatchery environment; therefore, natural spawning with wild fish reduces the fitness of the natural population (Taylor 1991). Researchers from the University of California at Davis have documented that hatchery Chinook salmon were more vulnerable to predation by Sacramento pikeminnow as they pass RBDD than were wild Chinook salmon (Lufkin 1996). To minimize hatchery effects in the population, LSNFH preferentially collects wild winter-run Chinook salmon adults for the program. A maximum of 15 percent of the estimated winter-run Chinook salmon run, but no more than 120 natural-origin winter-run Chinook salmon per broodyear may be collected for broodstock use. If necessary, up to 10 percent (a maximum of 12 fish) of the LSNFH broodstock may be composed of hatchery adult returns. To ensure that hatchery production does not overwhelm the recovering population, annual hatchery releases are kept within the 200,000 to 250,000 range and the effects of the program are well-monitored.

The rising proportion of hatchery fish among returning adults threatens to shift the population from a low to moderate risk of extinction. Lindley *et al.* (2007) recommend that in order to maintain a low risk of genetic introgression with hatchery fish, no more than five percent of the naturally-spawning population should be composed of hatchery fish. Since 2001, hatchery origin winter-run Chinook salmon have made up more than five percent of the run, and in 2005 the contribution of hatchery fish exceeded 18 percent (Lindley *et al.* 2007). Potential consequences to wild fish stocks from hatchery production include hybridization and genetic introgression, competition, predation, and increasing fishing pressure (Waples 1991).

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Because LSNFH is a conservation hatchery using best management practices, a more appropriate tool to determine associated genetic risk may be the Proportionate Natural Influence (PNI). PNI is an index of gene flow rates between hatchery and natural populations that can be calculated by using the following formula:

$$PNI\ Approx = pNOB/(pNOB+pHOS)$$

Where pNOB is defined as the Proportion of Natural Origin Brood Stock, and pHOS as the Proportion of Hatchery Origin In-River Spawners.

The Hatchery Scientific Review Group (HSRG), an independent scientific review panel for the Pacific Northwest Hatchery Reform Project, developed guidelines as minimal requirements for minimizing genetic risks of hatchery programs to naturally spawning populations. One of those guidelines is that PNI must exceed 0.5 in order for the natural environment to have a greater influence than the hatchery environment on the genetic constitution of a naturally-spawning population. A second guideline is that PNI should be greater than 0.67 for natural populations considered essential for the recovery or viability of an ESU/DPS.

The average PNI for LSNFH winter-run Chinook salmon from 2003 through 2012 is 0.89 (Null 2013); a level which satisfies the HSRG guidelines for minimizing the genetic effects of hatchery programs on natural populations.

In summary, LSNFH is one of the most important reasons that Sacramento River winter-run Chinook salmon still persist and the hatchery is considered beneficial to the ESU over the short term. However, if the continued existence of the ESU depends on LSNFH, it by any reasonable definition cannot be characterized as having a low risk of extinction, and therefore the ESU should not be delisted on that basis. If the status of the ESU improves such that it has a high likelihood of persistence without LSNFH, then the LSNFH winter-run Chinook program should be phased out and eventually terminated. To obtain long-term sustainability, ESUs need to have some low-risk populations with essentially no hatchery influence in the long run; they could have additional populations with some small hatchery influence, but there needs to be a core of populations that are not dependent on hatchery production.

2.1.7. Threats Assessment

A detailed threats assessment was conducted for the Sacramento River winter-run Chinook salmon ESU (Appendix B). The threats/stressors affecting each winter-run Chinook salmon life stage are described in that appendix. A stressor matrix[3], in the form of a single Microsoft Excel worksheet, was developed to structure the winter-run Chinook salmon population, life stage, and stressor information into hierarchically-related tiers so that stressors to the ESU could be prioritized. The individual tiers within the matrix, from highest to lowest, are: (1) population; (2) life stage; (3) primary stressor category; and (4) specific stressor. These individual tiers were related hierarchically so that each variable within a tier had several associated variables at the next lower tier, except at the lowest (i.e., fourth) tier.

[3] For winter-run Chinook salmon, a single stressor matrix was developed corresponding to the mainstem upper Sacramento River population, whereas for spring-run Chinook salmon and steelhead, multiple individual stressor matrices were developed corresponding to each of the extant populations for these species.

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The general steps required to develop and utilize the winter-run Chinook salmon stressor matrix are described as follows:

- Each life stage within the population was weighted so that all life stage weights in the population summed to one
- Each primary stressor category within a life stage was weighted so that all primary stressor category weights in a life stage summed to one
- Each specific stressor within a primary stressor category was weighted so that all specific stressor weights in a primary stressor category summed to one
- A composite weight for each specific stressor was obtained by multiplying the product of the population weight, the life stage weight, the primary stressor weight, and the specific stressor weight by 100
- A normalized weight for each specific stressor was obtained by multiplying the composite weight by the number of specific stressors within a particular primary stressor group
- The stressor matrix was sorted by the normalized weight of the specific stressors in descending order

Specific information explaining the individual steps taken to generate this prioritized list are provided in Appendix B.

The completed stressor matrix sorted by normalized weight is a prioritized list of the life stage-specific stressors affecting the ESU. Each life stage of winter-run Chinook salmon is affected by stressors of "Very High" importance. These stressors include:

- The barriers of Keswick and Shasta dams, which block access to historic staging and spawning habitat
- Flow fluctuations, water pollution, water temperature impacts in the upper Sacramento River during embryo incubation
- Loss of juvenile rearing habitat in the form of lost natural river morphology and function, and lost riparian habitat and instream cover
- Predation during juvenile rearing and outmigration
- Ocean harvest
- Entrainment of juveniles at the C.W. Jones and Harvey O. Banks pumping plants

The complete prioritized list of life stage-specific stressors to the Sacramento River winter-run Chinook salmon ESU is presented in Appendix B.

2.1.8 Conservation Measures

Artificial Propagation

Captive broodstock and conservation hatchery programs were established for the Sacramento River winter-run Chinook salmon ESU in the early 1990s. The captive broodstock program was originally located at the Bodega Marine Laboratory and the hatchery program was initially established at the CNFH and then later re-located to the LSNFH. These programs were established to augment the

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naturally spawning population in the Sacramento River as well as to provide a captive broodstock in case the natural population was unexpectedly decimated. The programs were successful in helping to stop winter-run Chinook salmon from going extinct. The captive broodstock program was discontinued in January 2005 and the final captive broodstock fish were utilized for a research study in 2006. The LSNFH winter-run Chinook salmon hatchery program continues to supplement the natural population while minimizing genetic risks.

LSNFH is expected to play a continuing role as a conservation hatchery for the protection and enhancement of the existing winter-run Chinook salmon population below Keswick and Shasta dams, and potentially will play a role in re-establishing winter-run salmon to habitats upstream of Shasta Dam and to Battle Creek.

Endangered Species Act

Actions taken by Reclamation and DWR to ensure that their operations of the CVP and SWP comply with Section 7 of the ESA likely contributed to habitat improvements benefiting the Sacramento River winter-run Chinook salmon ESU. Implementation of the reasonable and prudent alternative in biological opinions for the CVP and SWP has improved fish habitat and passage conditions in the Sacramento River and the Delta through maintenance of minimum water flows during fall and winter months, establishment of temperature criteria to support spawning and rearing upstream of RBDD (coupled with water releases from Shasta Dam), operation of the RBDD gates for improved adult and juvenile fish passage, and constraints on Delta water exports to reduce impacts on juvenile outmigrants.

Ecosystem Restoration Program

Two large, ongoing comprehensive conservation programs in the Central Valley provide a wide range of ecosystem and species-specific protective efforts potentially benefiting Chinook salmon – the State's ERP (formerly the CALFED Bay/Delta Program) and the CVPIA. CALFED was a cooperative effort of more than 20 State and Federal agencies working with local communities to improve water quality and reliability for California's water supplies, and has made efforts to restore the Bay/Delta. The ERP has funded projects involving habitat restoration, floodplain restoration and protection, instream and riparian habitat restoration and protection, fish screening and passage, research on non-native species and contaminants, research and monitoring of fishery resources, and watershed stewardship and outreach. A full description of ERP projects and achievements is available at http://www.dfg.ca.gov/ERP/. A few ERP accomplishments that improved salmon and steelhead habitat include:

- restoration and protection of 8,000 acres of wetlands in San Pablo Bay and Suisun Marsh;
- protection of more than 11,000 acres and 18 river miles for riparian and shaded-riverine-aquatic habitat;
- restoration of more than 3,900 acres and 59 miles of riparian and riverine aquatic habitat; and
- installation or improvement of 70 fish screens (11 that draw >250 cfs).

Overall, the ERP has been a beneficial program for winter-run Chinook salmon. Continued implementation of stage two of ERP, which runs through the year 2030, will be needed to advance winter-run Chinook salmon recovery.

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CALFED also established the Environmental Water Account (EWA) to protect migratory fish from entrainment and to increase water supply reliability for the SWP and CVP. A review of the success of EWA revealed that the benefit to salmon is unclear (White and Brandes 2004).

Central Valley Project Improvement Act

The CVPIA balances the priorities of fish and wildlife protection, restoration, and mitigation with irrigation, domestic water use, fish and wildlife enhancement, and power augmentation. The CVPIA was enacted in 1992 with a mandated goal of doubling the natural production of anadromous fish, including winter-run Chinook salmon. Reclamation and USFWS have conducted studies and implemented hundreds of actions, including modifications of CVP operations, management and acquisition of water for fish and wildlife needs, flow management for fish migration and passage, increased water flows, replenishment of spawning gravels, restoration of riparian habitats, and screening of water diversions. Individual actions implemented under the CVPIA that have improved conditions for winter-run Chinook salmon include:

- Installing and operating the Shasta Temperature Control Device;
- Improved and continued efforts for passage at RBDD;
- Completion of state-of-the-art screen and passage improvements at the diversions for the Glen-Colusa Irrigation District and Anderson-Cottonwood Irrigation District; and
- Screening most of the larger diversions in the system (Cummins *et al.* 2009).

An independent review of the CVPIA Fisheries Program identified several successes of the program, but ultimately concluded that, "*After 16 years of implementation the CVPIA anadromous fish program is not close to its stated doubling goal, nor has it solved the problems that led to the listing of several species of salmon and steelhead under the ESA* (Cummins *et al.* 2009)."

Fisheries Management Measures

Seasonal time/area restrictions and minimum size limits for the sport and commercial ocean salmon fisheries are in place for the protection of winter-run Chinook salmon. Additionally, there is a regulatory management framework to further reduce ocean fishery impacts when the status of winter-run is declining or unfavorable (NMFS 2012a). The State has established specific in-river fishing regulations and no-retention prohibitions designed to protect winter-run Chinook salmon during their freshwater life stages.

2.2 Spring-run Chinook Salmon

2.2.1 ESA Listing Status

Central Valley spring-run Chinook salmon (*O. tshawytscha*), currently listed as threatened, were proposed as endangered by NMFS on March 9, 1998 (63 FR 11482). NMFS (1998) concluded that the Central Valley spring-run Chinook salmon ESU was in danger of extinction because native spring-run Chinook salmon have been extirpated from all tributaries in the San Joaquin River Basin, which represented a large portion of the historic range and abundance of the ESU as a whole. Moreover, the only streams considered to have wild spring-run Chinook salmon at that time were Mill and Deer creeks, and Butte Creek (tributaries to the Sacramento River). These populations were considered relatively small with sharply declining trends.

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Hence, demographic and genetic risks due to small population sizes were considered to be high. NMFS (NMFS 1998) also determined that habitat problems were the most important source of ongoing risk to this ESU.

On September 16, 1999, NMFS listed the Central Valley ESU of spring-run Chinook salmon as a "threatened" species (64 FR 50394). Although in the original Chinook salmon status review and proposed listing it was concluded that the Central Valley spring-run Chinook salmon ESU was in danger of extinction (Myers *et al.* 1998), in the status review update, the Biological Review Team (BRT) majority shifted to the view that this ESU was not in danger of extinction, but was likely to become endangered in the foreseeable future. A major reason for this shift was data indicating that a large run of spring-run Chinook salmon on Butte Creek in 1998 was naturally produced, rather than strays from the Feather River Fish Hatchery (FRFH).

NMFS determined that the Central Valley spring-run Chinook salmon ESU is likely to become endangered in the foreseeable future throughout all or a significant portion of their range after reviewing the best available information, including public and peer review comments, biological data on the species' status, and an assessment of protective efforts (64 FR 50394). On March 11, 2002, pursuant to a January 9, 2002 rule issued by NMFS under Section 4(d) of the ESA (16 USC § 1533(d)), the take restrictions that apply statutorily to endangered species began to apply with specific limitations to the Central Valley ESU of spring-run Chinook salmon (67 FR 1116). On June 14, 2004, following a five-year species status review, NMFS proposed that the Central Valley spring-run Chinook salmon remain a threatened species based on the BRT strong majority opinion that the Central Valley spring-run Chinook ESU is ''likely to become endangered within the foreseeable future'' (69 FR 33102). The BRT based its conclusions on the greatly reduced distribution of the Central Valley spring-run Chinook ESU and hatchery influences on natural populations. In addition, the BRT noted moderately high risk for the abundance, spatial structure, and diversity Viable Salmonid Population (VSP) criteria, and a lower risk for the productivity criterion reflecting positive trends. On June 28, 2005, NMFS reaffirmed the threatened status of the Central Valley spring-run Chinook salmon ESU (70 FR 37160). **Figure 2-4** depicts the Central Valley spring-run Chinook salmon ESU.

2.2.2 Species Description and Taxonomy

The Chinook salmon, also largely referred to as king salmon in California, are the largest of the Pacific salmon. The following physical description of the species is provided by Moyle (2002). Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. There are numerous small black spots in both sexes on the back, dorsal fins, and both lobes of the tail. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw. Parr have 6 to 12 parr marks, each equal to or wider than the spaces between them and most centered on the lateral line. The adipose fin of parr is pigmented on the upper edge, but clear at its base. The dorsal fin occasionally has one or more spots on it but the other fins are clear.

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2.2.3 Life History/Habitat Requirements

The habitat requirements for spring-run Chinook salmon are the same as those described above for winter-run Chinook salmon. The primary differences in the habitat requirements between the two runs are the duration and the time of year that the different life stages of the species utilize the habitat.

Adult Central Valley spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFW 1998), and enter the Sacramento River between March and September, primarily in May and June (Moyle 2002; Yoshiyama *et al.* 1998). Spring-run Chinook salmon generally enter rivers as sexually immature fish and must hold in freshwater for up to several months before spawning (Moyle 2002). While maturing, adults hold in deep pools with cold water. Spawning normally occurs between mid-August and early October, peaking in September (Moyle 2002).

The length of time required for embryo incubation and emergence from the gravel is dependent on water temperature. For maximum embryo survival, water temperatures reportedly must be between 41°F and 55.4°F and oxygen saturation levels must be close to maximum (Moyle 2002).

Under those conditions, embryos hatch in 40 to 60 days and remain in the gravel as alevins (the life stage between hatching and egg sack absorption) for another 4 to 6 weeks before emerging as fry (Moyle 2002).

Spring-run fry emerge from the gravel from November to March (Moyle 2002). Juveniles may reside in freshwater for 12 to 16 months, but some migrate to the ocean as young-of-the-year in the winter or spring months within eight months of hatching (CALFED 2000b). The average size of fry migrants (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). By contrast, studies in Butte Creek (Ward *et al.* 2003) found the majority of spring-run migrants to be fry moving downstream primarily during December, January, and February, and that these movements appeared to be influenced by flow. Small numbers of spring-run juveniles remained in Butte Creek to rear and migrate as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer creek juveniles typically exhibit a later young-of-the-year migration and an earlier yearling migration (Lindley *et al.* 2004). By contrast, data collected on the Feather River suggests that the bulk of juvenile emigration occurs during November and December (DWR and Reclamation 1999; Painter *et al.* 1977). Seesholtz *et al.* (2003) speculate that because juvenile rearing habitat in the Low Flow Channel of the Feather River is limited, juveniles may be forced to emigrate from the area early due to competition for resources. **Table 2-3** depicts the temporal occurrence of spring-run life stages in the Sacramento River.

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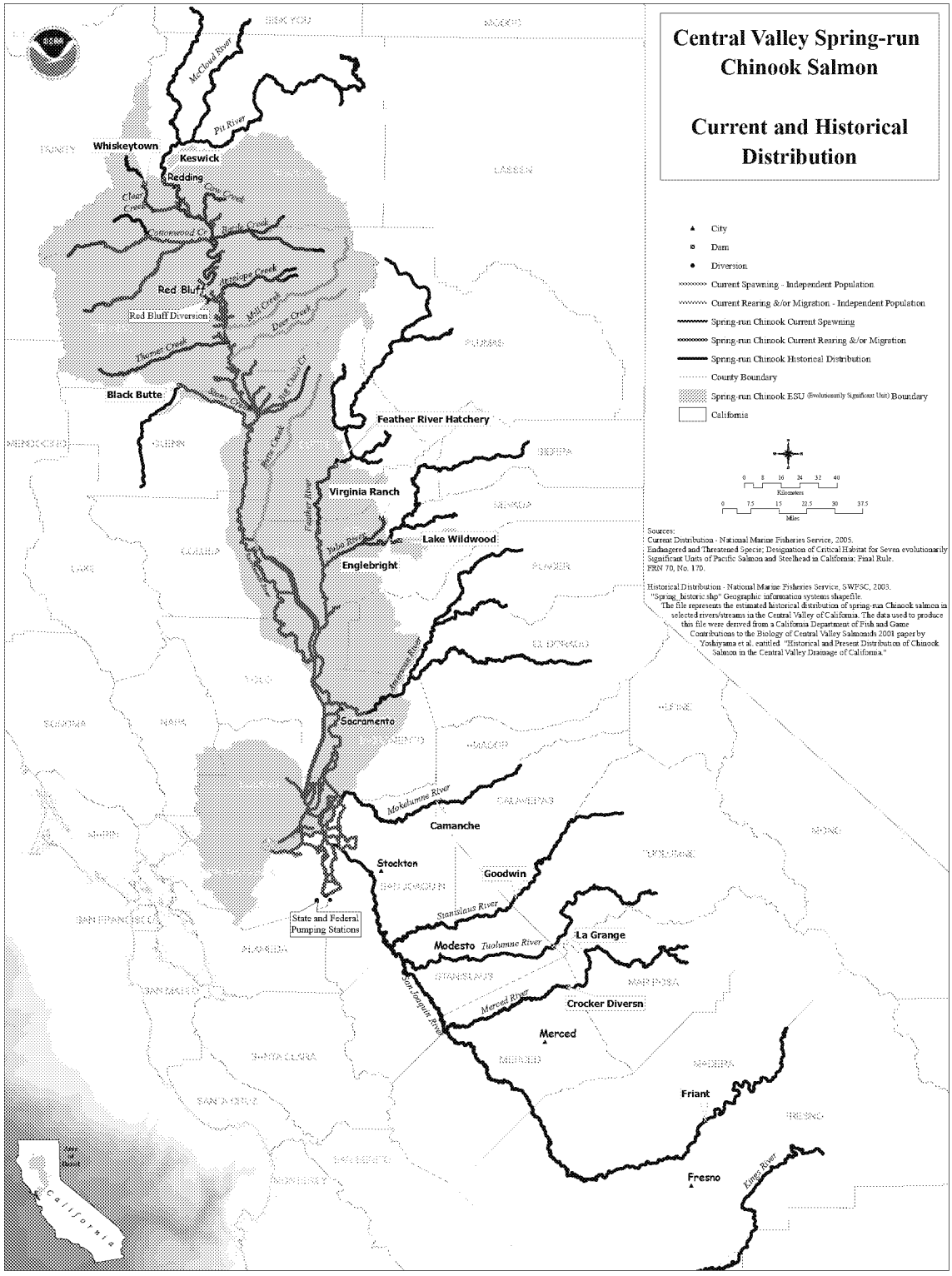


Figure 2-4. Central Valley Spring-run Chinook Salmon ESU, and Current and Historical Distribution.

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2.2.4 Abundance Trends and Distribution

Historically, spring-run Chinook salmon occurred in the headwaters of all major river systems in the Central Valley where natural barriers to migration were absent.

The Central Valley 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 (CDFW 1998). More than 500,000 Central Valley spring-run Chinook salmon were caught in the Sacramento-San Joaquin commercial fishery in 1883 (Yoshiyama *et al.* 1998).

Although spring-run Chinook salmon were probably the most abundant salmonid in the Central Valley under historic conditions, large dams eliminated access to almost all historical habitat and the spring-run has suffered the most severe declines of any of the four Chinook salmon runs in the Sacramento River Basin (Fisher 1994).

Beginning in the 1880s, harvest, water development, construction of dams that prevented access to headwater areas and habitat degradation significantly reduced the number and range of spring-run Chinook salmon.

Before construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River (Fry 1961). The San Joaquin populations essentially were extirpated by the 1940s, with only small remnants of the run persisting through the 1950s in the Merced River (Yoshiyama *et al.* 1998). From 1970 through 2012, Central Valley spring-run Chinook salmon run size estimates have fluctuated from highs near 30,000 to lows near 3,000 (**Figure 2-5**).

The only known streams that currently support self-sustaining populations of non-hybridized spring-run Chinook salmon in the Central Valley are Mill, Deer and Butte creeks (CDFW 1998). Each of these populations is small and isolated. **Figure 2-6** depicts the annual run size estimates for these populations. These populations are genetically distinct from other populations classified as spring-run in the Central Valley (e.g., Feather River) (DWR 2004a). Banks *et al.* (2000) suggest the spring-run phenotype in the Central Valley is shown by two genetically distinct subpopulations, 1) Butte Creek, and 2) Deer and Mill creeks. Although the spring-run Chinook salmon in Deer and Mill creeks represent a single genetically distinct subpopulation, they are considered in this Recovery Plan as two separate populations because Deer and Mill creeks provide two discrete spawning areas with independent population dynamics Lindley *et al.* (2004).

The FRFH was constructed in the mid-1960s by DWR to mitigate for the loss of Chinook salmon and steelhead spawning habitat by construction of Oroville Dam. The FRFH was opened in 1967 (DWR 2002) and is operated by CDFW. The FRFH is the only hatchery in the Central Valley producing spring-run Chinook salmon. The current production target for spring-run Chinook salmon at the FRFH is two million smolts.

Prior to 2004, FRFH hatchery staff differentiated spring-run from fall-run by opening the ladder to the hatchery on September 1. Those fish ascending the ladder from September 1 through September 15 were assumed to be spring-run Chinook salmon while those ascending the ladder after September 15 were assumed to be fall-run (Kastner 2003). This practice led to considerable hybridization between spring- and fall-run Chinook salmon (DWR 2004a). Since 2007, the fish ladder remains open for 9.5 months of the year (September 15

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through June 30) and those fish ascending the ladder are marked with an external tag and returned to the river. This practice allows FRFH staff to identify those previously marked fish as phenotypic spring-run when they re-enter the ladder in September reducing the potential for hybridization between the spring and fall runs (DWR 2004a).

The FRFH also releases a significant portion of its spring-run production into San Pablo Bay (1,000,000 juvenile smolts). This practice increases the chances that these fish will stray into other Central Valley streams when they return as adults to spawn. This straying has the potential for genetic hybridization to occur between FRFH spring-run with local spring-run and fall-run populations, increasing the risk of genetic introgression and subsequent homogeneity among Central Valley Chinook salmon runs. In addition, this straying has the potential to transfer genetic material from hatchery fish to wild naturally-spawning fish and is generally viewed as an adverse hatchery impact. Of particular concern would be the straying of hatchery fish into Deer, Mill, or Butte creeks, affecting the genetic integrity of the only significantly distinct spring-run Chinook salmon in the Central Valley (DWR 2004a). **Figure 2-7** shows the total Central Valley spring-run Chinook salmon spawning run size estimates broken down by constituent component for the years 1970 through 2008. The figure indicates that since about 1982, the proportion of the spring-run in the Central Valley comprised of FRFH fish has substantially increased. The current and historical distribution of Central Valley spring-run Chinook salmon was presented in **Figure 2-4**.

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Table 2-3. Temporal Occurrence of Adult and Juvenile Sacramento River Spring-run Chinook Salmon in the Sacramento River

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult												
Sacramento River Basin[1,2]												
Sacramento River[3]												
Mill Creek[4]												
Deer Creek[4]												
Butte Creek[4]												
Juvenile												
Sacramento River Tributaries[5]												
Upper Butte Creek[6]												
Mill, Deer, Butte Creeks[4]												
Sacramento River at RBDD[3]												
Sacramento River at KL[7]												
Chipps Island (Trawl)[8*]												

Sources: [1]Yoshiyama et al. 1998; [2]Moyle 2002; [3]Myers et al. 1998; [4]Lindley et al. 2006a; [5]CDFW 1998; [6]McReynolds et al. 2005; Ward et al. 2002, 2003; [7]Snider and Titus 2000, [8]USFWS 2001

Relative Abundance: = High = Medium = Low

* Note: By the time yearly spring-run Chinook salmon reach Chipps Island they cannot be distinguished from fall-run yearlings.

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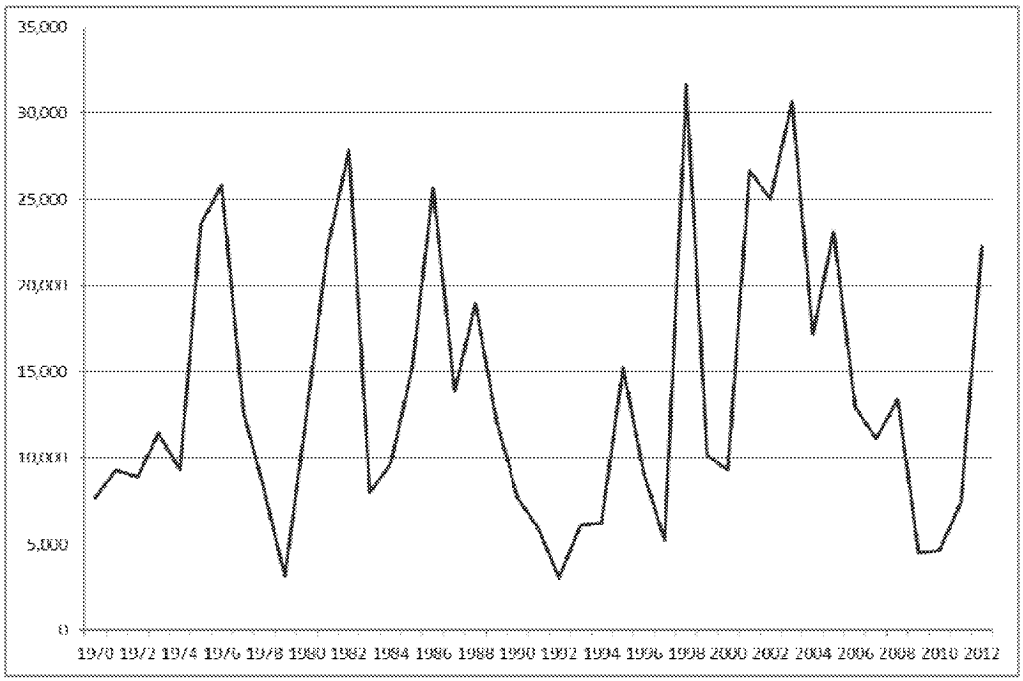


Figure 2-5. Central Valley Spring-run Chinook Salmon Run Size Estimates (1970–2012).

Source: (CDFW GRANDTAB http://www.fws.gov/stockton/*)*

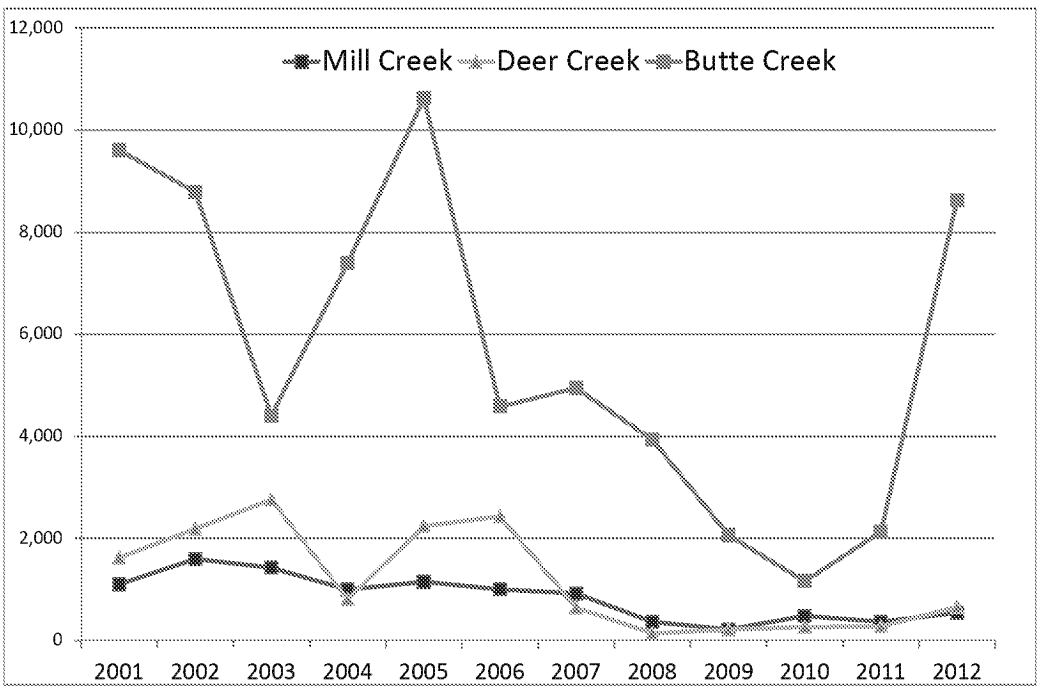


Figure 2-6. Mill, Deer, and Butte Creek Spawning Run Size Estimates for Central Valley Spring-run Chinook Salmon (2001–2012). All estimates were obtained by snorkel surveys. Source: (CDFW GRANDTAB and Annual Reports)

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2.2.5 Critical Habitat

When designating critical habitat, NMFS focuses on "Primary Constituent Elements" (PCEs), which are the principal biological or physical constituent elements within the defined area that are essential to the conservation of the listed species (50 CFR 424.12(b)). PCEs considered essential for the conservation of the Central Valley spring-run Chinook salmon ESU are those sites and habitat components that support one or more life stages(50 CFR 226.211(c)), including:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction and excessive predation with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

NMFS proposed[4] critical habitat for Central Valley spring-run Chinook salmon on December 10, 2004 (69 FR 71880), and published a final rule designating critical habitat for this species on September 2, 2005 (70 FR 52488). **Figure 2-8** depicts the designated critical habitat and distribution for Central Valley spring-run Chinook salmon.

[4] NMFS proposed critical habitat for Central Valley spring-run Chinook salmon on February 5, 1999 (63 FR 11482) in compliance with Section 4(a)(3)(A) of the ESA, which requires that, to the maximum extent prudent and determinable, NMFS designates critical habitat concurrently with a determination that a species is endangered or threatened (NMFS 1999). On February 16, 2000 (65 FR 7764), NMFS published a final rule designating critical habitat for Central Valley spring-run Chinook salmon. Critical habitat was designated to include all river reaches accessible to listed Chinook salmon in the Sacramento River and its tributaries in California. Also included were river reaches and estuarine areas of the Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge.

In response to litigation brought by the National Association of Homebuilders (NAHB) (NAHB v. Evans, 2002 WL 1205743 No. 00–CV–2799 (D.D.C.)), NMFS sought judicial approval of a consent decree withdrawing critical habitat designations for 19 Pacific salmon and *O. mykiss* ESUs. The District Court in Washington DC approved the consent decree and vacated the critical habitat designations by Court order on April 30, 2002 (NAHB v. Evans, 2002 WL 1205743 (D.D.C. 2002)).

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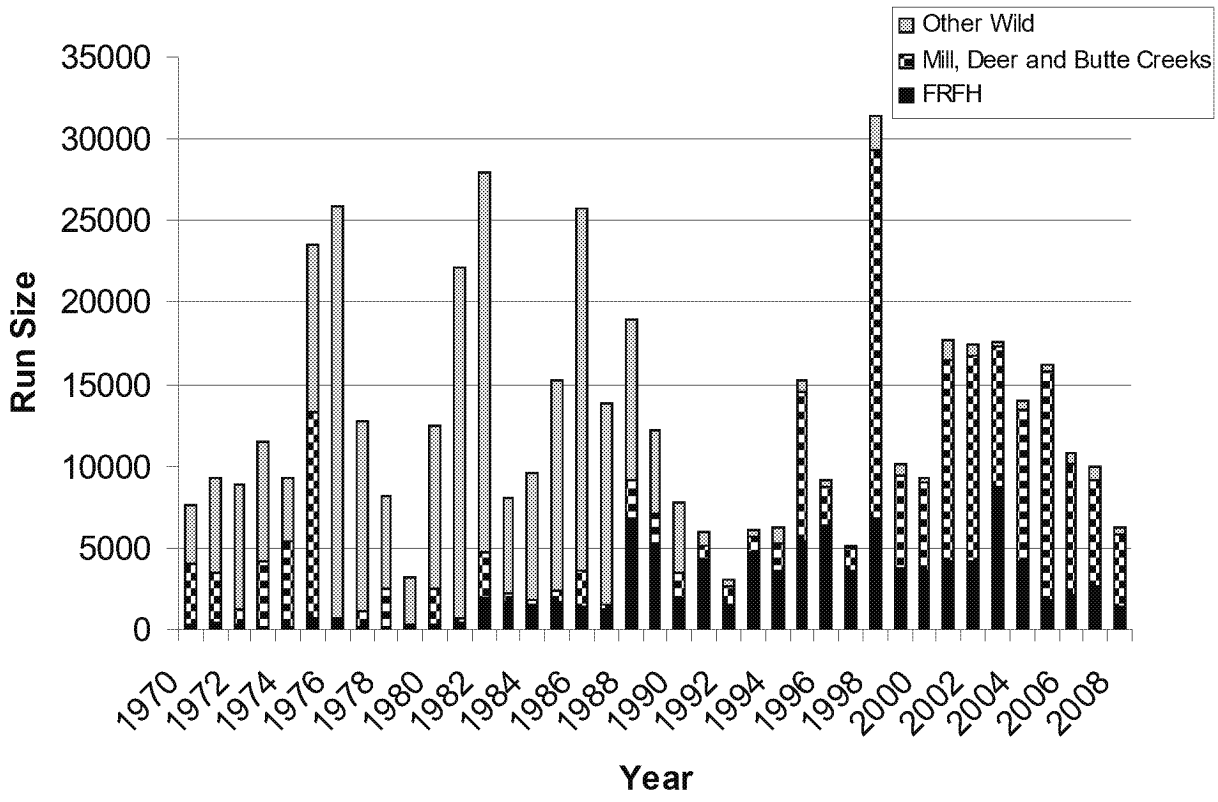


Figure 2-7. Central Valley Spring-run Chinook Salmon Spawning Run Size Composition (1970–2008)

Source: (CDFW GRANDTAB 2009)

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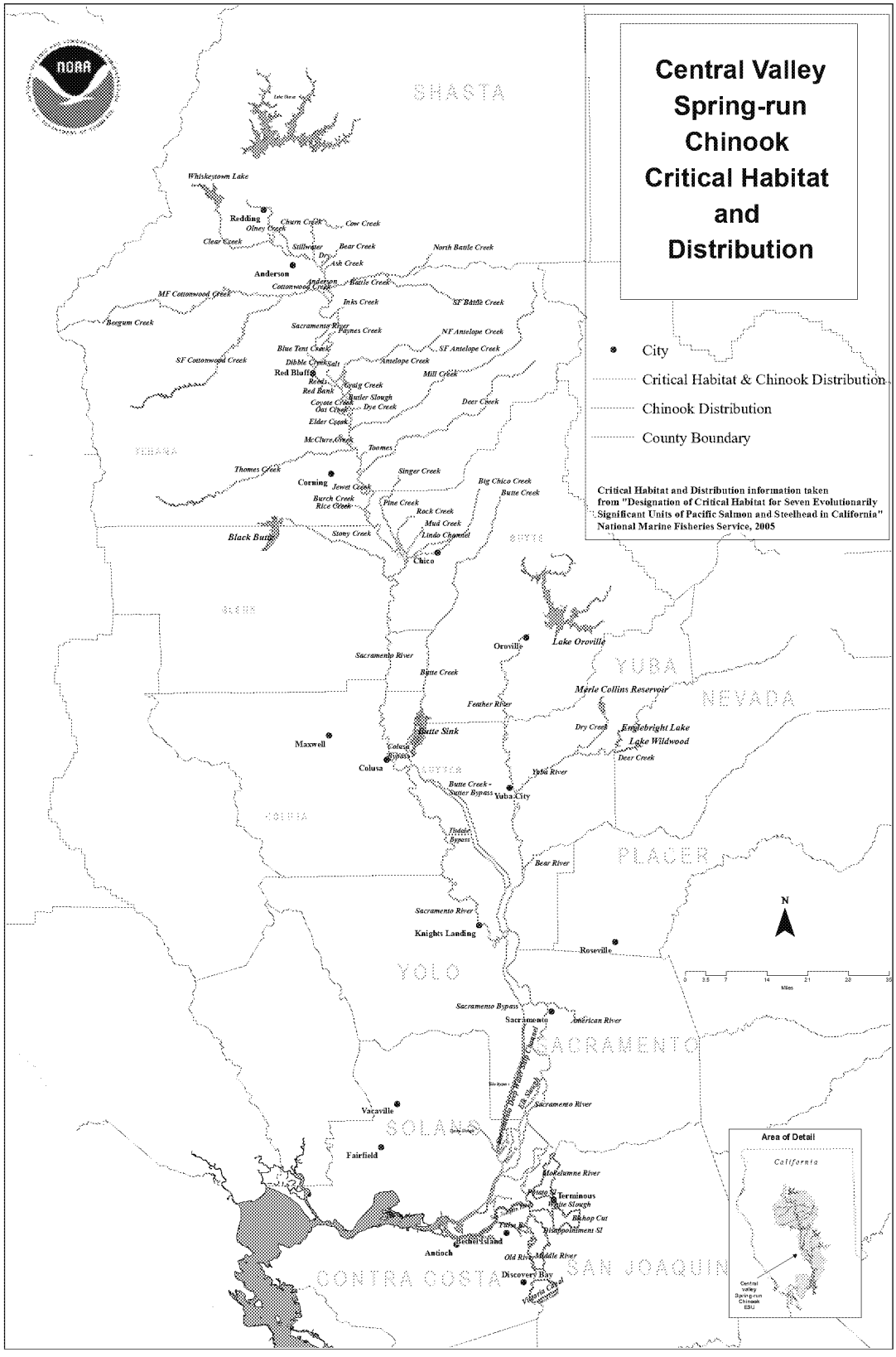


Figure 2-8. Central Valley Spring-run Chinook Salmon Designated Critical Habitat and Distribution

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2.2.6 Reasons for Listing

The Central Valley spring-run Chinook salmon ESU is currently faced with three primary threats: (1) loss of most historic spawning habitat; (2) degradation of the remaining habitat; and (3) genetic introgression with the FRFH spring-run Chinook salmon strays. Spring-run Chinook salmon require cool freshwater in summer, most of which is upstream of impassable dams. The ESU is currently limited to independent populations in Mill, Deer, and Butte creeks, persistent and presumably dependent populations in the Feather and Yuba rivers and in Big Chico, Antelope, and Battle creeks, and a few ephemeral or dependent populations in the Northwestern California region (e.g., Beegum, Clear, and Thomes creeks). This ESU continues to be threatened by habitat loss, degradation and modification, small hydropower dams and water diversions that reduce or eliminate instream flows during migration, unscreened or inadequately screened water diversions, excessively high water temperatures, and predation by non-native species.

The potential effects of climate change are likely to adversely affect spring-run Chinook salmon and their recovery. These effects are more thoroughly discussed in Chapter 6.

Listing Factors for Spring-run Chinook Salmon

Section 4 of the ESA requires the Secretary of the Interior or Commerce, depending upon the species involved, to determine if any species is an endangered or threatened species for any of the following listing factors: (1) present or threatened destruction, modification or curtailment of its habitat or range; (2) overutilization for commercial, recreational. scientific or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) other natural or manmade factors affecting its continued existence. Each of these listing factors with respect to spring-run Chinook salmon are summarized below.

The Present or Threatened Destruction, Modification, or Curtailment of Spring-run Chinook Salmon's Habitat or Range.

Habitat Loss

Loss of historic spawning habitat was a major reason for listing spring-run Chinook salmon under the ESA and it remains an important threat, as most of that habitat continues to be blocked by the direct or indirect effects of dams. Perhaps 15 of the 19 historical populations of Central Valley spring-run Chinook salmon are extinct, with their entire historical spawning habitats behind various impassable dams (Lindley *et al*. 2007). The construction of dams in the Central Valley has eliminated virtually all historic spawning habitat of spring-run Chinook salmon in the basin. Native spring-run Chinook salmon have been extirpated from all tributaries in the San Joaquin River Basin, which represents a large portion of the historic range and abundance of the ESU.

Like most spring-run Chinook salmon, Central Valley spring-run Chinook salmon require cool freshwater while they mature over the summer. In the Central Valley, summer water temperatures are reportedly suitable for Chinook salmon only above 150 to 500-m elevations, and most of that high elevation habitat is now upstream of impassable dams (NMFS 2005). Current spawning is restricted to the mainstem and a few river tributaries in the Sacramento River

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(NMFS 1998). Naturally-spawning populations of Central Valley spring-run Chinook salmon currently are restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (CDFW 1998).

The construction of Shasta and Keswick dams on the Sacramento River and Oroville Dam on the Feather River and subsequent blocking of upstream migration has eliminated the spatial separation between spawning fall-run and spring-run Chinook salmon. Reportedly, spring-run Chinook salmon migrated to the upper Feather River and its tributaries from mid-March through the end of July (CDFW 1998). Fall-run Chinook salmon reportedly migrated later and spawned in lower reaches of the Feather River than spring-run Chinook salmon (Yoshiyama *et al.* 2001). The same pattern likely also existed on the Sacramento River. Restricted access to historic spawning grounds currently causes spring-run Chinook salmon to spawn in the same lowland reaches that fall-run Chinook salmon use as spawning habitat. The overlap in spawning site locations, combined with an overlap in spawning timing (Moyle 2002) with temporally adjacent runs, is responsible for interbreeding between spring-run and fall-run Chinook salmon in the lower Feather River (Hedgecock *et al.* 2001) and in the Sacramento River below Keswick Dam.

In the upper Sacramento River, lower Feather River, and lower Yuba River, spring-run Chinook salmon spawning may occur a few weeks earlier than fall-run spawning, but currently there is no clear distinction between the two because of the disruption of spatial segregation by Shasta and Keswick dams on the Sacramento River, Oroville Dam on the Feather River, and Englebright Dam on the Yuba River. Thus, spring-run and fall-run Chinook salmon spawning overlap temporally and spatially. This presents difficulties from a management perspective in determining the proportional contribution of total spawning escapement by the spring- and fall-runs. Because of unnaturally high densities of spawning, particularly in the in the Low Flow Channel of the Feather River, spawning habitat is likely a limiting factor. Intuitively, it could be inferred that the slightly earlier spawning Chinook salmon displaying spring-run behavior would have better access to the limited spawning habitat, although early spawning likely leads to a higher rate of redd superimposition. Redd superimposition occurs when spawning Chinook salmon dig redds on top of existing redds dug by other Chinook salmon. The rate of superimposition is a function of spawning densities and typically occurs in systems where spawning habitat is limited (Fukushima *et al.* 1998). Redd superimposition may disproportionately affect early spawners and, therefore, potentially affect Chinook salmon exhibiting spring-run life history characteristics.

Habitat Degradation

Another major reason why spring-run Chinook salmon are in need of ESA protection is because the remaining spawning and rearing habitat for this species is severely degraded (63 FR 11482, March 9, 1998; Myers *et al.* 1998; Good *et al.* 2005; NMFS 2011b). Threats to spring-run Chinook salmon habitat include, but are not limited to: (1) operation of antiquated fish screens, fish ladders, and diversion dams on streams throughout the Sacramento River Basin including on Deer, Mill, Butte, and Antelope creeks; (2) levee construction and

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maintenance projects that have greatly simplified riverine habitat and have disconnected rivers from the floodplain; and (3) water delivery and hydroelectric operation on the main-stem Sacramento River (Central Valley Project), and the Feather River (State Water Project).

General degradation of rearing and migrating habitat includes elevated water temperatures, agricultural and municipal diversions and returns, restricted and regulated flows, entrainment of migrating fish into unscreened or poorly screened diversions, predation by nonnative species, and the poor quality and quantity of remaining habitat (NMFS 1998). Hydropower dams and water diversions in some years have greatly reduced or eliminated in-stream flows during spring-run migration periods (NMFS 1998b).

Overutilization of Spring-run Chinook Salmon for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization of spring-run Chinook salmon for commercial, recreational, scientific, or educational purposes was not identified as an important risk to spring-run Chinook salmon when the species was listed in 1999 (63 FR 11482; March 9, 1998). The spring-run Chinook salmon status review that informed the 1999 listing determination stated that, "*Harvest rates* [of spring-run Chinook salmon] *appear to be moderate.* (Myers *et al.* 1998)." No spring-run Chinook salmon ocean harvest rate data were available to support that statement. Some limited information obtained since spring-run Chinook salmon were listed suggests that harvest in the ocean fisheries may be more of a risk to the species than originally thought. An analysis done by Grover *et al.* (2004) indicated that Butte Creek spring-run Chinook salmon are vulnerable to the commercial and recreational ocean salmon fisheries with an estimated 36 percent of brood year 1998 and 42 percent of brood year 1999 harvested in the ocean, respectively. Those harvest rates are about twice that of winter-run Chinook salmon (NMFS 2010c). Grover *et al.* (2004) cautioned the interpretation of their own results because of the low number of coded wire tag recoveries and the analysis covered just two cohorts. Further analysis of spring-run Chinook salmon harvest rates is needed to better understand the ocean fisheries' impacts on this ESU.

Disease or Predation

Disease

Disease was not an important factor in the listing of spring-run Chinook salmon (63 FR 11482, March 9, 1998; Myers *et al.* 1998). There is no evidence that spring-run Chinook salmon have experienced unusual levels of disease in the wild. There have been numerous outbreaks of infectious hematopoietic necrosis virus (IHNV) in Chinook salmon at CNFH and the FRFH. Although the virus had been detected in stream salmonids, there have been no reported epizootics of IHNV in Central Valley stream populations (i.e., the virus was detected but the fish themselves were asymptomatic of the disease) (DWR 2009). It appears that IHNV is not readily transmitted from hatchery fish to salmon and other fish in streams, estuary or the ocean (DWR 2009).

Predation

Predation was not identified as an important factor in the listing of spring-run Chinook salmon (63 FR 11482, March 9, 1998; Myers *et al.* 1998), but more recently it has gained attention as a potentially significant source of mortality (Moyle 2002; Vogel

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2011). See section 2.1.6 above for information on predators of juvenile Chinook salmon in the Central Valley and their potential impact.

The Inadequacy of Existing Regulatory Mechanisms

Laws relevant to the protection and restoration of spring-run Chinook salmon are the ESA, the Magnuson-Stevens Fishery Conservation and Management Act, the CVPIA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Clean Water Act, the National Environmental Policy Act, and numerous State laws administered by CDFW, DWR, or the SWRCB. These laws and associated regulations provide adequate mechanisms for recovering spring-run Chinook salmon; however some of the goals of these existing mechanisms have not yet been achieved. The effectiveness of applying the regulatory mechanisms is to some extent controlled by societal values. The people of California will need to place a higher value on improving natural ecosystems in order for existing regulatory mechanisms to be most effective at recovering anadromous salmonids in the Central Valley.

Other Natural or Manmade Factors Affecting the Continued Existence of Spring-run Chinook Salmon

Reduced Genetic Integrity

Threats to the genetic integrity of spring-run Chinook salmon was identified as a serious concern to the species when it was listed in 1999 (63 FR 11482, March 9, 1998; Myers *et al.* 1998). Three main factors compromised the genetic integrity of spring-run Chinook salmon: (1) the lack of reproductive isolation following dam construction throughout the Central Valley resulting in introgression with fall-run Chinook salmon in the wild; (2) within basin and inter-basin mixing between spring- and fall- broodstock for artificial propagation, resulting in introgression in hatcheries; and (3) releasing hatchery-produced juvenile Chinook salmon in the San Francisco estuary, which contributes to the straying of returning adults throughout the Central Valley.

In the 1940s, trapping of adult Chinook salmon that originated from areas above Keswick and Shasta dams may have resulted in stock mixing, and further mixing with fall-run Chinook salmon apparently occurred with fish transferred to the CNFH. Deer Creek, one of the locations generally believed most likely to retain essentially native spring-run Chinook salmon, was a target of adult outplants from the 1940s trapping operation, but the success of those transplants is uncertain (Myers *et al.* 1998).

Much of the Central Valley Chinook salmon production is of hatchery origin, and over the years hatchery fish have interbred with wild populations of both fall-run and spring-run Chinook salmon. This problem has been exacerbated by the continued practice of trucking juvenile Chinook salmon to the Delta for release, contributing to the straying of returning adults throughout the Central Valley.

The FRFH spring-run Chinook salmon program releases half its production near the hatchery and the other half is released far downstream of the hatchery (CDFW 2001a). Given the large number of juveniles released off station, the potential contribution of straying adults to rivers throughout the Central Valley is considerable (Myers *et al.* 1998). Cramer (1996) reported that up to 20 percent of the Feather River spring-run Chinook salmon are recovered in the

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American River sport fishery. From 2004 through 2010 on the Yuba River, hatchery origin Chinook salmon accounted for an average of 21.4% of the total annual run of spring-run Chinook salmon passing upstream of Daguerre Point Dam (USACE 2012). Analysis of coded wire tags suggests that most of those hatchery fish originated from the FRFH (USACE 2012).

Catastrophic Environmental Disturbance

Although not identified as a reason for listing spring-run Chinook salmon under the ESA, the potential for a catastrophic environmental disturbance has more recently been recognized as a key threat to the species. Lindley *et al.* (2007) report that the current distribution of viable populations makes the Central Valley spring-run Chinook salmon ESU vulnerable to catastrophic disturbance. All three extant independent populations are in basins whose headwaters lie within the debris and pyroclastic flow radii of Lassen Peak, an active volcano that USGS views as highly dangerous. Additionally, a fire with a maximum diameter of 30 km, big enough to burn the headwaters of Mill, Deer, and Butte creeks simultaneously, has roughly a 10 percent chance of occurring somewhere in the Central Valley each year. Impacts on salmon and their habitat from fires include potential death during a fire that goes through a drainage, reduced water quality from fire suppression activities and associated chemicals, increased water temperatures from lost canopy, increased sedimentation, and reduced habitat complexity and large woody debris. A catastrophic environmental disturbance affecting Mill, Deer, and Butte creeks would greatly reduce the abundance and distribution of the spring-run Chinook salmon ESU.

2.2.7 Threats Assessment

A detailed threats assessment was conducted for the Central Valley spring-run Chinook salmon ESU, and followed the same general procedure previously described for winter-run Chinook salmon. The threats/stressors affecting each spring-run Chinook salmon diversity group and population are described in Appendix B.

The completed stressor matrix sorted by normalized weight is a prioritized list of the life stage-specific stressors affecting the ESU. For spring-run Chinook salmon, threats were prioritized within each diversity group, as well as within each population. Specific information explaining the individual steps taken to generate these prioritized lists are provided in Appendix B.

Some major stressors to the entire Central Valley spring-run Chinook salmon ESU include passage impediments/barriers, ocean harvest, warm water temperatures for holding and rearing, limited quantity and quality of rearing habitat, predation, and entrainment. The complete prioritized list of life stage-specific stressors to this ESU is presented in Appendix B.

Some of the most important specific stressors to each diversity groups within the ESU are described below.

Northern Sierra Nevada Diversity Group

- Agricultural diversions, diversion dams, and/or weirs on Deer, Mill, Antelope, and Butte creeks impeding or blocking access to upstream spawning habitat;
- Warm water temperatures in Antelope, Butte, and Big Chico creeks during the adult immigration

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and holding life stage, especially in dry or extreme years;

- Englebright Dam blocking access to habitat historically used by Yuba River spring-run Chinook salmon;
- Oroville Dam blocking access to habitat historically used by Feather River spring-run Chinook salmon;
- Entrainment in Antelope Creek resulting from terminal diversions and loss of channel connectivity;
- Loss of rearing habitat in the lower and middle sections of the Sacramento River and in the Delta;
- Ocean harvest on all populations; and
- Predation on juveniles from all populations rearing and migrating through the Sacramento River and Delta.

Basalt and Porous Lava Diversity Group

- Keswick and Shasta dams blocking access to habitat historically used by spring-run Chinook salmon in the upper Sacramento River watershed;
- Passage impediments and flow fluctuations resulting from hydropower operations on the North and South Forks of Battle Creek;
- Loss of rearing habitat in the Sacramento River and Delta;
- Ocean harvest on all populations; and
- Predation on juveniles from all populations rearing and migrating through the Sacramento River and Delta.

Northwestern California Diversity Group

- Warm water temperatures in all three watersheds during the adult immigration and holding life stage;
- Limited spawning habitat availability in all three watersheds;
- Loss of rearing habitat in the lower and middle sections of the Sacramento River and in the Delta;
- Whiskeytown Dam blocking access to habitat potentially historically used by Clear Creek spring-run Chinook salmon;
- Ocean harvest on all populations; and
- Predation on juveniles from all populations rearing and migrating through the Sacramento River and Delta.

2.2.8 Conservation Measures

ERP and CVPIA actions in the Sacramento River tributaries have focused on riparian and shaded riverine aquatic habitat restoration, improved access to available upstream habitat, improved instream flows, and reduced loss of juveniles at diversions, particularly for spring-run Chinook salmon and steelhead. For a description of ERP, CVPIA and other actions, refer to the previous discussion of Conservation Measures for winter-run Chinook salmon.

The Delta Pumping Plant Fish Protection Agreement (Delta Agreement) signed in 1986 was intended to mitigate for SWP and

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pumping plant impacts. From 1986 through 2007, approximately $60 million from the Delta Agreement has been spent on over 40 fish mitigation projects. These funds resulted in the screening of water diversions, enhanced law enforcement efforts to reduce illegal fish harvest, installation of seasonal barriers to guide fish away from undesirable spawning habitat or migration corridors, salmon habitat restoration, and removal of four dams to improve fish passage on Butte Creek for Chinook and steelhead. Approximately one-third of the approved funding for salmon projects specifically targeted spring-run Chinook salmon and steelhead in the upper Sacramento River tributaries. Projects implemented under the agreement that have most directly benefited spring-run Chinook salmon include water exchange projects to improve passage flows on Mill and Deer creeks, and fish screens and fish ladder improvements on Butte Creek.

Harvest protective measures benefiting spring-run Chinook salmon include seasonal constraints on sport and commercial fisheries south of Point Arena. In addition, the State has listed spring-run Chinook under the CESA, and has thus established specific in-river fishing regulations and no-retention prohibitions designed to protect this ESU (e.g., fishing method restrictions, gear restrictions, bait limitations, seasonal closures, and zero bag limits), in tributaries such as Deer, Big Chico, Mill, and Butte creeks.

2.3 Steelhead

2.3.1 ESA Listing Status

NMFS proposed to list Central Valley steelhead (anadromous *O. mykiss*), which is currently listed as threatened, as endangered on August 9, 1996 (61 FR 41541). NMFS concluded that the California Central Valley steelhead ESU was in danger of extinction because of habitat degradation and destruction, blockage of freshwater habitats, water allocation problems, the pervasive opportunity for genetic introgression resulting from widespread production of hatchery steelhead and the potential ecological interaction between introduced stocks and native stocks. Moreover, NMFS proposed to list steelhead as endangered because steelhead had been extirpated from most of their historical range.

On March 19, 1998, NMFS listed the Central Valley steelhead as a threatened species (63 FR 13347). NMFS concluded that the risks to Central Valley steelhead had diminished since the completion of the 1996 status review based on a review of existing and recently implemented State conservation efforts and Federal management programs (e.g., CVPIA AFRP, CALFED) that address key factors for the decline of this species. In addition, NMFS noted that additional actions benefiting Central Valley steelhead included efforts to enhance fisheries monitoring and conservation actions to address artificial propagation.

On September 8, 2000, pursuant to a July 10, 2000, rule issued by NMFS under Section 4(d) of the ESA (16 USC § 1533(d)), the take restrictions that apply statutorily to endangered species began to apply with specific limitations to Central Valley steelhead (65 FR 42422). On January 5, 2006, NMFS reaffirmed the threatened status of the Central Valley steelhead and applied the DPS policy to the species because the resident and anadromous life forms of steelhead remain "markedly separated" as a consequence of physical, ecological and behavioral factors, and may therefore warrant delineation as a

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separate DPS (71 FR 834). NMFS (1998) based its conclusion on conservation and protective efforts that, "*mitigate the immediacy of extinction risk facing the Central Valley steelhead DPS.*" **Figure 2-9** depicts the California Central Valley steelhead DPS.

2.3.2 Species Description and Taxonomy

Steelhead and rainbow trout are the same species. In general, steelhead refers to the anadromous form of the species. Normally, adult steelhead reach a larger size than resident rainbow trout. Sacramento River Basin steelhead immigrants range in size from 12 to 18 inches (30.5 to 45.7 cm) FL for adults returning after 1 year in the ocean, to 18 to 23 inches (45.7 to 58.4 cm) FL for adults returning after 2 years in the ocean (S.P. Cramer & Associates 1995).

Steelhead can be identified by the numerous black spots on the caudal fin, adipose fin, dorsal fin and back (Moyle 2002). When in freshwater, steelhead often display the pinkish to red lateral band and cheeks typical of resident rainbow trout. The back is normally an iridescent blue to brown, the sides and belly are silver, white or yellowish (Moyle 2002). The resident forms are usually darker than the sea-run. Juvenile coloration is similar to adults except that juveniles often have 8 to 13 widely spaced parr marks centered on the lateral line, 5 to 10 dark marks on the back between the head and dorsal fin, white to orange tips on the dorsal and anal fins, and few, if any, dark spots on the tail (Moyle 2002).

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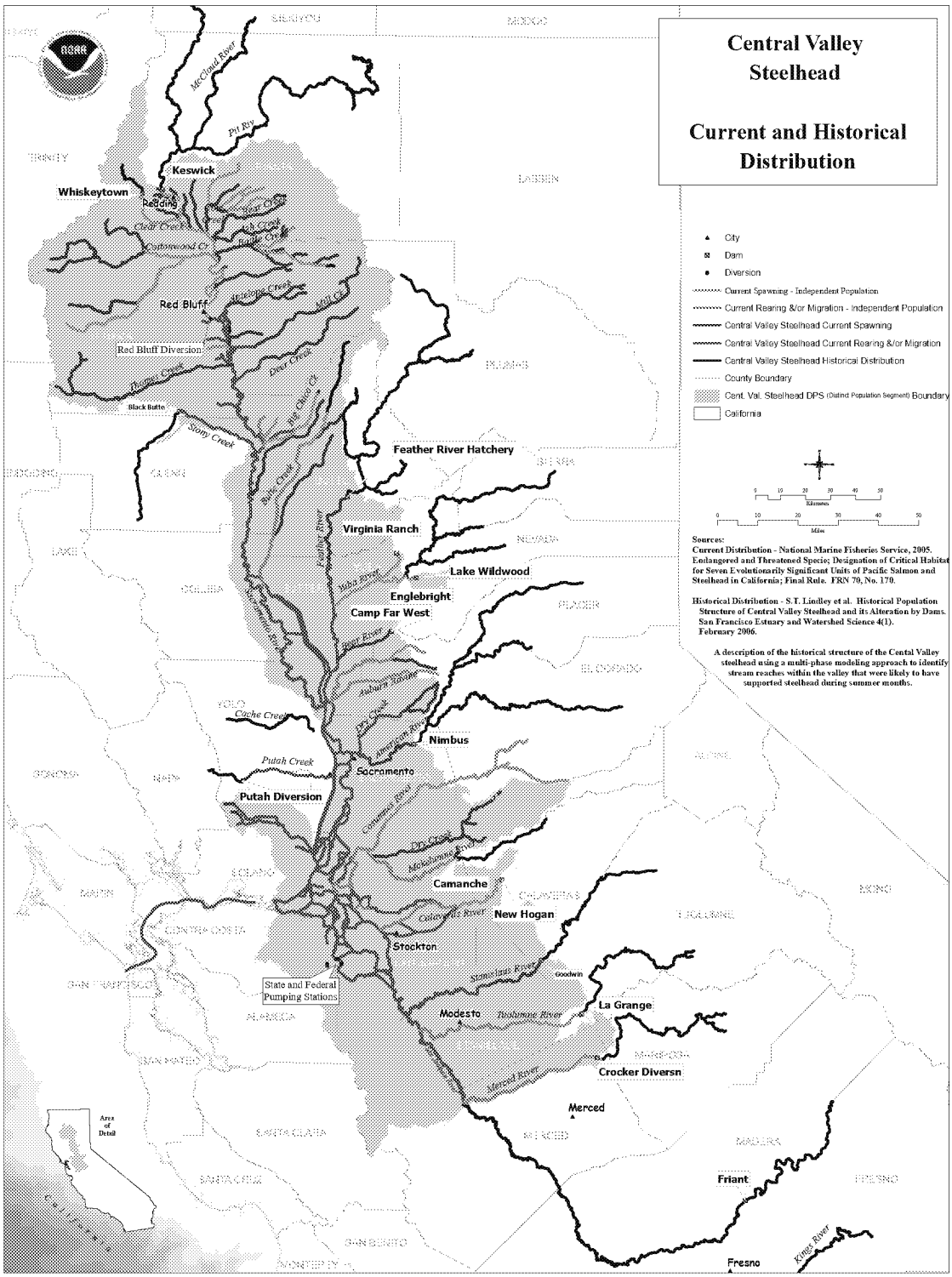


Figure 2-9. California Central Valley Steelhead Distinct Population Segment, and Current and Historical Distribution. See Lindley *et al.* 2006 (Table 1) in Appendix C for a list of the 81 historic independent steelhead populations in the Central Valley. Note: this figure does not include populations in the Suisun Bay Tributaries diversity group, the Central Western diversity group, or populations in the southern Sierra Nevada diversity group that are south of the upper San Joaquin River.

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2.3.3 Life History/Habitat Requirements

Life History

Oncorhynchus mykiss may exhibit anadromy or freshwater residency. Resident forms are usually referred to as rainbow trout, while anadromous life forms are termed "steelhead." Zimmerman *et al.* (2008) demonstrated that resident rainbow trout can produce anadromous smolts and anadromous steelhead can produce resident rainbow trout in the Central Valley. That study indicated that the proportion of resident rainbow trout to anadromous steelhead in the Central Valley is largely in favor of the resident form with 740 of 964 *O. mykiss* examined being the progeny of resident rainbow trout (Zimmerman *et al.* 2008).

Steelhead typically migrate to marine waters after spending two years in fresh water. They reside in marine waters for typically two or three years prior to returning to their natal stream to spawn as four- or five-year-olds. Unlike Pacific salmon, steelhead are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying, and most that do so are females (Moyle 2002).

Currently, Central Valley steelhead are considered "ocean-maturing" (also known as winter) steelhead, although summer steelhead may have been present prior to construction of large dams (Moyle 2002). Ocean maturing steelhead enter fresh water with well-developed gonads and spawn shortly after river entry. Central Valley steelhead enter fresh water from August through April. They hold until flows are high enough in tributaries to enter for spawning (Moyle 2002). Steelhead adults typically spawn from December through April, with peaks from January through March in small streams and tributaries where cool, well oxygenated water is available year-round (Hallock *et al.* 1961; McEwan 2001). Depending on water temperature, steelhead eggs may incubate in redds for over one month before hatching as alevins. Following yolk sac absorption, alevins emerge from the gravel as young juveniles or fry and begin actively feeding (Moyle 2002).

In the Sacramento River, juvenile steelhead generally migrate to the ocean in spring and early summer at 1 to 3 years of age and 10 to 25 cm FL, with peak migration through the Delta in March and April (Reynolds *et al.* 1993). Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River Basin migrate downstream during most months of the year, but the peak emigration period occurred in the spring, with a much smaller peak in the fall.

Table 2-4 depicts the temporal occurrence of steelhead life stages in the Sacramento River. Steelhead may remain in the ocean from one to four years, growing rapidly as they feed in the highly productive currents along the continental shelf (Barnhart 1986). Oceanic and climate conditions such as sea surface temperatures, air temperatures, strength of upwelling, El Niño events, salinity, ocean currents, wind speed, and primary and secondary productivity affect all facets of the physical, biological and chemical processes in the marine environment. Some of the conditions associated with El Niño events include warmer water temperatures, weak upwelling, low primary productivity (which leads to decreased zooplankton biomass), decreased southward transport of subarctic water, and increased sea levels (Pearcy 1997). For juvenile steelhead, warmer water and weakened upwellings are possibly the

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most important of the ocean conditions associated with El Niño. Because of the weakened upwelling during an El Niño year, juvenile California steelhead would need to migrate more actively offshore through possibly stressful warm waters with numerous inshore predators.

Strong upwelling is probably beneficial because of the greater transport of smolts offshore, beyond major concentrations of inshore predators (Pearcy 1997).

Habitat Requirements

A description of freshwater habitat requirements for steelhead is presented in the following sections. Habitat requirements are organized by the species life stage.

Adult Immigration and Holding

Adult steelhead immigration into Central Valley streams typically begins in August and continues into March (McEwan 2001; NMFS 2004). Steelhead immigration generally peaks during January and February (Moyle 2002). Optimal immigration and holding temperatures have been reported to range from 46°F to 52°F (CDFW 1991b).

Central Valley steelhead are known to use the Sacramento River as a migration corridor to spawning areas in upstream tributaries. Historically, steelhead likely did not utilize the mainstem Sacramento River downstream from the Shasta Dam site except as a migration corridor to and from headwater streams. Likewise, the Feather River below the current site of Oroville Dam was likely used only as a migration corridor to upstream reaches.

Adult Spawning

Central Valley steelhead spawn downstream of dams on every major tributary within the Sacramento and San Joaquin River systems. The female steelhead selects a site with good intergravel flow, digs a redd with her tail, usually in the coarse gravel of the tail of a pool or in a riffle, and deposits eggs while an attendant male fertilizes them. Water velocities over redds are typically 20 to 155 cm/sec, and depths are 10 to 150 cm (Moyle 2002). The preferred water temperature range for steelhead spawning is reported to be 30°F to 52°F (CDFW 2000).

Embryo Incubation

Following deposition of fertilized eggs in the redd, they are covered with loose gravel. Central Valley steelhead eggs can reportedly survive at water temperature ranges of 35.6°F to 59°F (Myrick and Cech 2001). However, steelhead eggs reportedly have the highest survival rates at water temperature ranges of 44.6°F to 50.0°F (Myrick and Cech 2001). The eggs hatch in three to four weeks at 50°F to 59°F, and fry emerge from the gravel four to six weeks later (Shapovalov and Taft 1954).

Juvenile Rearing and Outmigration

Regardless of life history strategy, for the first year or two of life rainbow trout and steelhead are found in cool, clear, fast-flowing permanent streams and rivers where riffles predominate over pools, there is ample cover from riparian vegetation or undercut banks, and invertebrate life is diverse and abundant (Moyle 2002). The smallest fish are most often found in riffles, intermediate size fish in runs, and larger fish in pools. Steelhead can be found where daytime water temperatures range from nearly 32°F to 81°F in the summer, although mortality may result at extremely low (i.e.,

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<39°F) or extremely high (i.e., > ~73°F) water temperatures if the fish have not been gradually acclimated (Moyle 2002). Juvenile steelhead in northern California rivers reportedly exhibited increased physiological stress, increased agonistic activity, and a decrease in forage activity after ambient stream temperatures exceeded 71.6°F (Nielsen *et al.* 1994).

When water temperatures become stressful in streams, juvenile steelhead are faced with the increased energetic costs of living at high water temperatures. Hence, juvenile steelhead will move into fast flowing riffles to feed because of the increased abundance of food, even though there are costs associated with maintaining position in fast water. At higher water temperatures, steelhead are more vulnerable to stress which can be fatal (Moyle 2002). Predators also have a strong effect on microhabitats selected by steelhead. Small steelhead select places to live based largely on proximity to cover in order to hide from predators.

Optimal water temperatures for growth of steelhead have been reported to be 59°F to 64.4°F (Moyle 2002). Many factors affect choice of water temperatures by steelhead, including the availability of food. As steelhead grow, they establish individual feeding territories. Some juvenile steelhead 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 ocean.

2.3.4 Abundance Trends and Distribution

Prior to dam construction, water development and watershed perturbations, Central Valley steelhead were distributed throughout the Sacramento and San Joaquin rivers (Busby *et al.* 1996; NMFS 1996b, McEwan 2001). Steelhead were found from the upper Sacramento and Pit rivers (now inaccessible due to Shasta and Keswick dams) south to the Kings and possibly the Kern River systems, and in both east- and west-side Sacramento River tributaries (Yoshiyama *et al.* 1996). Lindley *et al.* (Lindley *et al.* 2006) estimated that historically there were at least 81 independent Central Valley steelhead populations distributed primarily throughout the eastern tributaries of the Sacramento and San Joaquin rivers (**see Appendix C**). Presently, impassable dams block access to 80 percent of historically available habitat, and block access to all historical spawning habitat for about 38 percent of historical populations (Lindley *et al.* 2006).

The current and historical distribution of Central Valley steelhead was presented in **Figure 2-9**. Existing wild steelhead populations in the Sacramento River basin occur in the upper Sacramento River and its tributaries, including Cottonwood, Antelope, Deer, and Mill creeks and the Yuba River. Other Sacramento River basin populations may exist in Big Chico and Butte creeks, and a few wild steelhead are produced in the American and Feather rivers (McEwan 2001). Snorkel surveys conducted from 1999 to 2008 indicate that steelhead are present in Clear Creek (Giovannetti and Brown 2009; Good *et al.* 2005). Monitoring data from 2005 to 2009 shows that steelhead are also present in Battle Creek (Newton and Stafford 2011).

A hatchery supported population of steelhead also occurs in the Mokelumne River, which flows directly into the Delta in between where the Sacramento and San Joaquin rivers enter the Delta.

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Central Valley steelhead were thought to be extirpated from the San Joaquin River system, until recent monitoring detected small populations of *O.mykiss* in the Stanislaus, Mokelumne, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). It is uncertain whether the *O.mykiss* in those rivers are predominantly resident or anadromous *O.mykiss*; presumably, both the anadromous and resident life history form of *O.mykiss* are present. On the Stanislaus River, small numbers of 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). Steelhead also currently occur in the Stanislaus, Calaveras, Merced, and Tuolumne rivers.

It is possible that naturally-spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that *O.mykiss* are widespread, throughout accessible streams and rivers in the Central Valley (Good *et al.* 2005).

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Table 2-4. The Temporal Occurrence of Adult and Juvenile Steelhead in the Sacramento River

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult												
Sacramento River[1,3]												
Sacramento River at Red Bluff[2,3]												
Mill, Deer Creeks[4]												
Sacramento River at Fremont Weir[6]												
Sacramento River at Fremont Weir[6]												
San Joaquin River[7]												
Juvenile												
Sacramento River[1,2]												
Sacramento River at Knights Landing[2,8]												
Sacramento River at KL[9]												
Chipps Island (Wild)[10]												
Mossdale[8]												
Woodbridge Dam[11]												
Stanislaus River at Caswell[12]												
Sacramento River at Hood[13]												

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

Relative Abundance: = High = Medium = Low

Note: NMFS recognizes that CDFW Steelhead Report Card Data provides a small sample size and involves some known sampling bias, but these data represent the best information available for the temporal distribution of adult steelhead in the San Joaquin River.

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Historic Central Valley steelhead run sizes are difficult to estimate because of the lack of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 (CDFW 1996). Over the last 30 years the steelhead populations in the upper Sacramento River have declined substantially. In 1996, NMFS estimated the Central Valley total run size based on dam counts, hatchery returns, and past spawning surveys was probably fewer than 10,000 fish. Both natural and hatchery runs have declined since the 1960s. Counts at RBDD averaged 1,400 fish from 1991 to 1993, compared to counts in excess of 10,000 fish in the late 1960. Because of adverse impacts on winter-run Chinook salmon, the operation of RBDD was changed so that the dam gates were raised earlier in the season, and this eliminated the ability to generate steelhead run-size estimates (McEwan 2001).

American River redd surveys and associated monitoring from 2002 through 2007 indicate that only a few hundred steelhead spawn in the river and the majority of those spawners originated from Nimbus Hatchery (Hannon and Deason 2008).

In analyzing flow-habitat relationships for anadromous salmonids in the upper Sacramento River upstream of the Battle Creek confluence and downstream of Keswick Dam, USFWS (2003) reported that it was not possible to differentiate between steelhead and resident rainbow trout. Specific information regarding steelhead spawning within the mainstem Sacramento River is limited due to lack of monitoring (NMFS 2004). Currently, the number of steelhead spawning in the Sacramento River is unknown because redds cannot be distinguished from a large resident rainbow trout population that has developed as a result of managing the upper Sacramento River for coldwater species.

2.3.5 Critical Habitat

When designating critical habitat, NMFS focuses on "Primary Constituent Elements" (PCEs), which are the principal biological or physical constituent elements within the defined area that are essential to the conservation of the listed species (50 CFR 424.12(b)). PCEs considered essential for the conservation of the California Central Valley steelhead DPS are those sites and habitat components that support one or more life stages (50 CFR 226.211(c)), including:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction and excessive predation with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between

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fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

NMFS proposed[5] critical habitat for Central Valley steelhead on December 10, 2004 (69 FR 71880) and published a final rule designating critical habitat for this species on September 2, 2005 (70 FR 52488). **Figure 2-10** depicts the designated critical habitat and distribution for Central Valley steelhead.

2.3.6 Reasons for Listing

Section 4 of the ESA requires the Secretary of the Interior or Commerce, depending upon the species involved, to determine if any species is an endangered or threatened species for any of the following listing factors: (1) present or threatened destruction, modification or curtailment of its habitat or range; (2) overutilization for commercial, recreational. scientific or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) other natural or manmade factors affecting its continued existence. Each of these listing factors with respect to Central Valley steelhead are summarized below.

The Present or Threatened Destruction, Modification, or Curtailment of Central Valley Steelhead's Habitat or Range.

The widespread degradation, destruction, and blockage of freshwater habitats within the Central Valley, and the continuing impacts to habitat resulting from water management were identified as key reasons why Central Valley steelhead were listed under the ESA (61 FR 41541, August 9, 1996; 63 FR 13347, March 19, 1998). These reasons are briefly discussed below under two categories – (1) habitat loss, and (2) habitat degradation.

Habitat Loss

About 80% of habitat identified by the TRT that was historically available to anadromous *O. mykiss* is now behind impassable dams, and 38% of the populations identified by the TRT have lost all of their habitat (Lindley *et al.* 2006). Anadromous *O. mykiss* populations may have been extirpated from their entire historical range in the San Joaquin Valley and most of the larger basins of the Sacramento River. The roughly 52% of watersheds with at least half of their historical area below impassable dams are all small, low elevation systems (Lindley *et al.* 2006).

[5] NMFS proposed critical habitat for Central Valley steelhead on February 5, 1999 (64 FR 5740) in compliance with Section 4(a)(3)(A) of the ESA, which requires that, to the maximum extent prudent and determinable, NMFS designates critical habitat concurrently with a determination that a species is endangered or threatened (NMFS 1999). On February 16, 2000 (65 FR 7764), NMFS published a final rule designating critical habitat for Central Valley steelhead. Critical habitat was designated to include all river reaches accessible to listed steelhead in the Sacramento and San Joaquin rivers and their tributaries in California. Also included were river reaches and estuarine areas of the Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge.

In response to litigation brought by the National Association of Homebuilders (NAHB) (NAHB v. Evans, 2002 WL 1205743 No. 00–CV–2799 (D.D.C.)), NMFS sought judicial approval of a consent decree withdrawing critical habitat designations for 19 Pacific salmon and *O. mykiss* ESUs. The District Court in Washington DC approved the consent decree and vacated the critical habitat designations by Court order on April 30, 2002 (NAHB v. Evans, 2002 WL 1205743 (D.D.C. 2002)).

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Habitat Degradation

The habitat in the Central Valley that remains accessible to anadromous *O. mykiss* has been drastically altered and degraded. Reynolds *et al.* (1993) reported that declines in Central Valley steelhead stocks are *"due mostly to water development, inadequate instream flows, rapid flow fluctuations, high summer water temperatures in streams immediately below reservoirs, diversion dams which block access, and entrainment of juveniles into unscreened or poorly screened diversions."* Other problems related to land use practices (agriculture and forestry) and urbanization also have certainly contributed to the decline of Central Valley steelhead (McEwan 2001).

Overutilization of Steelhead for Commercial, Recreational, Scientific, or Educational Purposes

The overutilization of Central Valley steelhead was not identified as an important reason for the species' listing (61 FR 41541; 63 FR 13347).

Commercial or Recreational Fishery Impacts on Central Valley Steelhead

Because there is no commercial fishery for Central Valley steelhead and the recreational fishery is regulated to protect wild steelhead, there is some reason to think that fishing impacts would not be a significant problem for this species. However, because the sizes of Central Valley steelhead populations are largely unknown, it is difficult to make conclusions about the impact of the recreational fishery (Good *et al.* 2005).

Scientific or Educational Utilization of Central Valley Steelhead

NMFS issues permits under the ESA for scientific research that stipulate specific conditions to minimize take of steelhead. These permitted studies provide information about steelhead in the Central Valley that is useful for management and conservation of the DPS and are not considered a factor for the decline of this species (NMFS 2011c).

Disease or Predation

Disease

Infectious disease is one of many factors which can influence adult and juvenile steelhead survival. Steelhead are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environments. Specific diseases such as bacterial kidney disease (BKD), ceratomyxosis, columnaris, Furunculosis, infectious hematopoietic necrosis (IHNV), redmouth and black spot disease, Erythrocytic Inclusion Body Syndrome (EIBS), and whirling disease among others are present and are known to affect steelhead and salmon (NMFS 1996).

Although disease was recognized as a potential factor in the decline of west coast steelhead (NMFS 1996), it was not specifically identified as an important reason why Central Valley steelhead were listed under the ESA (61 FR 41541; 63 FR 13347).

The Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms was not identified as a key factor in the listing of Central Valley steelhead. Although there is a lengthy discussion of this listing factor in the Final Rule listing Central Valley steelhead as threatened, most of the discussion applies to other steelhead ESUs, which were also considered for listing at that time (63 FR 13347).

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Other Natural or Manmade Factors Affecting the Continued Existence of Central Valley Steelhead

Hatchery Management/Reduced Genetic Integrity

Along with habitat loss and habitat degradation, hatchery management was identified as a key factor in the listing of Central Valley steelhead (61 FR 41541; 63 FR 13347). Over the past several decades, the genetic integrity of Central Valley steelhead has been diminished by increases in the proportion of hatchery fish relative to naturally produced fish, the use of out-of-basin stocks for hatchery production, and straying of hatchery produced fish (CDFW and NMFS 2001; California Hatchery Scientific Review Group 2012). Four hatcheries in the Central Valley produce steelhead, and each hatchery has specific production targets, as identified in Table 2-5. Currently there is still great concern about the ecological and genetic impacts of steelhead hatchery management in the Central Valley (California Hatchery Scientific Review Group 2012). These concerns continue to be related to the proportion of hatchery fish relative to naturally produced fish, the predominance of Eel River steelhead genetics in the Nimbus Hatchery steelhead program, and straying of hatchery produced steelhead.

Potential adverse effects to wild steelhead populations associated with hatchery production are similar to those described above for winter-run Chinook salmon. Research has indicated that approximately 63 to 92 percent of steelhead smolt production is of hatchery origin (NMFS 2003). Overall, hatchery-origin fish appear to comprise the majority of the DPS (Lindley *et al.* 2007)

Habitat fragmentation and population declines resulting in small, isolated populations also pose genetic risk from inbreeding, loss of rare alleles, and genetic drift.

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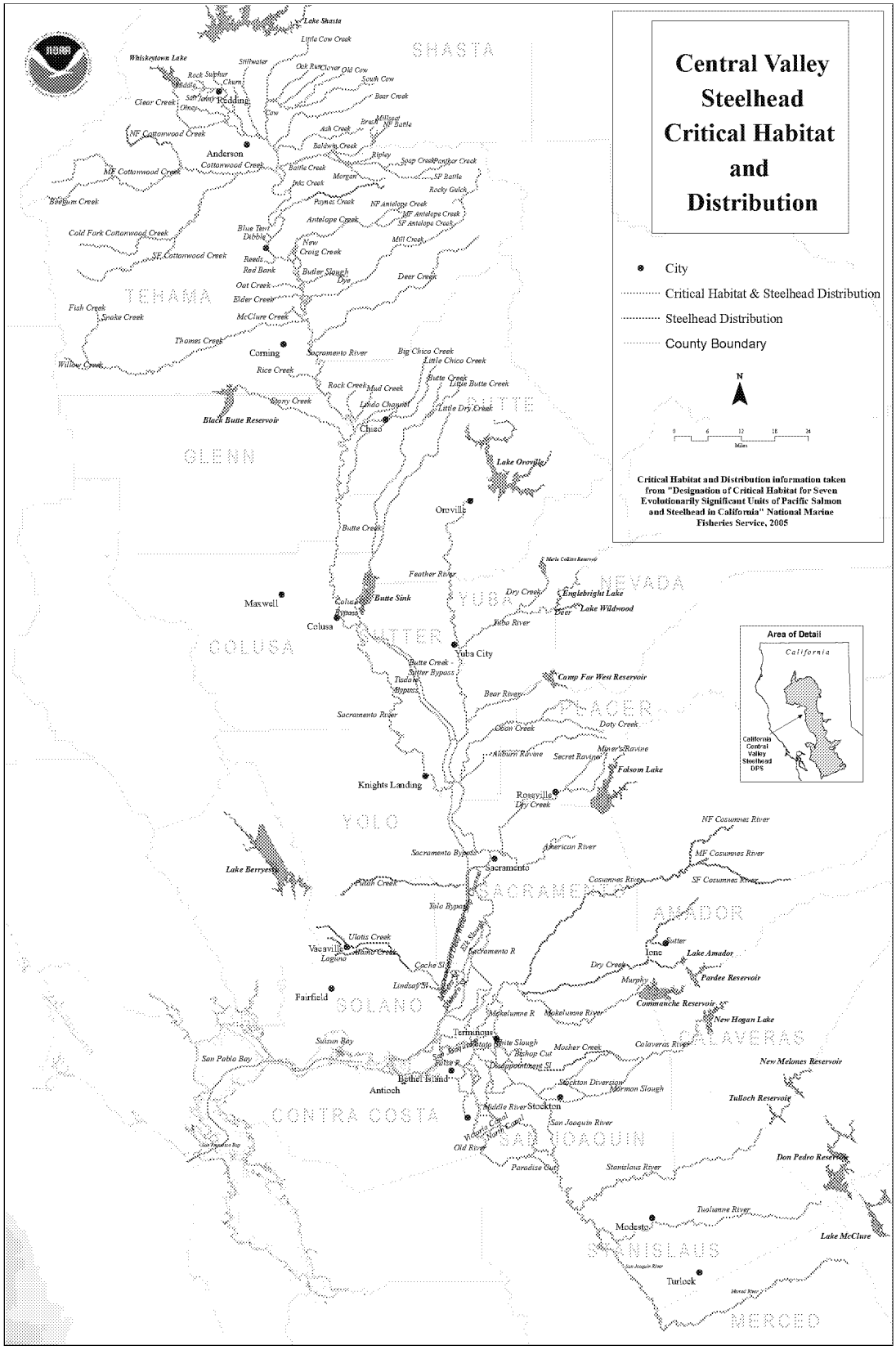


Figure 2-10. Central Valley Steelhead Designated Critical Habitat and Distribution

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Table 2-5. Annual Steelhead Production Targets for Central Valley Hatcheries

Hatchery	Production Target
Coleman National Fish Hatchery	600,000
Feather River Fish Hatchery	500,000
Nimbus Hatchery	430,000
Mokelumne Fish Hatchery	100,000

There is still significant local genetic structure to Central Valley steelhead populations. Hatchery effects appear to be localized – for example, Feather River and the FRFH steelhead are closely related, as are American River and Nimbus Hatchery fish (DWR 2002). The Coleman National Fish Hatchery steelhead program was derived from the endemic stock of steelhead in the upper Sacramento River. Early-returning (October – December) steelhead in Battle Creek are similar genetically to the Coleman NFH adults and late-returning (March –May) natural-origin steelhead in Battle Creek are similar genetically to mainstem Sacramento River steelhead (Capton *et al.* 2004).

In general, although genetic structure was found, all naturally-spawned *O. mykiss* populations within the Central Valley basin were closely related, regardless of whether they were sampled above or below a known barrier to anadromy. This is due to some combination of pre-impoundment historic shared ancestry, downstream migration and, possibly, limited, anthropogenic upstream migration. However, lower genetic diversity in above-barrier populations indicates a lack of substantial genetic input upstream and highlights lower effective population sizes for above-barrier populations. Above-barrier populations clustered with one another and below-barrier populations are most closely related to populations in far northern California, specifically the genetic groups that include the Eel and Klamath rivers. Since Eel River origin broodstock were used for many years at Nimbus Hatchery on the American River, it is likely that Eel River genes persist there and have also spread to other basins by migration, and that this is responsible for the clustering of the below-barrier populations with northern California ones. This suggests that the below-barrier populations in this region appear to have been widely introgressed with hatchery fish from out of basin broodstock sources. The consistent clustering of the above-barrier populations with one another, and their position in the California-wide trees, indicate that they are likely to most accurately represent the ancestral population genetic structure of steelhead in the Central Valley (Garza and Pearse 2008).

A significant transfer of genetic material has occurred among hatcheries within the Central Valley, as well as some transfer from systems outside the Central Valley. For example, an Eel River strain of steelhead was used as the founding broodstock for the Nimbus Hatchery (DWR 2002). Additionally, eyed eggs from the Nimbus Hatchery were transferred to the FRFH several times in the late 1960s and early 1970s (DWR 2002). There have also been transfers of steelhead from the FRFH to the Mokelumne Hatchery. In the late 1970s, a strain of steelhead was brought in from Washington State for the FRFH (DWR 2002).

Environmental Variability

Variability in natural environmental conditions has both masked and exacerbated the problems associated with degraded and altered riverine and estuarine habitats. Floods and persistent drought conditions have periodically reduced steelhead spawning, rearing, and migration habitats.

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El Nino events and periods of poor ocean conditions can threaten the survival of steelhead populations already reduced to low abundance levels due to the loss and degradation of freshwater and estuarine habitats. Alternatively, periods of favorable ocean conditions can offset the poor condition of inland habitats and result in increased population abundance and productivity by increasing the size and correlated fecundity of returning adults (NMFS 1996).

2.3.7 Threats Assessment

A detailed threats assessment was conducted for the California Central Valley steelhead DPS, and followed the same general procedure previously described for winter-run Chinook salmon. The threats/stressors affecting each steelhead diversity group and population are described by life stage in Appendix B.

Some major stressors to the entire California Central Valley steelhead DPS include passage impediments and barriers, warm water temperatures for rearing, hatchery effects, limited quantity and quality of rearing habitat, predation, and entrainment. The complete prioritized list of life stage-specific stressors to the DPS is presented in Appendix B.

Many of the most important stressors specific to the steelhead diversity groups correspond to the diversity group-specific stressors described for the Central Valley spring-run Chinook salmon ESU in section 2.2.7. The only diversity group (i.e., area) unique to the California Central Valley steelhead DPS, relative to the diversity groups in the Central Valley spring-run Chinook salmon ESU is the southern Sierra Nevada diversity group. Some of the most important stressors to steelhead in the southern Sierra Nevada diversity group include:

- Friant Dam blocking access to habitat historically used by San Joaquin River steelhead;
- Passage impediments on Calaveras River including Bellota Weir and flash board dams;
- Limited habitat availability in each watershed and in the mainstem San Joaquin River for spawning and juvenile rearing;
- La Grange and Don Pedro dams blocking access to habitat historically used by Tuolumne River steelhead;
- Goodwin and New Melones dams blocking access to habitat historically used by Stanislaus River steelhead;
- McSwain and Crocker Huffman dams blocking access to habitat historically used by Merced River steelhead;
- Camanche and Pardee dams blocking access to habitat historically used by Mokelumne River steelhead;
- Entrainment at the Jones and Banks Pumping Plants and associated losses from predation; and
- Inadequate summer flow on the Tuolumne River.

2.3.8 Conservation Measures

Conservation measures that have been taken to improve habitat for steelhead include, activities under the Clear Creek Restoration Program, the Battle Creek Salmon and Steelhead Restoration Project, several actions taken by the AFRP and the ERP, the Lower Yuba River Habitat Restoration Project, and actions under the San Joaquin River

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Restoration Program. Specific information on how each of these programs and projects has benefited steelhead is described in the 5-year status review published in 2011 (NMFS 2011c).

Other ongoing measures to protect steelhead in the State of California include 100 percent adipose fin-clipping of all hatchery steelhead, although they are not coded-wire tagged and, therefore, determination of hatchery of origin, as well as straying rates, remain problematic for stock identification.

The State also works closely with NMFS to review and improve inland fishing regulations. As a result, zero bag limits for unmarked steelhead, gear restrictions, closures, and size limits designed to protect smolts are additional inland harvest measures that protect Central Valley steelhead.

While some conservation measures have been successful in improving habitat conditions for Central Valley steelhead, access to historic habitat remains blocked in many cases and fundamental problems still remain with the quality of the species' remaining habitat (see Lindley *et al*. 2009 and Cummins *et al*. 2008) and it continues to be highly degraded. The loss of historical habitat and the degradation of remaining habitat both continue to be major threats to this DPS.

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3.0 Recovery Strategy

"The wide-ranging migration patterns and unique life histories of anadromous salmonids take them across ecosystem and management boundaries in an increasingly fragmented world, which creates the need for analyses and strategies at similarly large scales."

- Good *et al.* 2007. Recovery Planning for Endangered Species Act-listed Pacific Salmon: Using Science to Inform Goals and Strategies

3.1 INTRODUCTION

A broad strategic framework is necessary to serve as a strategic planning guide to integrate the actions contributing to the overarching goal of recovery of the two Chinook salmon ESUs and the steelhead DPS, which contain a mixture of hatchery and wild fish, and resident and anadromous fish. To address the complexity associated with the multi-faceted considerations for recovery efforts within the Central Valley Domain, San Francisco Estuary, and Pacific Ocean, this recovery strategy: explains the connection between the biological needs and situational background of the ESUs/DPS and the recovery program; and, presents the most effective means to achieve the individual recovery criteria and objectives, and, in turn, the delisting of the ESUs/DPS.

This chapter describes where we want to get to in terms of the number and spatial distribution of viable and dependent populations. Eliminating differences between the current viability and the desired viability is at the core of the recovery strategy. Having a strong rationale for, and understanding of, what a recovered Central Valley ESU/DPS will look like is critical to developing an effective strategy.

To convey this rationale and understanding, the chapter first describes the key facts and assumptions upon which the recovery plan is based. These facts and assumptions cover salmonid conservation principles, recovery implementation principles, and specific watershed classifications for recovery. Next, the primary objectives of the recovery plan are described. Lastly, adaptive management and monitoring are discussed because both will play a critical role in recovering the Chinook salmon ESUs and steelhead DPS.

3.2 FACTS AND ASSUMPTIONS

3.2.1 Salmonid Conservation Principles

Recovery of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead across such vast and altered ecosystems as the Central Valley, the San Francisco Estuary, and the Pacific Ocean, will require a broadly focused, science-based strategy. The scientific rationale for the strategy in this plan focuses on two key salmonid conservation principles. The first is that functioning, diverse, and interconnected habitats are necessary for a species to be viable.

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That is, we cannot achieve salmon and steelhead recovery without providing sufficient habitat. Anadromous salmonids persisted in the Central Valley for thousands of years because the available habitat capacity and diversity allowed species to withstand and adapt to environmental changes including catastrophes such as prolonged droughts, large wildfires, and volcanic eruptions. The second salmonid conservation principle guiding the recovery strategy is that a species' viability is determined by its spatial structure, diversity, productivity, and abundance (McElhany *et al.* 2000). Life history diversity, genetic diversity, and metapopulation organization are ways that salmonids adapt to their complex and connected habitats. These factors are the basis of salmonid productivity and contribute to the ability of salmonids to cope with environmental variation that is typical of freshwater and marine environments.

Habitat Capacity and Diversity

A purpose of the ESA is to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, so that these species no longer require the protections of the ESA (i.e., can be delisted).

The availability and quality of habitat is fundamental to species viability; viable ESUs/DPSs and populations require a network of complex and interconnected habitats that are created, altered, and maintained by natural physical processes in freshwater, the estuary, and the ocean. Restoration of Central Valley anadromous salmonids must address the entire natural and cultural ecosystem, which encompasses the continuum of freshwater, estuarine, and ocean habitats where salmonid fishes complete their life histories. This consideration includes human developments, as well as natural habitats.

These diverse and high-quality habitats, which have been extensively degraded by human activities, are crucial for salmonid spawning, rearing, migration, maintenance of food webs, and predator avoidance. Ocean conditions, which are variable, are important in determining the overall patterns of productivity of salmon populations.

Unfortunately, habitat for Central Valley salmonids has been extensively altered. Dams have disconnected fish from their historic habitats and altered flow regimes downstream by storing winter and spring runoff and releasing higher–than-historic flows during summer for agricultural and municipal uses. More than 1,600 miles of levee construction in the Central Valley have constricted river channels, disconnected floodplains from active river channels, reduced riparian habitat, and reduced natural channel function, particularly in the Delta and the lower reaches of the Sacramento and San Joaquin Rivers. Thousands of water diversions within the Central Valley reduce instream flows, and the state and federal pumping facilities in the south Delta reverse natural river flows, disrupt natural tidal patterns, and alter the migration patterns and survival of salmonid individuals and populations.

Habitat conservation and enhancement efforts should focus on the sites and areas identified in NMFS's critical habitat designations for each of the three species. Additionally, consideration should be given to the PCEs and other relevant habitat conditions as summarized below.

Freshwater Spawning Sites

- have good water quality and quantity
- have substrate for spawning, incubation, and larval development

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Freshwater Rearing Sites

- have good water quality and quantity and floodplain connectivity to maintain habitat conditions
- have forage for juvenile development
- have natural cover to provide refuge (such as submerged and overhanging large wood, log jams, beaver dams, aquatic vegetation, large rocks or boulders, side channels, undercut banks, etc.)

Freshwater Migration Corridors

- are unobstructed
- have good water quality and quantity
- have natural cover to provide refuge to support juvenile and adult mobility and survival
- afford safe passage conditions for migrations

Estuarine Areas

- are unobstructed
- have good water quality and quantity, with salinity conditions to support juvenile and adult physiological transitions between freshwater and saltwater
- have natural cover to provide refuge to support migrations among systems
- have forage for juvenile and adult migrating fish
- are free from overabundance of non-native predators

Nearshore Marine Areas[6]

- are unobstructed
- have good water quality and quantity conditions
- have forage to support growth and maturation of fish
- have natural cover to provide refuge

Offshore Marine Areas[6]

- have good water quality conditions
- have prey to support growth and maturation

Population Viability

Recovery planning seeks to ensure the viability of protected species. In the short term, viability of populations (and ESU/DPS) depends on the demographic properties of the population or ESU/DPS, such as population size, growth rate, the variation in growth rate, and carrying capacity (Tuljapurkar and Orzack 1980), all of which depend largely on the quality and quantity of habitat. In the longer term, genetic diversity, and the diversity of habitats that support genetic diversity, become increasingly important (McElhany

[6] For winter-run Chinook salmon marine areas are not explicitly included as physical biological features in the final rule designating critical habitat for that ESU (58 FR 33212; June 16, 1993); however, marine areas are important as the species spends the majority of its life cycle in the ocean. The preamble to the final rule designating critical habitat for CV spring-run Chinook salmon and CV steelhead discussed marine areas as primary constituent elements for the ESUs addressed in the final rule (70 FR 52488, 52521; September 2, 2005); however, the final rule did not include marine areas as primary constituent elements for CV spring-run Chinook salmon and CV steelhead (50 CFR 226.211(c); 70 FR 52488, 52537, September 2, 2005), and there are no marine areas designated as critical habitat for these species..

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et al. 2000; Kendall and Fox 2002; Williams and Reeves 2003).

NMFS has developed guidelines to apply the four Viability of Salmon Population (VSP) parameters (abundance, productivity, spatial structure, and diversity). Application of the guidelines determines whether or not a population is viable (McElhany *et al.* 2000). The four parameters and their associated attributes are presented in **Figure 3-1.** The rationale applies these factors to define viable populations.

As presented in Good *et al.* (2005), criteria for VSP are based on population characteristics 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. Abundance and productivity data are used to assess the status of populations of threatened and endangered ESUs (Good *et al.* 2005). 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 survive long-term environmental change. Spatial structure reflects how abundance is distributed among available or potentially available habitats.

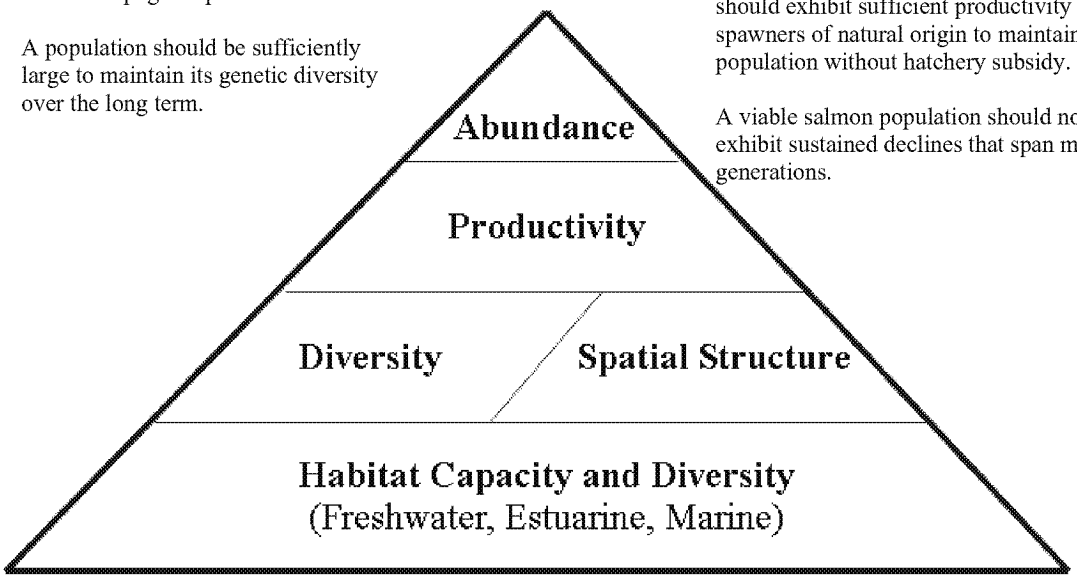
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ABUNDANCE
A population should be large enough to have a high probability of surviving environmental variation of the patterns and magnitudes observed in the past and expected in the future.
A population should have sufficient abundance for compensatory processes to provide resilience to environmental and anthropogenic perturbation.

A population should be sufficiently large to maintain its genetic diversity over the long term.

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 3-1. Viable salmonid population (VSP) parameters and their attributes. The quality and diversity of habitat (habitat capacity and diversity) available to the species in each of its three main habitat types (freshwater, estuarine and marine environments) are critical factors to VSP.

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ESU Viability

Good *et al.* (2007) reported that viability of Pacific salmon ESUs depends on the status and distribution of populations within the entire ESU. In general, the ESU is more likely to be viable if it contains multiple populations (metapopulations), some of which meet viability criteria. Viability of the ESU is also more likely if: (1) populations are geographically widespread but some are close enough together to facilitate connectivity; (2) populations do not all share common catastrophic risks; and (3) populations display diverse life-histories and phenotypes (McElhany *et al.* 2000).

Considerations regarding ESU viability are discussed in ISAB (2005), and are generally adopted herein for application to the two Chinook salmon ESUs and the steelhead DPS in the Central Valley Domain. To be viable, an ESU needs more than simple persistence over time; it needs to be in an ecologically and evolutionarily functional state. Evaluation of ESU viability depends not only on the numbers of component populations and the abundance and productivity of those individual populations, but also on the integration of population dynamics within the ecosystem as a whole. For an ESU to fulfill the entire complement of ecological and evolutionary interactions and functions (ISAB 2005), it needs to contain viable populations inhabiting a variety of different habitats, interconnected as a metapopulation.

A viable ESU consists of a group of populations existing as a metapopulation that is self-sustaining for the foreseeable future. Populations within a viable ESU need to exhibit the abundance, productivity, diversity, and spatial distribution of natural spawners, sufficient to accomplish the following: avoid the loss of genetic and/or life history diversity during short-term reductions in abundance that are expected parts of environmental cycles; fulfill key ecological functions that are attributable to the species, such as nutrient cycling and food web roles; and provide for long-term evolutionary adaptability to changing environmental conditions.

This Recovery Plan endeavors to avoid loss of currently small, peripheral, or in any way seemingly less-valuable populations. The importance of these populations is not well understood, but it is likely they contribute significantly to ESU and DPS scale viability by providing increased life history diversity. They also are likely to buffer against local catastrophic occurrences.

In addition to the considerations presented by ISAB (2005), the Central Valley TRT addressed ESU viability for the Central Valley Domain, using two other approaches. The goal of these two approaches is to distribute risk and maximize future potential for adaptation.

In the first approach, the Central Valley TRT assessed ESU viability by examining the number and distribution of viable populations across the landscape, and their proximity to sources of catastrophic disturbance. Risk-spreading examines how viable populations are distributed among geographically-defined regions within an ESU. For example, the Puget Sound, Willamette/Lower Columbia and Interior Columbia TRTs have used the idea of dividing ESUs into subunits (Myers *et al.* 2003; Ruckelshaus *et al.* 2002; Interior Columbia Basin Technical Recovery Team 2003), and of requiring population presence and redundancy in the subunits (The Central Valley TRT referred to this approach as the "representation and redundancy" rule). ESU

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subunits are intended to capture geographically important components of habitat, life history, or genetic diversity that contribute to the viability of salmonid ESUs (Hilborn *et al.* 2003; Bottom *et al.* 2005).

In practice, this approach holds that if extinction risks are not strongly correlated, two populations, each with low risk of extinction, would be extremely unlikely to go extinct simultaneously (McElhany *et al.* 2003). Should a catastrophic event cause one of the populations to go extinct, the other(s) could serve as a source of colonists to re-establish the extirpated population.

In the second approach, the TRT attempted to account explicitly for the spatial structure of the ESU and the spatial structure of various catastrophic risks, including volcanoes, wildfires, and droughts. The product of this approach is a set of diversity groups. A diversity group is a geographically-distinct portion of the ESU/DPS which is ecologically or otherwise identifiable and which is essential to the recovery of the entire listed entity (e.g., to conserve genetic robustness, demographic robustness, and important life history stages).

To meet the objective of representation and redundancy, diversity groups need to contain multiple populations to survive in a dynamic ecosystem subject to unpredictable stochastic events, such as pyroclastic events or wild fires.

As discussed in Lindley *et al.* (2004), the Central Valley Basin is characterized by a wide range of climatological, hydrological, and geological conditions. The Central Valley TRT used the Jepson floristic ecoregions defined by Hickman (1993) as a starting point for salmon ecoregions, but modified them to account for geologic characteristics that produce spring-dominated base flow. Such conditions strongly influence salmonid habitat, but not upland plants. The resulting ecoregions for salmon and steelhead consider geology and are referred to herein as "Diversity Groups".

Delineation of Recovery Units

The four diversity groups listed below serve as recovery units, in that each one that was historically occupied by a species is essential for the recovery of that species. The diversity group structure is presented in **Figure 3-2** for the Chinook salmon ESUs and in **Figure 3-3** for the steelhead DPS in the Central Valley Domain.

The Central Valley Domain Diversity Groups are:

- The **basalt and porous lava diversity group** composed of the upper Sacramento River (including watersheds upstream of Shasta Dam), Cow Creek and Battle Creek watersheds

- The **northwestern California diversity group** composed of streams that enter the mainstem Sacramento River from the northwest, such as Clear Creek

- The **northern Sierra Nevada diversity group** composed of streams tributary to the Sacramento River from the east, from Antelope Creek to the Mokelumne River, and

- The **southern Sierra Nevada diversity group** composed of streams tributary to the San Joaquin River from the east.

The diversity groups reflect the historic distribution of each species. As a result, the number (and geographic range) of diversity groups differs by species. For winter-run Chinook salmon, all populations required for

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recovery are located in a single diversity group. This is the northernmost area called the "basalt and porous lava" diversity group. This recovery unit includes the streams that historically supported winter-run Chinook salmon, spring-run Chinook salmon, and steelhead. All of these streams receive large inflows of cold water from springs throughout the summer, upon which winter-run Chinook salmon depend. This region includes part of the upper Sacramento drainage (currently blocked by Shasta Dam), part of the Modoc Plateau region, and extends south to the Battle Creek watershed.

Three additional recovery units have been identified for spring-run Chinook salmon and steelhead. Though the southern part of the Cascades region (i.e., the drainages of Mill, Deer and Butte creeks) also contain some geology that results in spring-fed baseflows, these streams are included in the northern Sierra Nevada diversity group. The Sierra Nevada watersheds are divided into northern and southern diversity groups (split at the Mokelumne River watershed). This division reflects the greater importance of snowmelt runoff in the southern Sierra, and also places tributaries to the Sacramento and San Joaquin rivers in different diversity groups. The fourth diversity group includes tributaries that drain the watersheds on the west side of the northern Sacramento watershed and extends from Shasta Dam in the north to Willow Creek and Black Butte Reservoir in the south.

Lindley *et al.* (2006) report that historically steelhead populations were located in tributaries to Suisun Bay and to the San Joaquin River from the west (i.e., Central Western California diversity group). Recovery of Central Valley steelhead can be achieved without the presence of populations in either the Suisun Bay or Central Western California diversity groups. This conclusion is based on the fact that the four Chinook salmon diversity groups, which did not include the Suisun Bay or Central Western California regions, supported abundant and diverse Chinook salmon populations for thousands of years. As such, the extent and diversity of habitats historically available in those four diversity groups would likely also support a viable steelhead DPS, if the quantity and quality of habitat currently available in those regions was sufficiently increased. Additionally, based on the quantity and quality of available steelhead habitat, the Central Western California diversity group, which drains the relatively low elevation watersheds along the west side of the San Joaquin River, likely contributed little to the abundance of Central Valley steelhead. The Sacramento River basin was the source of most steelhead production (Lindley *et al.* 2006).

Because recovery can be reached without them, the Suisun area and the Central Western California diversity groups are not considered to be steelhead recovery units in this plan.

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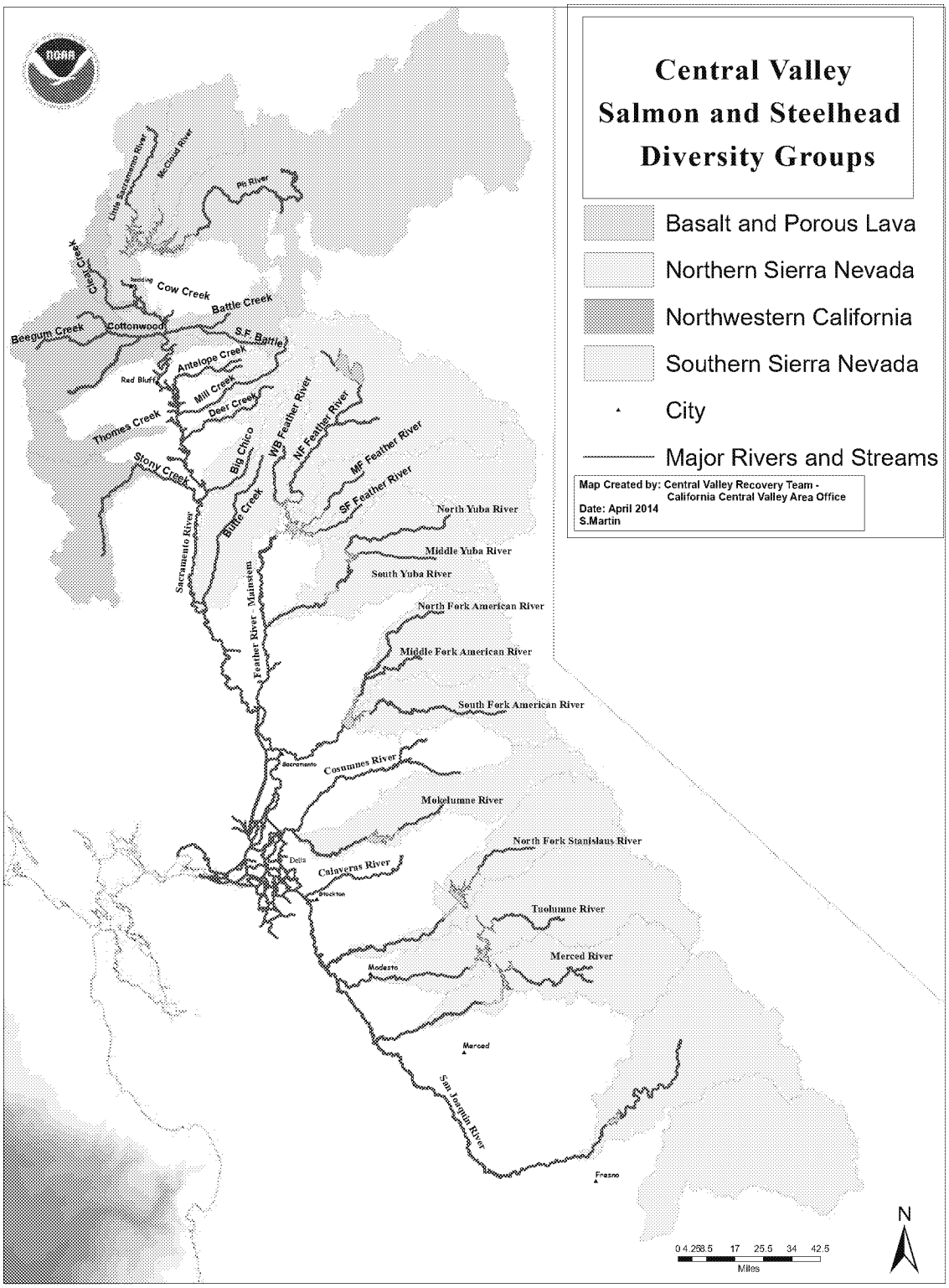


Figure 3-2. Diversity Groups for the Sacramento River Winter-run Chinook salmon and Central Valley Spring-run Chinook salmon ESUs in the Central Valley Domain. The Sacramento River Winter-run Chinook Salmon ESU Historically Occurred in the Basalt and Porous Lava Diversity Group, while Spring-run Chinook Salmon Occurred in all of the Diversity Groups Shown.

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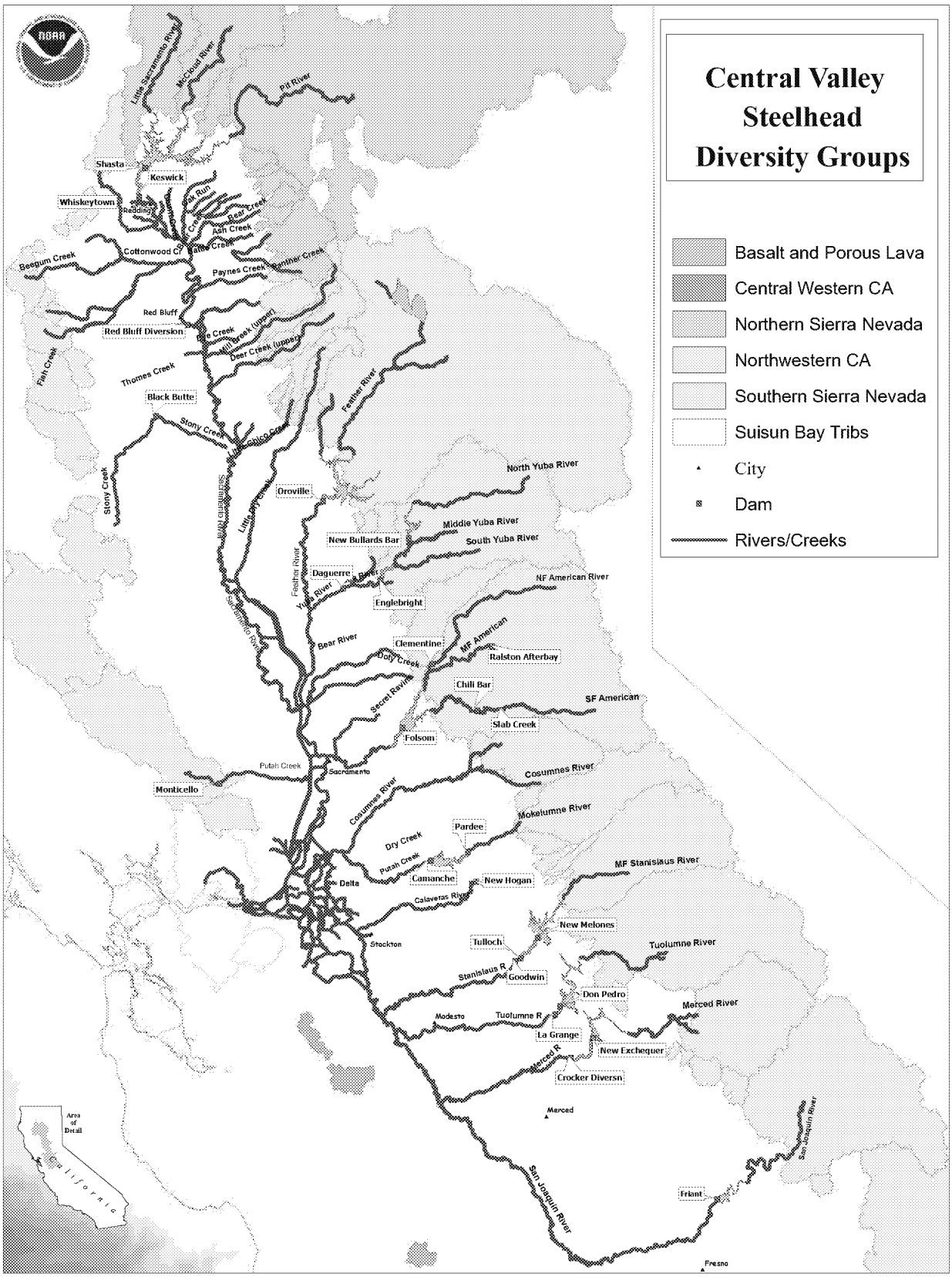


Figure 3-3. Diversity Groups for the California Central Valley Steelhead DPS in the Central Valley Domain.

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3.2.2. Recovery Implementation Principles

The Strategy is based on five foundational implementation principles. The principles take into account the magnitude of the actions required by the strategy and the significant investment of resources required. Success is dependent on actions throughout the range of the species, in freshwater, estuarine, and ocean habitats and will require public understanding and support. Key elements in sustaining public support are investing in the most cost-effective practices, and continually assessing and reporting recovery plan progress and effectiveness. The five principles are described briefly below.

System wide Approach

Because the listed species are wide-ranging, and depend on headwater, riverine, estuarine, and ocean habitats, recovery implementation should address this entire set of ecosystems.

Cost Effectiveness

To focus investments on those actions with the highest likelihood of success, implementation of the strategy should give priority to measures with a proven record of success within the ESUs and DPS, or in ecologically comparable environments. Prior to initiating actions, similar actions previously implemented in the ESUs or DPS should be reviewed for lessons learned. It will also be beneficial to review the success of actions undertaken in other locations.

Self-Sustaining Improvements

Due to the uncertainty of future budgets, priority will be given to measures that, once implemented, are self-sustaining. In cases in which necessary actions will need maintenance (e.g., reintroductions into habitat upstream of impassible dams), priority will be given to options that need the least intervention in the long term.

Stakeholder Cooperation and Public Support

Partnerships and collaboration between all stakeholders and regulatory agencies are necessary to accelerate actions, increase available resources, reduce duplication of effort, encourage innovative solutions, improve communication, and increase public involvement and support through shared authority and ownership of habitat restoration (USFWS 2001). The Department of the Interior AFRP and the ERP contain processes for building partnerships to pursue restoration actions. The AFRP and the ERP continue to build partnerships and provide funds to local agencies and watershed groups, as well as other Federal and State agencies, in order to implement specific restoration actions throughout the Central Valley Domain. NMFS is engaged in both of these efforts, as well as with local agency and stakeholder efforts.

NMFS recognizes the high cost, broad geographic scope, and the economic, social, and cultural implications of necessary actions. NMFS therefore encourages local agencies and stakeholder groups to share or lead implementation of recovery and habitat restoration actions within the Central Valley Domain, and views such involvement as essential to success of the Recovery Plan.

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In addition to participation by local, state and other Federal agencies, public support is necessary for the acceptance and successful implementation of the Recovery Plan for the Central Valley Domain. As stated by USFWS (2001), public sentiment is an indicator of perceived economic and social effects of restoration actions, and public support for an action will facilitate implementation and attract partners for future actions. NMFS will continue to coordinate with public stakeholders to assist in identifying, planning, and implementing recovery actions.

Adaptive Management and Monitoring

The plan will incorporate adaptive management into all components and actions. The reduced distribution and abundance of the listed species necessitates immediate action, but some key data gaps exist. Incorporating effective monitoring into plan actions will assist in addressing data needs and in modifying recovery actions where necessary. Effective monitoring, evaluation, and reporting will also provide for accountability.

Recovery Plan implementation includes an adaptive management and monitoring component to increase the effectiveness of, and to address the scientific uncertainty associated with specific restoration actions. The adaptive management component allows NMFS, as well as local water agencies and irrigation districts, municipal and county governmental agencies, watershed groups, and state and other Federal agencies, to learn from past experiences and to alter actions based on their measured effectiveness. There will be a thorough review of the effectiveness of the recovery actions implemented, as reflected by population and habitat condition responses, at the 5-year status reviews of the Chinook salmon ESUs and the steelhead DPS.

Within the framework of the Recovery Plan, NMFS has the flexibility to work with partners. This includes support in developing and implementing recovery actions that address specific problems as they arise or intensify. As additional information becomes available regarding threats abatement, the links between threats and population responses, and the viability of Chinook salmon and steelhead in the Central Valley Domain, specific measures as well as the plan itself will be modified. The adaptive management and monitoring component provides a framework to obtain the appropriate types and amounts of data to evaluate the effectiveness of recovery actions and the progress toward recovery. Therefore, the adaptive management and monitoring program needs to address system-wide, watershed, population, and action-specific scales. The program is outlined in greater detail in at the end of this chapter in section 3.4.

3.2.3 Watershed Classifications (Core 1, 2, or 3)

A key element of this recovery strategy is focus of actions on watersheds that can support viable populations and contribute to meeting Diversity Group requirements for distribution and redundancy. To assess their potential to contribute to species recovery, watersheds in the four Diversity Groups that supported historic populations of any of the three listed species have been placed into three categories, based on their potential to support populations with low risk of extinction. The three categories are Core 1, Core 2, and Core 3. Watersheds that supported the three species, historic and current distribution, and watershed classifications are presented in Tables 3-1, 3-2 and 3-3.

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Core 1 watersheds possess the known ability or potential to support a viable population. For a population to be considered viable, it must meet the criteria for low extinction risk for Central Valley salmonids (Lindley *et al.* 2007). The criteria include population size, population decline, catastrophic decline and hatchery influence (see Table 4-1). Only a few of the Core 1 populations meet the long-term objective of low extinction risk; the remaining Core 1 populations have the potential to do so.

Core 2 populations meet, or have the potential to meet, the biological recovery standard for moderate risk of extinction set out in Table 4-1. These watersheds have lower potential to support viable populations, due to lower abundance, or amount and quality of habitat. These populations provide increased life history diversity to the ESU/DPS and are likely to provide a buffering effect against local catastrophic occurrences that could affect other nearby populations, especially in geographic areas where the number of Core 1 populations is lowest.

Core 3 watersheds have populations that are present on an intermittent basis and require straying from other nearby populations for their existence. These populations likely do not have the potential to meet the abundance criteria for moderate risk of extinction. Core 3 watersheds are important because, like Core 2 watersheds, they support populations that provide increased life history diversity to the ESU/DPS and are likely to buffer against local catastrophic occurrences that could affect other nearby populations. Dispersal connectivity between populations and genetic diversity may be enhanced by working to recover smaller Core 3 populations that serve as stepping stones for dispersal.

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Table 3-1. Population presence, risk of extinction and classification of watersheds with historic populations of winter-run Chinook salmon. Currently there is one population in the mainstem Sacramento River downstream of Keswick Dam. "Primary": top priority for reintroduction; "Candidate": possible area for reintroduction; "Non-candidate": reintroduction should not be attempted here. "NA": not applicable.

Diversity Group	River, Creek or sub-reach	Historic Population	Current Population	Population Extinction Risk (from Williams *et al.* 2011)	Classification
Basalt and Porous Lava	Battle Creek	Yes	No	NA	Primary
	Mainstem Sacramento River (below Keswick)	No	Yes	moderate	Core 1
	McCloud River	Yes	No	NA	Primary
	Pit River	Yes	No	NA	Non-Candidate
	Little Sacramento River	Yes	No	NA	Candidate

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Table 3-2: Population presence, risk of extinction, and classification of watersheds with historic and current populations of spring-run Chinook salmon. "Primary": top priority for reintroduction; "Candidate": possible area for reintroduction; "Non-candidate": reintroduction should not be attempted here. "NA": not applicable

Diversity Group	River, Creek or Sub-reach	Historic Population	Current Population	Population Extinction Risk (from Williams *et al.* 2011)	Classification
Basalt and Porous Lava	Battle Creek	Yes	Yes	Moderate	Core 1
	Mainstem Sacramento River (blw Keswick)	No	Yes	High	Core 2
	Little Sacramento River	Yes	No	NA	Candidate
	McCloud River	Yes	No	NA	Primary
	Pit River	Yes	No	NA	Non-Candidate
Northwestern California	Stony Creek	Yes	No	NA	Core 3
	Thomes Creek	Yes	Yes	NA	Core 3
	Cottonwood/Beegum	Yes	Yes	High	Core 2
	Clear Creek	Yes	Yes	Moderate	Core 1
Northern Sierra Nevada	Mokelumne (below Comanche)	No	No	NA	Candidate
	Mokelumne (above Pardee)	Yes	No	NA	Candidate
	American River (above Folsom)	Yes	No	NA	Candidate
	American River (below Nimbus)	Yes	No	NA	Non-Candidate
	Feather River (below Oroville)	No	Yes	High	Core 2
	West Branch Feather (above Oroville)	Yes	No	NA	Non-Candidate
	North Fork Feather (above Oroville)	Yes	No	NA	Candidate
	Middle Fork Feather (above Oroville)	Yes	No	NA	Non-Candidate
	South Fork Feather (above Oroville)	Yes	No	NA	Non-Candidate
	Yuba River (below Englebright)	No	Yes	High	Core 2
	North Yuba River (above Englebright)	Yes	No	NA	Primary
	Middle Yuba River (above Englebright)	Yes	No	NA	Primary
	South Yuba River (above Englebright)	Yes	No	NA	Candidate
	Butte Creek	Yes	Yes	Low	Core 1
	Big Chico	Yes	Yes	High	Core 2
	Deer Creek	Yes	Yes	High	Core 1
	Mill Creek	Yes	Yes	High	Core 1
	Antelope Creek	Yes	Yes	High	Core 2
Southern Sierra Nevada	Stanislaus River (below Goodwin)	No	No	NA	Candidate
	Upper Stanislaus River (abv New Melones)	Yes	No	NA	Candidate
	Tuolumne River (below La Grange)	No	No	NA	Candidate
	Upper Tuolumne River (abv La Grange and Don Pedro)	Yes	No	NA	Candidate
	Merced River (below Crocker Huffman)	No	No	NA	Candidate
	Upper Merced River (abv New Exchequer)	Yes	No	NA	Candidate
	San Joaquin River (below Friant)	No	No	NA	Primary
	San Joaquin above Friant	Yes	No	NA	Candidate

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Table 3-3. Population presence, risk of extinction, and classification of watersheds with historic and current populations of steelhead. "Primary": top priority for reintroduction; "Candidate": possible area for reintroduction; "Non-candidate": reintroduction should not be attempted here. "NA": not applicable

Diversity Group	River, Creek or Sub-reach	Historic Population	Current Population	Population Extinction Risk (from Williams *et al.* 2011, Lindley *et al.* 2007)	Classification
Basalt and Porous Lava	Battle Creek	Yes	Yes	High	Core 1
	Cow Creek	Yes	Yes	Uncertain	Core 2
	Mainstem Sacramento River (below Keswick)	No	Yes	Uncertain	Core 2
	Little Sacramento River	Yes	No	NA	Candidate
	McCloud River	Yes	No	NA	Primary
	Pit River	Yes	No	NA	Non-Candidate
	Redding Area Tributaries	Yes	Yes	Uncertain	Core 2
Northwestern California	Putah Creek	Yes	Yes	Uncertain	Core 2
	Stony Creek	Yes	Yes	Uncertain	Core 3
	Thomes Creek	Yes	Yes	Uncertain	Core 2
	Cottonwood/Beegum	Yes	Yes	Uncertain	Core 2
	Clear Creek	Yes	Yes	Uncertain	Core 1
Northern Sierra Nevada	Cosumnes River	Yes	Yes	Uncertain	Core 3
	Mokelumne River (below Comanche)	No	Yes	High	Core 2
	Mokelumne River (above Pardee)	Yes	No	NA	Candidate
	American River (below Nimbus)	No	Yes	High	Core 2
	Upper American (above Folsom)	Yes	No	NA	Candidate
	Auburn Ravine	No	Yes	Uncertain	Core 2
	Dry Creek	Yes	Yes	Uncertain	Core 3
	Feather River (below Oroville)	No	Yes	High	Core 2
	West Branch Feather (above Oroville)	Yes	No	NA	Non-Candidate
	North Fork Feather (above Oroville)	Yes	No	NA	Candidate
	Middle Fork Feather (above Oroville)	Yes	No	NA	Non-Candidate
	South Fork Feather (above Oroville)	Yes	No	NA	Non-Candidate
	Bear River	Yes	Yes	Uncertain	Core 3
	Yuba River (below Englebright)	No	Yes	Uncertain	Core 2
	North, Middle, South Yuba Rivers (above Englebright)	Yes	No	NA	Primary
	Butte Creek	Yes	Yes	Uncertain	Core 2
	Big Chico	Yes	Yes	Uncertain	Core 2
	Deer Creek	Yes	Yes	Uncertain	Core 1
	Mill Creek	Yes	Yes	Uncertain	Core 1
	Antelope Creek	Yes	Yes	Uncertain	Core 1
Southern Sierra Nevada	Calaveras River (below New Hogan)	No	Yes	Uncertain	Core 1
	Upper Calaveras River (above New Hogan)	Yes	No	NA	Non-Candidate
	Stanislaus River (below Goodwin)	No	Yes	Uncertain	Core 2
	Upper Stanislaus River (above New Melones)	Yes	No	NA	Candidate
	Tuolumne River (below La Grange)	No	Yes	Uncertain	Core 2
	Upper Tuolumne River (abv La Grange and Don Pedro)	Yes	No	NA	Candidate
	Merced River (below Crocker Huffman)	No	Yes	Uncertain	Core 2
	Upper Merced River (above New Exchequer)	Yes	No	NA	Candidate
	San Joaquin River (below Friant)	No	No	NA	Candidate
	Upper San Joaquin (above Friant)	Yes	No	NA	Non-Candidate

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Factoring Climate Change into Watershed Classifications

Areas targeted for emphasis in the strategy were selected based on current population distribution and abundance, existing habitat, and the impacts of existing stressors. Obviously, conditions are not static. The best available projections indicate that the climate is likely to warm considerably in the future. Lindley *et al.* (2007) reported on three greenhouse gas emission scenarios. The scenario with lowest emissions projected a mean summer air temperature increase of at least 2°C (3.6°F) in the geographical area under consideration, the intermediate scenario predicts an increase of around 5°C (9°F), and the highest emissions scenario, which is the least-likely, but still possible, projects an increase of 8°C (14.4°F) by the year 2100. Because spring-run Chinook salmon and steelhead both exhibit juvenile over-summer rearing as part of their life history strategies, long-term climate change considerations are discouraging for both species, unless coldwater refugia at local and larger scales exist or can be provided (see Section 6.6.2).

To generalize, populations in low elevation habitats are more likely to be negatively affected by temperature increases. Vulnerability to adverse climate change effects is assumed to be buffered somewhat in higher elevations (less change in snowmelt and water temperature) and in geology that results in springs and groundwater. Specifically, hydrologic changes are likely to be buffered somewhat in the Basalt and Porous Lava and Southern Sierra Nevada Diversity Groups due to groundwater dominance and elevations high enough to retain snow, respectively. One additional factor is habitat located below reservoirs; the assumption is that releases of cold water could be made in support of listed species, and serve as a buffer.

By screening Core 1 and "primary" watersheds for these characteristics, a very rough assessment of vulnerability of habitats to climate change was done to help identify watershed priorities. Watersheds at the lower elevations, which do not have coldwater springs or other sources of coldwater (e.g., Thomes Creek, Big Chico Creek), were among the lower priority watersheds. By contrast, watersheds where salmon have access to coldwater via high elevation, springs, or releases from storage reservoirs were considered higher priority.

3.3 Primary Objectives of the Recovery Effort

Based on recommendations from the Central Valley TRT, this recovery effort has two primary objectives: (1) secure existing populations by addressing stressors; and (2) reintroduce populations into historically occupied or other suitable areas (Lindley *et al.* 2007). These objectives are considered equal in importance and both should be pursued simultaneously. Each objective is more fully described below.

3.3.1 Secure Existing Populations

All four historic winter-run Chinook salmon populations are extinct, with only one current population that is supplemented with hatchery production. Of the 18 or 19 populations of spring-run Chinook salmon, three remain. One (Butte Creek) has low risk of extinction; the other two (Deer Creek and Mill Creek) are at high risk of extinction. Of perhaps 81 historic steelhead populations, fewer than two dozen remain. These numbers reflect the perilous condition of these species, and underline the importance of the few remaining

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populations to the long term recovery of the species. From this current, limited pool must come the individuals and genetic composition to support broader future population distribution. Loss of any of these populations would further jeopardize chances for recovery.

The strategy is consistent with the TRT recommendation that every extant population be viewed as necessary for the recovery of the ESUs and DPS. Wherever possible, the status of extant populations should be improved. Further information on population status and watershed condition can be found in Appendix A- Watershed Profiles.

Protection and enhancement of habitat for existing Core 1 and Core 2 populations are both vitally important. The strategy emphasizes protections and improvements in watersheds that support these populations, as well as actions necessary to eliminate or reduce threats present in the rivers and bay delta that connect them with the ocean.

Actions that protect and improve populations in Core 1 and Core 2 watersheds are the highest priority for investment of limited resources. This does not mean actions should not be taken in watersheds that support Core 3 populations, and, in fact, local groups are encouraged to undertake appropriate actions. It simply means that agencies should not substitute action in Core 3 watersheds for efforts in the Core 1 and Core 2 watersheds.

Address Threats

The primary means of securing existing populations is to reduce or eliminate the threats to the species and their habitats. Therefore, it was necessary to first identify the threats to each of the three species covered in this recovery plan; this was accomplished with the threats assessment described in Appendix B. Next, specific actions that address each prioritized threat must be identified. Those threat abatement actions (i.e., recovery actions), and the steps taken to identify and prioritize them, are described in Chapter 5.

3.3.2 Reintroduce Populations in Historically Occupied or Suitable Habitat

Meeting objectives for redundancy and distribution will require reintroducing some populations to habitats that historically supported the species, but are currently inaccessible because of existing dams (e.g. McCloud River). Also necessary are reintroduction of fish into watersheds that are currently accessible, but not utilized (e.g., winter-run Chinook salmon in Battle Creek).

Efforts to reintroduce fish will be challenging and expensive, and will require tremendous effort. To focus efforts, the strategy sets priorities for redundancy and spatial distribution within the four diversity groups. Priorities, based on existing information for the three listed species, are shown in **Tables 3-4, 3-5, and 3-6**. The highest-priority watersheds (primary watersheds) for re-introduction have been identified based on the current understanding of habitat conditions and the fact that reintroduction planning efforts are already underway in those watersheds. Watersheds with less potential, or where potential has not been assessed are classified as "candidates."

This classification is based on current information. As the availability of habitat in these areas is further assessed, and measures necessary to facilitate the re-introductions evaluated and compared, priorities may change.

Populations will need to be re-established in some areas now blocked by dams or that have insufficient flows. Assuming that most of these dams will remain in place for the foreseeable future, it will be necessary to

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provide fish passage around the dams in both directions. Near-term priority actions will include assessing habitat suitability and passage logistics. In the long-term reintroductions to high elevation habitats will need to be successful in at least a few watersheds, particularly as air temperatures increase and precipitation patterns change (see Chapter 6). Moving forward, information is needed to confirm that conditions are suitable for reintroduction in the priority watersheds, to determine which candidate watersheds have the highest likelihood of successful reintroduction, and to determine what measures are necessary to facilitate reintroductions.

A complete picture of the watershed priorities for each species are displayed in **Figures 3-4, 3-5, and 3-6**. These maps also provide a picture of what the distribution of a recovered ESUs/DPS would look like.

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Table 3-4. Priorities for Winter-Run Chinook Salmon by Diversity Group.

Diversity Group	Current Core 1 Population	Diversity Group Objective*	Re-introduction Priorities	Current Core 2 Populations
Basalt and Porous Lava	Sacramento River	3	McCloud River (Primary)	None
			Battle Creek (Primary)	
*number of populations with low risk of extinction				

Table 3-5. Priorities for Spring-Run Chinook Salmon by Diversity Group.

Diversity Group	Current Core 1 Populations	Diversity Group Objective*	Re-introduction Priorities	Current Core 2 Populations
Basalt and Porous Lava	Battle Creek	2	McCloud River (Primary)	Sacramento River (below Keswick)
Northwestern California	Clear Creek	1	None	Cottonwood/Beegum
Northern Sierra Nevada	Mill Creek	4	Yuba River above Englebright (Primary)	Yuba River (below Englebright)
	Deer Creek			Antelope Creek
	Butte Creek			Feather River (below Oroville)
Southern Sierra Nevada	None	2	San Joaquin (below Friant) (Primary)	None Currently Identified
			One Candidate Watershed	
* number of populations with low risk of extinction				

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Table 3-6. Priorities for Steelhead by Diversity Group.

Diversity Group	Current Core 1 Populations	Diversity Group Objective	Re-introduction Priorities	Current Core 2 Populations
Basalt and Porous Lava	Battle Creek	2	McCloud River (Primary)	Cow Creek
				Redding Area Tributaries
				Sacramento River (below Keswick)
Northwestern California	Clear Creek	1	None	Thomes Creek
				Putah Creek
				Cottonwood/Beegum
Northern Sierra Nevada	Antelope Creek	4	Yuba River above Englebright (Primary)	Yuba River (below Englebright Dam)
	Deer Creek			Butte Creek
				Feather River (below Oroville Dam)
	Mill Creek			Big Chico Creek
				Auburn Ravine
				American River
Southern Sierra Nevada	Calaveras River	2	One Candidate Watershed	Stanislaus River (below Goodwin)
				Merced River (below Crocker Huffman)
				Tuolumne River (below La Grange)
* number of populations with low risk of extinction				

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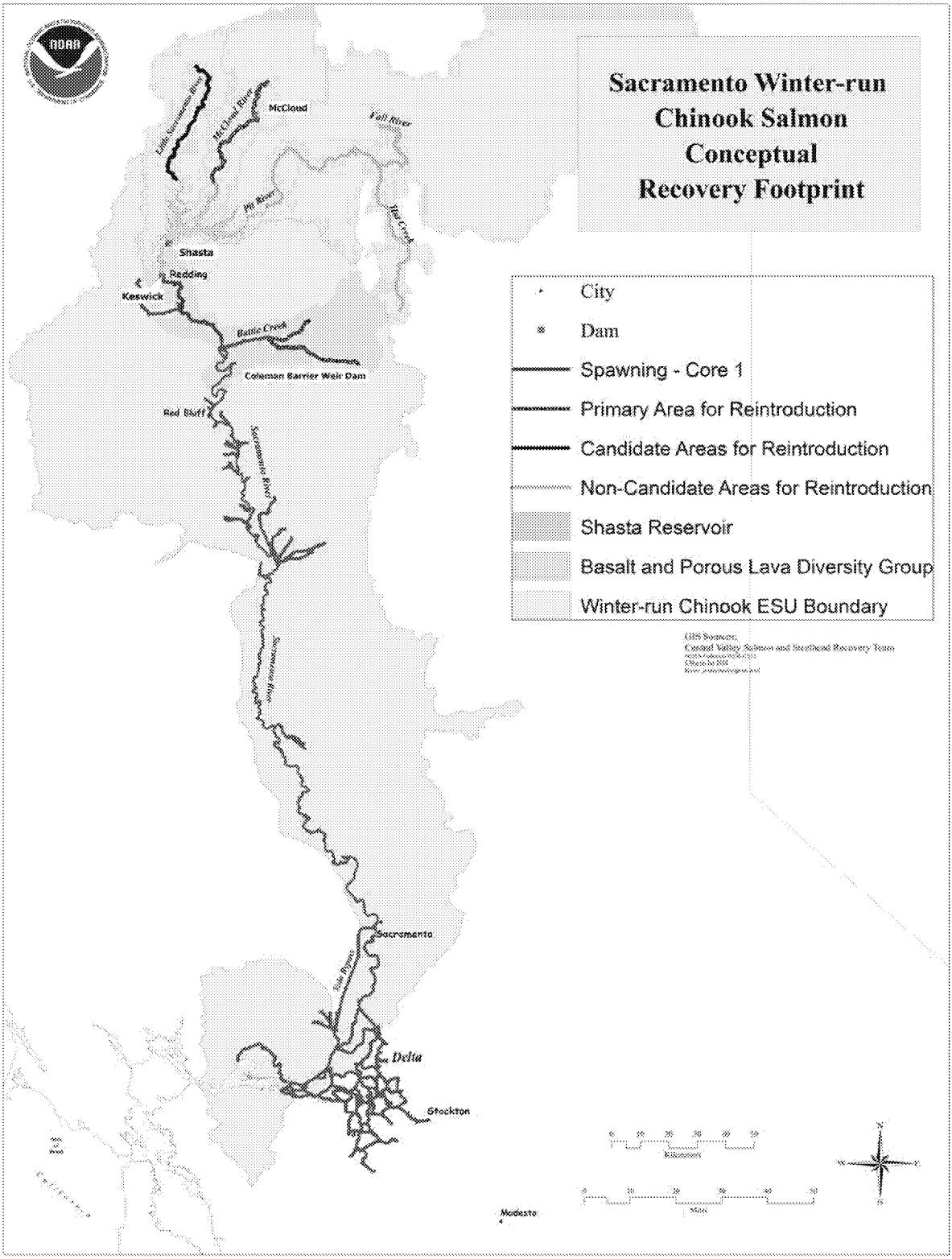


Figure 3-4. Sacramento River Winter-run Chinook Salmon Recovery Footprint. The primary and candidate areas for reintroduction depicted on this map are areas where, although dams block access, the primary constituent elements that are necessary to support freshwater migration, holding, spawning and rearing still exist or could be restored.

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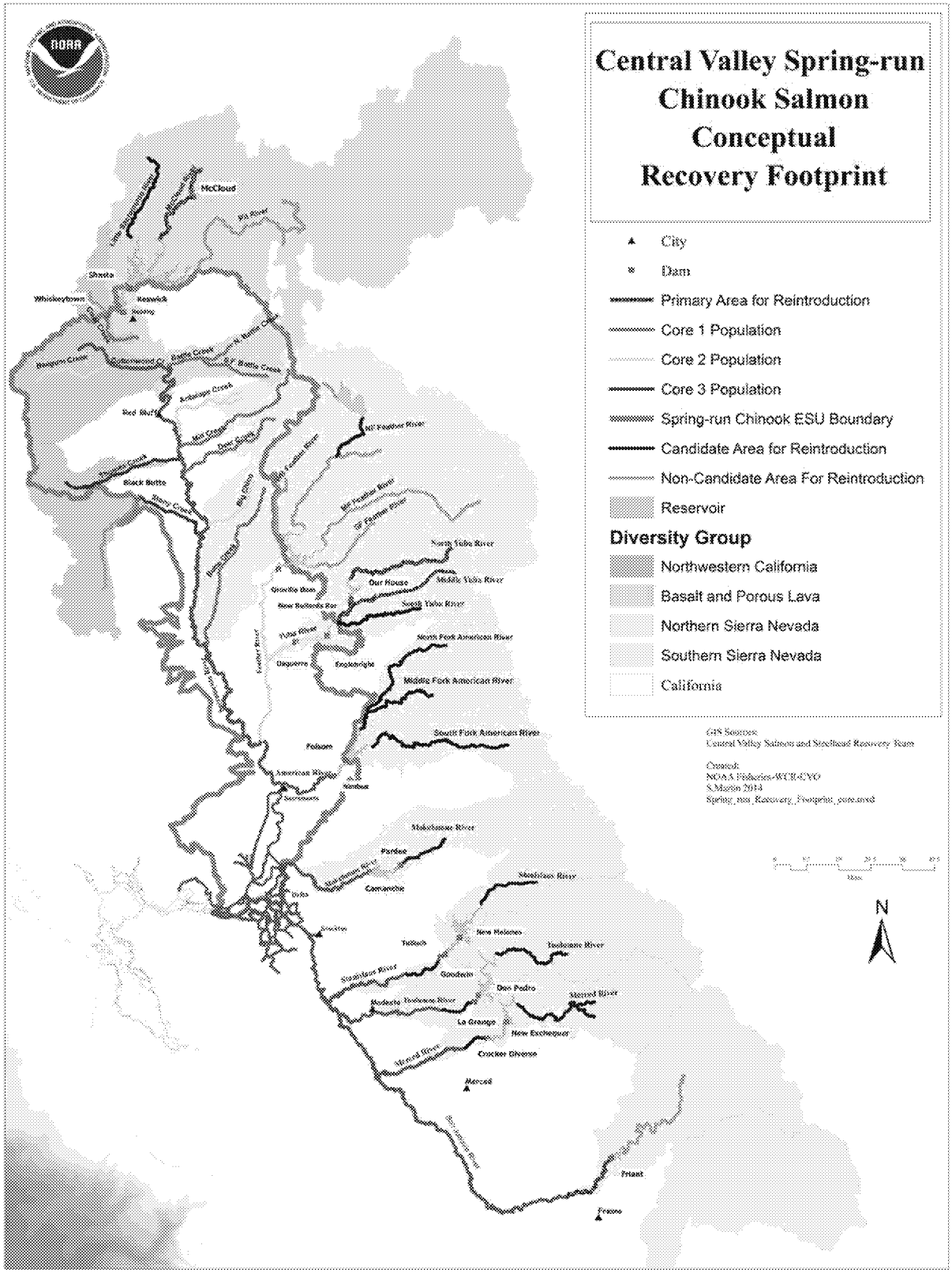


Figure 3-5. Central Valley Spring-run Chinook Salmon Recovery Footprint. The primary and candidate areas for reintroduction depicted on this map are areas where, although dams block access, the primary constituent elements that are necessary to support freshwater migration, holding, spawning and rearing still exist or could be restored.

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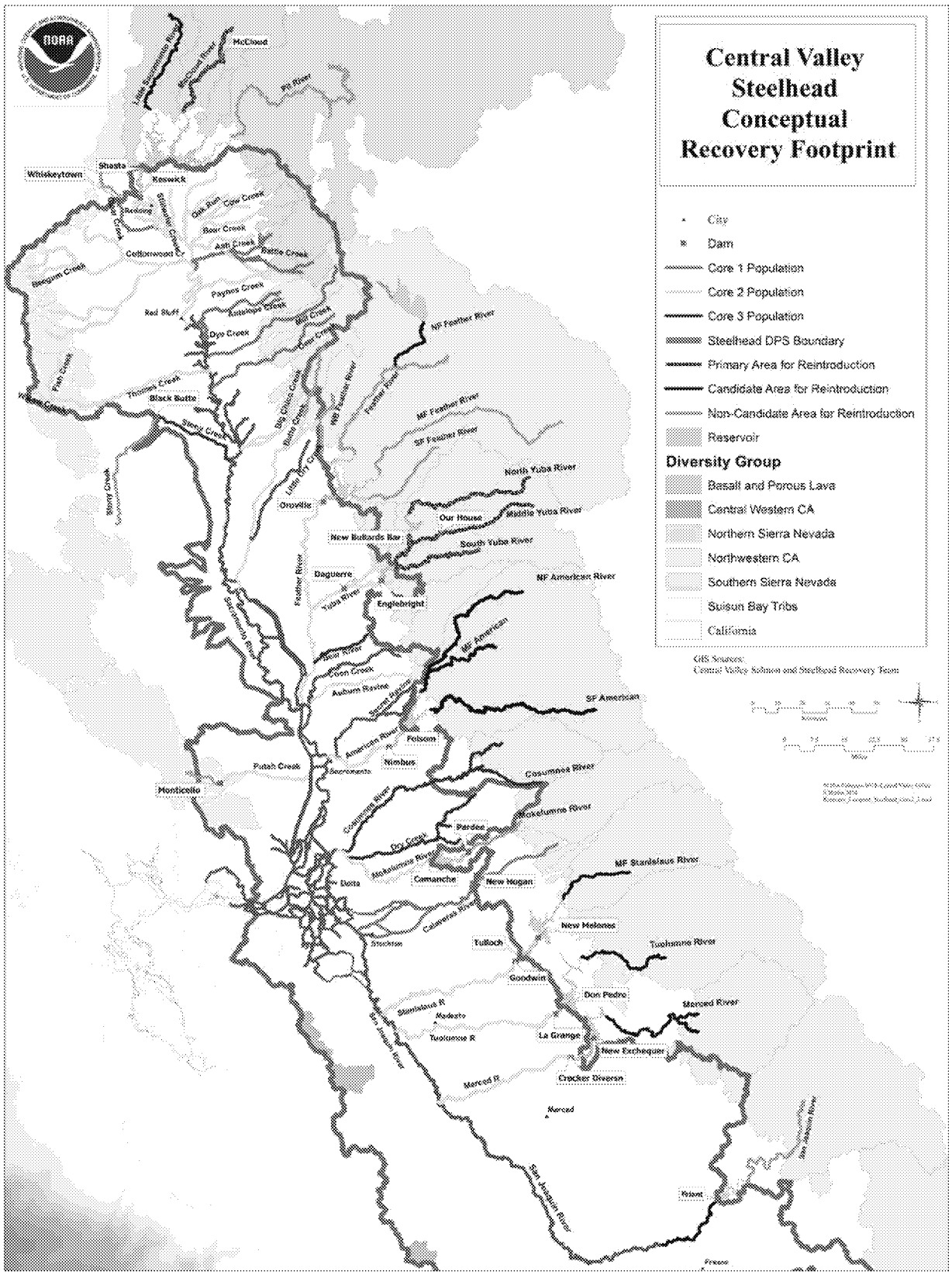


Figure 3-6. California Central Valley Steelhead DPS Recovery Footprint. The primary and candidate areas for reintroduction depicted on this map are areas where, although dams block access, the primary constituent elements that are necessary to support freshwater migration, holding, spawning and rearing still exist or could be restored.

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Re-introduction of anadromous fishes to historic habitats will require a new approach to watershed management, especially in regard to the operation and licensing of hydroelectric projects. Many of the keystone passage impediments to upstream habitat are regulated by the Federal Energy Regulatory Commission (FERC). In many watersheds, FERC also regulates upstream hydroelectric projects and facilities, and in most cases the licenses issued by FERC expire on different schedules, making the necessary, coordinated ecosystem-wide approach to relicensing difficult. Numerous hydroelectric licenses will come up for renewal in the next 20 years. Re-introduction of fish to historic habitats will require concerted watershed-scale approaches by FERC and other involved parties to align license schedules, develop new stream flow regimes, and facilitate comprehensive fish passage plans. This approach is especially necessary in the McCloud, upper Yuba, upper American, and other watersheds where hydroelectric projects influence areas identified for re-introduction, and affect downstream habitats that are essential for recovery. Re-introduction will require improved resource agency coordination, including joint filings under FERC proceedings, aligning regulatory schedules and products, and sharing biological, technical, and policy expertise on high priority projects.

The Sacramento River winter-run Chinook salmon ESU currently has one population, and that population spawns outside the species historic spawning range. For that reason, introductions into historically occupied habitat are necessary to meet requirements for redundancy. Re-introduction in the McCloud Rivers has the highest probability of success. Priority for the third population in the Diversity Group is introduction of the species in Battle Creek, which has suitable habitat for the species.

As with winter-run Chinook salmon, spring-run Chinook salmon will require re-introductions into historically occupied or currently suitable habitat in the Basalt and Porous Lava, Northern Sierra Nevada, and Southern Sierra Nevada Diversity Groups, in order to meet requirements for distribution and redundancy. Primary areas for spring-run Chinook salmon re-introduction into historic habitat include upstream of Shasta Dam in the Basalt diversity group and the Yuba River above Englebright Dam in the Northern Sierra Nevada. In the Southern Sierra Nevada, the strategy calls for reintroduction of spring-run Chinook salmon in the San Joaquin River below Friant Dam, and in one additional watershed in the Southern Sierra Nevada (Table 3-5).

Reintroductions of steelhead to historically occupied or currently suitable habitat will be necessary to meet objectives for distribution and redundancy in the Basalt and Porous Lava, Northern Sierra Nevada, and Southern Sierra Nevada Diversity Groups. Priorities for re-introduction are included in Table 3-6. These priorities include the McCloud River in the Basalt and Porous Lava Group and the Yuba River above Englebright in the Northern Sierra Nevada. Top priority areas for steelhead reintroductions in the Southern Sierra Nevada have yet to be established.

Reintroducing Chinook salmon and steelhead to historic habitats, particularly those habitats upstream of impassable barriers, will be extremely complicated and many questions will need to be answered as the projects progress. A few of the most important biological questions include:

- which donor populations should be used?;

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- how will donor fish be collected, how many will be needed, and what life stages should be used?;
- how and where will juveniles produced upstream of a barrier be collected, and how will they be transported downstream of the barrier?; and
- where and when will adults and juveniles be released?

In addition to those questions, which apply to all three species, re-introducing steelhead upstream of impassable barriers comes with unique complications and associated questions. First, because steelhead are iteroparous (i.e., they spawn multiple times in their lifetime), the question of what to do with the adult steelhead that spawn upstream of the barrier arises. Assuming those adults should be allowed to carry out their natural life history strategy by returning to the ocean after spawning, an effective collection method will need to be implemented.

Another important issue related to steelhead re-introductions deals with the occurrence of resident *O.mykiss* upstream of the barriers, which, in some Central Valley locations, contain genetic material representative of ancestral *O.mykiss* (Garza and Pearse 2008). This adds additional considerations to the donor stock selection question raised above – should the ancestral stock be used or a below barrier stock? This question and others associated with integrating below and above barrier populations will need to be addressed.

Lastly, reintegrating *O.mykiss* below and above barriers does not guarantee an increase in steelhead abundance, at least in the short-term while the selection regime favors residency. There are more resident *O.mykiss* than anadromous *O.mykiss* in the Central Valley (McEwan 2001), indicating selection pressure in the favor of the resident form. If selection pressures on the anadromous and resident form were equal, then one would expect their relative abundances to be somewhat equal and likely biased to anadromous *O.mykiss* because anadromous fish attain a much larger size than resident fish, and thus are able to outcompete the resident fish for quality spawning habitat and are much more fecund, producing twice as many eggs per body weight (Moyle 2002). Hypotheses for why there are more resident than anadromous *O.mykiss* in the Central Valley include: (1) low survival of *O.mykiss* through the Delta; (2) cold water releases from dams providing thermally survivable habitat for *O.mykiss* to live in year-round; and (3) a combination of 1 and 2. Achieving a better understanding of the factors influencing the selection between anadromous and resident life history strategies is an important step for efforts to expand steelhead habitat upstream of impassable barriers.

In the face of all of the complications and questions related to anadromous salmonid reintroductions in the Central Valley, it is important to recognize that recovering winter-run Chinook salmon, spring-run Chinook salmon, and steelhead is highly unlikely without significant habitat expansion (Lindley *et al.* 2007; Cummins *et al.* 2008; Moyle *et al.* 2008).

Role of Hatcheries in Securing Existing Populations and Reintroducing Populations in Historically Occupied or Suitable Habitat

The principal strategy of salmonid conservation and recovery continues to be through the protection and restoration of the healthy ecosystems upon which they depend, in line with the ESA's stated purpose to conserve "the ecosystems upon which endangered and threatened species

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depend" (ESA section 2(b)). However, a natural recovery of local extinctions depends on one or more recolonization events, a process that operates on an indefinite timescale. Likewise, the viability of a depressed population, characterized by small size, fragmented structure, and impacted genetics (e.g., bottlenecks, inbreeding, outbreeding depression, etc.), may be so compromised that its response to restored or increased availability of habitat is not sufficient to prevent imminent extinction. Either case may demand management intervention to attain viable salmonid populations. Conservation hatcheries may provide an appropriate means for establishing new populations and for allowing existing populations to recover. Two relevant examples from the Central Valley are the development of a conservation hatchery to help re-establish spring-run Chinook salmon in the San Joaquin River and the ongoing operation of the winter-run Chinook salmon conservation program at the Livingston Stone National Fish Hatchery.

There is considerable uncertainty regarding the ability of artificial propagation to increase population viability over the long-term, and it cannot be assumed that artificial augmentation will reduce extinction risk. There is a risk to natural recovery from increasing dependency on hatchery production. Conservation hatcheries must therefore monitor the effects of their programs on the natural population using criteria which would trigger modification to or cessation of the conservation program.

3.4 ADAPTIVE MANAGEMENT AND MONITORING

Successful adaptive management relies on accurate data provided by effective long-term monitoring programs. Past and current CV salmonid monitoring programs have suffered from inconsistent and/or inadequate funding. For successful species recovery and effective use of limited resources, a funding mechanism for long term effective monitoring of CV salmonids should be a fundamental top priority in the recovery plan.

Implementation of the Recovery Strategy will involve actions throughout the ESUs and DPS, conducted by a variety of agencies and stakeholders, addressing a multitude of site specific and systematic issues. These efforts are complicated by uncertainties, which include the actual abundance and distribution of the listed species, interactions between the species and their habitat, and the design and effectiveness of recovery actions. An effective means of gathering and sharing information on the condition of the resources, and the lessons learned during implementation of actions, is essential to bring accountability and efficiency to the process, and to allow for informed revisions to the recovery approach.

Adaptive management and monitoring will provide a framework to obtain the appropriate types and amounts of data to evaluate the effectiveness of recovery actions and progress toward recovery. The plan, outlined below, includes an approach to coordination of the numerous monitoring and research tasks required for implementation of the strategy.

Track Performance

This effort will document that recovery actions are implemented, as well as determine if they were implemented as intended and designed.

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Monitor effectiveness of implemented actions

The goal of this component of the plan is to determine if actions, once implemented, meet their objectives. Because priority for future restoration efforts will be given to actions shown to be effective, this information will lead to adjustments in priority for actions. At the site level, it will assist in project design, to take advantage of lessons learned.

Review progress in meeting recovery criteria

This information is needed to assess progress toward the goal of delisting, and includes three parts: viability in each Diversity Group (population distribution and abundance), habitat monitoring, and evaluation of threats.

Viability

Existing adult salmonid escapement monitoring programs in the Central Valley are currently inadequate to estimate population status and evaluate population trends in a statistically valid manner for the following management purposes: (1) providing a sound basis for assessing recovery of listed stocks; (2) monitoring the success of restoration programs; (3) evaluating the contribution of hatchery fish to Central Valley populations; and (4) managing sustainable ocean and inland harvest (Allen 2005).

Numerous programs are underway to collect information on anadromous fish species in the Central Valley. Although each of these programs and monitoring activities provides important information about the overall status of the specific resources and their habitats in the Central Valley and Bay/Delta, they are generally implemented on a project-by-project basis. Other streams and associated populations within the Chinook salmon ESUs and the steelhead DPS within the Central Valley Domain have no existing monitoring surveys or programs. Clearly, a more coordinated and comprehensive system-wide watershed and population monitoring system is needed.

As previously noted, there is great need for the development and implementation of a comprehensive monitoring plan for steelhead populations throughout the Central Valley Domain. The Central Valley Domain TRT was unable to assess the status of the California Central Valley steelhead DPS because nearly all of its approximately 80 historic populations are classified as data-deficient, with a few exceptions that are closely associated with a hatchery (Lindley *et al.* 2007).

In addition to population status and trend evaluation, accurate estimation of adult Chinook salmon and steelhead spawner escapement is necessary for harvest management. Age and run-specific escapement data in the Central Valley are necessary to utilize more accurate models associated with ocean harvest management.

Habitat

Watershed-level monitoring, including selected habitat variables, is necessary to evaluate the effectiveness of multiple restoration actions. Watershed-specific monitoring evaluations will contribute to the assessment of threat abatement and population responses. Additionally, the long-term effects of habitat restoration actions need to be assessed throughout the Central Valley Domain. Components that require monitoring include long-term changes in the characteristics of targeted recovery/restoration components such as aquatic habitat, riverine channel

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configuration, riparian vegetation, and floodplain structure and function.

Long-term habitat monitoring will also include parameters useful in tracking trends of climate change effects, such that necessary modifications to recovery objectives can be made.

Evaluation of Threats

Actions included in the strategy are intended to address threats to the listed species and their habitats. Monitoring implementation and effectiveness of actions will help track progress and provide information necessary to guide adaptive management. This data, along with monitoring of watershed and habitat conditions outlined above, will provide the information necessary to evaluate the degree to which threats have been eliminated or reduced as well as to identify any new threats.

Coordination research and monitoring targeted to address information gaps

Recovering the Chinook salmon ESUs and steelhead DPS will require numerous investigations and studies. The majority of these will address a specific question (e.g., gravel movement) at a particular site, while some are fairly broad questions (e.g., assess reintroduction potential above a group of impoundments). Also necessary are the system wide habitat and population monitoring programs outlined above. Coordination of these efforts is necessary so that questions are addressed in a priority sequence, and so that information and approaches are shared and efforts are not duplicated. A consistent framework for research and monitoring will directly inform recovery objectives and goals.

Reporting

There is a need to effectively share information with the public, stakeholders, and cooperators. To this end, NOAA is in the process of developing an internet-based recovery action tracking system. The reporting will support the annual reporting for the Government Performance and Results Act, Bi-Annual Recovery Reports to Congress, and the 5-Year Status Review.

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4.0 Recovery Goals, Objectives and Criteria

"Merely increasing a species' numbers, range and abundance does not ensure its long-term health and sustainability; only by alleviating threats can lasting recovery be achieved."

- Interim Endangered and Threatened Species Recovery Planning Guidance (NMFS 2010b)

This chapter describes the goals of this Recovery Plan and includes a brief discussion of the biological basis for meeting those goals for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. This chapter also explains the objectives and criteria to be used to determine when recovery of the listed species has been achieved. Two main types of criteria are presented. First, biological criteria pertaining to both ESU/DPS and population viability are described. Next, threat abatement criteria are covered to determine when the threats that led to listing of the species have been eliminated or adequately reduced.

4.1 Recovery Goals

The overarching goal of this Recovery Plan is the removal of the Sacramento River winter-run Chinook salmon ESU, Central Valley spring-run Chinook salmon ESU, and California Central Valley steelhead DPS from the Federal List of Endangered and Threatened Wildlife (50 CFR 17.11; 50 CFR 224.101; 50 CFR 223.102). Because recovery plans are not regulatory documents, successful implementation and recovery of listed species will require the support, efforts and resources of many entities, from Federal and State agencies to individual members of the public. Another goal will be to encourage and support effective partnerships with regional stakeholders to meet the objectives and criteria of the Recovery Plan. The objectives and criteria to accomplish the overarching goal of species delisting build upon the technical input and guidance provided by the Central Valley TRT, and other information provided during public workshops and co-manager reviews. Much of the technical recovery discussion in this section is taken directly from information developed by the TRT (Lindley *et al.* 2004; 2006; 2007).

The Endangered and Threatened Species Recovery Planning Guidance (NMFS 2010b) describes the recovery planning goal as recovery and long-term sustainability of an endangered or threatened species and, therefore, delisting of the species. Further, NMFS (2010b) states that goals usually can be subdivided into discrete component objectives which, collectively, describe the conditions (criteria) necessary for achieving the goal. Simply stated, recovery objectives are the parameters of the goal, and criteria are the values for those parameters. The objectives and related criteria, representing the components of the recovery goal, identify mechanisms for pursuing the goal (including necessary recovery actions) and allow confirmation when the goal has been reached.

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According to NMFS (2010b), recovery and long-term sustainability of an endangered or threatened species require:

- Adequate reproduction for replacement of losses due to natural mortality factors (including disease and stochastic events)
- Sufficient genetic robustness to avoid inbreeding depression and allow adaptation
- Sufficient habitat (type, amount, and quality) for long-term population maintenance
- Elimination or control of threats (this may also include having adequate regulatory mechanisms in place).

4.2 Integrating TRT Products into Recovery Objectives and Criteria

The ESA requires that recovery plans, to the maximum extent practicable, incorporate objective, measurable criteria which, when met, would result in a determination in accordance with the provisions of the ESA that the species be removed from the Federal List of Endangered and Threatened Wildlife; the criteria described herein fulfill that role with regard to the aforementioned species.

Population or demographic parameters are considered through the biological recovery criteria, while the threats criteria consider threats under the five ESA listing factors in ESA section 4(a)(1) (threats criteria). Together, these make up the "objective, measurable criteria" required under section 4(f)(1)(B).

These recovery criteria were derived from the TRT products (Appendix C), and as such, they represent the best scientific analysis incorporating the most current understanding of the ESUs and DPS and their populations.

4.2.1 Biological Basis for Recovery Criteria

For delisting, the ESU/DPS should meet the criteria for populations and diversity groups listed below in Sections 4.3.2 and 4.3.4. Downlisting (endangered to threatened) criteria for winter-run Chinook salmon are provided in Section 4.3.4.1. These delisting and downlisting criteria are based on population- and ESU-level considerations as discussed below in Sections 4.2.1.1 and 4.2.1.2.

Population Level Considerations

This plan includes both population-level and Diversity Group recovery criteria. The population-level criteria are used to determine whether a population is viable or not. A viable population is one with a low extinction risk in the wild over the long-term (McElhany *et al.* 2000).

The Central Valley TRT incorporated the four VSP parameters into assessments of population viability, and two sets of population viability criteria were developed, expressed in terms of extinction risk (Table 4-1). The first set of criteria deal with direct estimates of extinction risk from population viability analysis (PVA) models. If data are available and such analyses exist and are deemed reasonable for individual populations, such PVA assessments may be efficient for assessing extinction risk. The Central Valley TRT assumed that, for PVA results, a 5 percent or less risk of extinction in 100 years is an acceptably low extinction risk for populations (Lindley *et al.* 2007).

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The second set of criteria are simpler and do not require PVA modeling results. These simpler extinction risk criteria are the basis of the population-level recovery criteria used in this Recovery Plan, with the low extinction risk levels defining what constitutes a viable population. The simpler criteria from Table 4-1 include population size (and effective population size), population decline, catastrophic rate and effect, and hatchery influence. Estimators for the various viability criteria are presented in Table 4-2.

Population Size (Abundance)

The effective population size criteria (second row of Table 4-1) relate to loss of genetic diversity. Very small populations, for example with *Ne* < 50, suffer severe inbreeding depression (Franklin 1980; Soulé 1980 *in* Lindley *et al.* 2007), and normally outbred populations with such low *Ne* have a high risk of extinction from this inbreeding. Somewhat larger, but still small, populations can be expected to lose variation in quantitative traits through genetic drift faster than it can be replaced by mutation. With future research, it may be possible to better define population size targets that conserve genetic variation and account for migration and genetic structuring within ESUs/DPS.

Census size N can be used if direct estimates of effective population size are not available. Census size is estimated as the product of the mean run size and the average generation time. The average spawning run size is computed as the mean of up to the three most recent generations, if that much data are available.

The general criteria for population size discussed below may be adjusted as further information is developed. Healthy populations should be at or near carrying capacity in most years. As such, a detailed and thorough assessment of each watershed's carrying capacity should be conducted, and the recovery criterion for abundance should be based on that estimated carrying capacity.

As recovery actions are implemented and habitats are restored and expanded, the low extinction risk abundance criterion (i.e., census size>2,500) may be too low for large watersheds or for abundant populations. For example, Butte Creek has supported spring-run Chinook salmon populations with a census size well in excess of 2,500 since 1998, suggesting that the carrying capacity of that system may be greater than that criterion.

Carrying capacity assessments could be accomplished by applying a consistent approach to measure habitat capacity throughout each ESU/DPS and then relating that capacity to assumed spawner density thresholds that correspond to varying levels of extinction risk (Williams *et al.* 2008). Until such population-specific abundance recovery criteria are developed, the low and moderate extinction risk abundance criterion (Table 4-1) serve as benchmarks for the developing population delisting criteria.

Population Decline (Productivity)

This criterion is intended to capture demographic risks. The rationale behind the population decline criteria are fairly straight forward: severe and prolonged declines to small run sizes are strong evidence that a population is at risk of extinction. Population growth (or decline) rate is estimated from the slope of the natural logarithm of spawners versus time for the most recent 10 years of spawner count data.

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Catastrophic Rate and Effect (Productivity)

The overall goal of the catastrophe criterion is to capture a sudden shift from a low risk state to a higher risk state. Catastrophes are defined as instantaneous declines in population size due to events that occur randomly in time, in contrast to regular environmental variation. A high risk catastrophic event is one that causes a 90 percent decline in population size over one generation. A moderate risk catastrophic event is one that is smaller but biologically significant, such as a year-class failure.

Hatchery Influence (Diversity)

The spawning of hatchery fish in the wild is a potentially serious threat to the viability of natural populations. Population genetics theory predicts that hatchery fish can negatively impact wild populations when they spawn in the wild. In assessing the genetic impact of immigration on a population, considerations include the source of the immigrants, duration of the impact, the number of immigrants relative to the size of the recipient population, and how genetically divergent the immigrants are from the recipient population. Definitions of the manner in which different immigration scenarios relate to extinction risk for natural populations are summarized in Figure 4-1. Application of these definitions can result in a low-risk classification even with moderate amounts of straying from best-practices hatcheries, as long as other risk measures are acceptable (Lindley *et al.* 2007). The fraction of naturally-spawning hatchery origin fish is the mean fraction over one to four generations.

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Table 4-1. Criteria for assessing the Level of Risk of Extinction for Populations of Pacific Salmonids, Applied to the Chinook Salmon ESUs and the Steelhead DPS in the Central Valley Domain (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.

Table 4-2 Estimation Methods and Data Requirements for Population Metrics. S_t denotes the number of spawners in year t; g is mean generation time, assumed as three years for California salmon (from Lindley et al. 2007).

Metric	Estimator	Data	Criterion
$\hat{S}_t$	$\sum_{i=t-g+1}^{t} S_i/g$	≥ 3 years spawning run estimates	Population decline
N_e	$N \times 0.2$ or other	varies	Population size
N	$\hat{S}_t \times g$	≥ 3 years spawning run estimates	Population size
Population growth rate (% per year)	slope of $\log(S_t)$ v. time $\times 100$	10 years S_t	Population decline
c	$100 \times (1 - \min(N_{t+g}/N_t))$	time series of N	Catastrophe
h	average fraction of natural spawners of hatchery origin	mean of 1-4 generations	Hatchery influence

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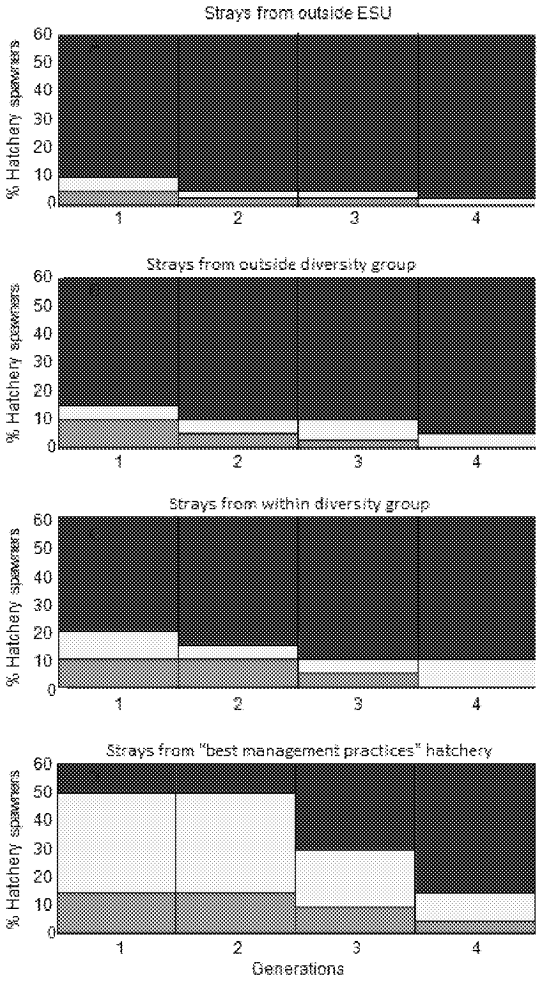


Figure 4-1. Extinction Risk Levels Corresponding to Different Amount, Duration and Source of Hatchery Strays.

Green bars indicate the range of low risk, yellow bars moderate risk, and red areas indicate high risk. Which chart to use depends on the relationship between the source and recipient populations. (A) hatchery strays are from a different ESU than the wild population. (B) Hatchery strays are from the same ESU but from a different diversity group within the ESU. (C) Hatchery strays are from the same ESU and diversity group, but the hatchery does not employ "best management practices." (D) Hatchery strays are from the same ESU and diversity group, and the hatchery employs "best management practices." (from Lindley *et al.* 2007)

Diversity Group and ESU/DPS Considerations

In order to delist the winter-run and spring-run Chinook salmon ESUs and the steelhead DPS, the TRT stated that there must be at least two viable populations in each diversity group (Lindley *et al.* 2007). This ESU/DPS-level recovery goal addresses the representation and redundancy rule for ESU/DPS viability.

The TRT recommendation of at least two viable populations is not applicable to the Northwestern California diversity group for spring-run Chinook salmon and steelhead, because this diversity group did not historically support viable populations. However due to management and restoration activities, the potential exists to support a viable population in Clear Creek.

As previously explained in Section 3.2.1, full steelhead recovery can be achieved without representation from either the Suisun Bay or Central Western California diversity groups.

4.3 Biological Objectives and Criteria at the Population, Diversity Group, and ESU/DPS Level

Implementation of the Recovery Plan is designed to ultimately achieve objectives for the ESUs/DPS at the Diversity Group level, and at the population level (i.e. watershed level) for the four VSP criteria of abundance, productivity, diversity, and spatial structure. Objectives addressing these requirements include demographic parameters, reduction or elimination of threats to the species (the listing factors), and any other particular vulnerability or biological needs inherent to the species.

4.3.1 Population Objectives

In general, viable populations should demonstrate a combination of population abundance, growth rate and genetic integrity that produces an acceptable probability of population persistence. Specifically, viable populations should meet the low extinction

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risk levels for the population decline and population size criteria described below in the following section.

4.3.2 Population Level Criteria

Consistent with the strategic approach to achieve recovery, this Recovery Plan establishes the following criteria for the viability of individual populations, similar to NMFS (2005b). The criteria are based on the VSP criteria for productivity and abundance, and diversity outlined in section 4.2.1

Low risk of extinction criteria

- Census population size is >2,500 adults -or- Effective population size is >500
- No productivity decline is apparent
- No catastrophic events occurring or apparent within the past 10 years
- Hatchery influence is low (see Figure 4-1).

Moderate risk of extinction criteria

- Census population size is 250 to 2,500 adults -or- Effective population size is 50 to 500 adults
- Productivity: Run size may have dropped below 500, but is stable
- No apparent decline in population growth rate resulting from catastrophic events within the past 10 years
- Hatchery influence is moderate

4.3.3 ESU/DPS Objectives

ESU/DPS viability depends on the number of populations within the ESU/DPS, their individual status, their spatial arrangement with respect to each other and sources of catastrophic disturbance, and the diversity of the populations and their habitats. In the most general terms, ESU/DPS viability increases with the number of populations (redundancy), the viability of these populations, spatial distribution of the populations, the diversity of the populations, and the diversity of habitats that they occupy.

For the ESUs and DPS to achieve recovery, each of the Diversity Groups should support both viable and dependent populations and meet goals for redundancy and distribution. Thus, an overall goal is to sustain populations in each of the Diversity Groups.

4.3.4 ESU/DPS Criteria

ESU Level Downlisting Criteria for Endangered Winter-run Chinook

Downlisting is the reclassification of a species from endangered to threatened. Two criteria have been identified with regard to downlisting of winter-run Chinook salmon from endangered to threatened:

- One population should meet each of the low extinction risk criteria described in section 4.3.2.; and
- In addition to the one viable population, the ESU should include one other spawning population that meets the moderate extinction risk criteria described in Table 4-1.

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These winter-run Chinook salmon downlisting criteria were identified because, when achieved, the species' viability would be notably improved from its current status, but would still be far from recovered (i.e., delisted). Currently, there is one population of winter-run Chinook salmon. In order to achieve the downlisting criteria, the species would need to be composed of two populations – one viable and one at moderate extinction risk. Having a second population would improve the species' viability, particularly through increased spatial structure and abundance, but further improvement would be needed to reach the goal of recovery. As identified in the next section, to delist winter-run Chinook salmon, three viable populations are needed. Thus, the downlisting criteria represent an initial key step along the path to recovering winter-run Chinook salmon.

ESU/DPS Delisting Criteria

In order for the Chinook salmon ESUs and the steelhead DPS to achieve recovery, Diversity Groups should display the following characteristics:

For the Winter-run Chinook salmon ESU:

- Three populations in the Basalt and Porous Lava Diversity Group at low risk of extinction

For the Spring-run Chinook salmon ESU:

- One population in the Northwestern California Diversity Group at low risk of extinction
- Two populations in the Basalt and Porous Lava Diversity Group at low risk of extinction
- Four populations in the Northern Sierra Diversity Group at low risk of extinction
- Two populations in the Southern Sierra Diversity Group at low risk of extinction
- Maintain multiple populations at moderate risk of extinction

For the California Central Valley steelhead DPS:

- One population in the Northwestern California Diversity Group at low risk of extinction
- Two populations in the Basalt and Porous Lava Flow Diversity Group at low risk of extinction
- Four populations in the Northern Sierra Diversity Group at low risk of extinction
- Two populations in the Southern Sierra Diversity Group at low risk of extinction
- Maintain multiple populations at moderate risk of extinction

For context, these ESU/DPS recovery criteria are shown in relation to historic and current conditions in Table 4-3. Although Table 4-3 does show that much improvement in the number and distribution of viable populations is needed, an encouraging take-away point is that these species can be recovered without achieving the historic condition. For example, a recovered spring-run Chinook salmon ESU requires nine viable populations, not the 19 that historically occurred in the Central Valley.

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Table 4-3: Number of independent, viable populations of winter-run and spring-run Chinook salmon and steelhead by diversity group under historic and current conditions, relative to the recovery criteria. The recovery criteria also include maintenance of all existing dependent populations.

Diversity Group	Historic, Current and Recovered Independent, Viable Populations - Total By Diversity Group								
	Winter-Run			Spring Run			Steelhead		
	Historic	Current	Recovery Criteria	Historic	Current	Recovery Criteria	Historic	Current	Recovery Criteria
Basalt and Porous Lava	4	0	3	4	0	2	12	Unknown	2
Northwestern California	0	0	0	0	0	1	14	Unknown	1
Northern Sierra	0	0	0	11	1	4	21	Unknown	4
Southern Sierra	0	0	0	4	0	2	26	Unknown	2

4.4 Threat Abatement

The underlying causes of species declines should be controlled prior to delisting. These causes include all threats identified at the time of listing, as well as any new factors identified since listing. Since listing, numerous additional threats have been identified and prioritized for the ocean, migratory corridors, and for each of the Diversity Groups and individual populations of the winter-run and spring-run Chinook salmon ESUs, and the steelhead DPS within the Central Valley Domain (Introduction, Appendix B).

NMFS believes that the condition of habitat in the ESUs/DPS will be directly affected by actions that address threats to the habitat. Therefore, changes to habitat condition will be inferred by monitoring progress and the degree to which threats to habitat are improved or removed, at both the watershed and system scale. Therefore, abatement of threats will also meet these habitat objectives:

- The spatial distribution and productive capacity of freshwater, estuarine, and marine habitats should be sufficient to maintain viable populations identified for recovery;
- The diversity of habitats for recovered populations should provide sufficient resilience and redundancy to withstand expected natural disturbance regimes such as wildfires, floods, droughts and volcanic eruptions. Historic conditions represent a reasonable template for a viable population; the closer the habitat resembles the historic diversity, the greater the confidence in its ability to support viable populations; and
- At a large scale, habitats should be protected and restored, with a trend toward an appropriate range of attributes for salmonid viability. Freshwater, estuarine, and marine habitat attributes should be maintained in a non-deteriorating state.

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4.4.1 Threats

Sacramento River Winter-run Chinook Salmon

Several factors have contributed to the decline of winter-run Chinook salmon through degradation of spawning, rearing, and migration habitats. The primary factors included in the listing of winter-run Chinook salmon were blockage of historical habitat by Shasta and Keswick dams, warm water releases from Shasta Dam, juvenile and adult passage constraints at RBDD, water exports in the southern Delta, heavy metal contamination from Iron Mountain Mine, high ocean harvest rates and entrainment in a large number of unscreened or poorly screened water diversions (NMFS 1997). Other factors include smaller water manipulation facilities and dams, loss of rearing habitat in the lower Sacramento River and Delta from levee construction, marshland reclamation, interaction with and predation by introduced species, adverse flow conditions, high summer water temperatures and vulnerability to drought (NMFS 1997). Since listing, some of these threats have been addressed, although numerous additional threats have been identified and prioritized (Appendix B).

Central Valley Spring-run Chinook Salmon

Listing factors and threats to Central Valley spring-run Chinook salmon fall into three broad categories: loss of historical spawning habitat; degradation of remaining habitat; and threats to genetic integrity. The last threat is to wild spawning populations resulting from spawning with FRFH spring-run Chinook salmon and naturally- and hatchery produced fall-run Chinook salmon. A complete prioritized list of the life stage-specific threats to the ESU is presented in Appendix B.

Central Valley Steelhead

Threats to Central Valley steelhead are similar to those for Central Valley spring-run Chinook salmon: loss of historical spawning habitat, degradation of remaining habitat, and threats to the genetic integrity of the wild spawning populations from hatchery steelhead production programs in the Central Valley. A complete prioritized list of life stage-specific threats to the DPS is presented in Appendix B.

4.4.2 Listing Factors

All threats to a species can be categorized into one of the five ESA listing factors:

1. The present or threatened destruction, modification, or curtailment of its habitat or range;
2. Overutilization for commercial, recreational, scientific, or educational purposes;
3. Disease or predation;
4. The inadequacy of existing regulatory mechanisms;
5. Other natural or manmade factors affecting its continued existence.

NMFS proposes that, to determine that the affected ESU/DPS is recovered to the point that it no longer requires the protections of the ESA, these five ESA listing factors should be addressed according to specific criteria identified for each of them in order to ensure that the underlying causes for listing the species are addressed.

It is likely that current threats may diminish or increase in severity due to anthropogenic or natural changes to the environment. Indeed, successful implementation of the actions in this recovery plan will ameliorate threats to the ESUs/DPS. Consequently, NMFS expects that the significance of threats will change over time. It is also

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possible that new threats may be identified. To track changes in the threat regime, every five years during the status reviews of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead, NMFS will evaluate whether the five listing factors have substantially changed.

4.4.3 Threat Abatement Criteria

NMFS is providing the specific threat abatement criteria listed below for each of the relevant listing factors to help to ensure that underlying causes of decline have been addressed and mitigated prior to considering a species for delisting. These threat abatement criteria correspond to the listing factors identified for winter- and spring-run Chinook salmon and steelhead in this Recovery Plan, and are related to each of the threats described in Appendix B.

- Populations have unobstructed access to Core 1, 2, and 3 watersheds and assisted access to primary watersheds for reintroduction that are obstructed. Man-made structures (e.g., bridges and water diversions) affecting these watersheds and in migratory habitat should meet NMFS' salmonid passage guidelines for stream crossings and screening criteria for anadromous salmonids (Listing Factors 1, 4, and 5)
- Utilization for commercial, recreational, scientific and educational purposes is managed, such that all core 1 populations meet the low extinction risk categories for abundance, productivity, and diversity (see table 4-1) (Listing Factor 2)
- Hatchery programs are operated so that all core 1 populations meet the low extinction risk criteria for hatchery influence (see table 4-1) (Listing Factors 3 and 5)
- Migration and rearing corridors meet the life-history, water quality and habitat requirements of the listed species, such that the corridor supports multiple viable populations (Listing Factors 1, 3, 4, and 5)

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5.0 Recovery Actions

"Once there is a firm commitment and a strategy alternative has been decided upon, the third and final pillar of an effective salmon recovery effort is that a number of specific actions will be required to achieve effective implementation."

- Jeffrey J. Dose. Commitment, Strategy, Action: The Three Pillars of Wild Salmon Recovery *in* Salmon 2100: the future of wild Pacific salmon

This Recovery Plan establishes a strategic approach to recovery, which identifies critical recovery actions for the Central Valley, as well as watershed- and site-specific recovery actions. Watershed-specific recovery actions address threats occurring in each of the rivers or creeks that currently support spawning populations of the Sacramento River winter-run Chinook salmon ESU, the Central Valley spring-run Chinook salmon ESU, or the California Central Valley steelhead DPS. Site-specific recovery actions address threats to these species occurring within a migration corridor (e.g., San Francisco Bay or the Delta).

This Recovery Plan maintains a consistent strategic framework for the establishment of recovery goals and criteria, the identification and prioritization of threats, and the identification of recovery actions. As described in the Recovery Strategy chapter, the framework for ESU or DPS recovery includes goals and criteria directed at the diversity group and population levels. Similarly, the threats assessment framework for each ESU or DPS also was organized by diversity groups and populations. For the winter-run Chinook salmon ESU, threats were prioritized for the one Sacramento River population; for spring-run Chinook salmon and steelhead, threats were prioritized within each diversity group as well as within each population.

Three steps were used to prioritize recovery actions as they are presented in this plan. First, results from the threats assessment and prioritization process (described in Appendix B) were used to guide the identification of watershed- and site-specific recovery actions for each diversity group and population. This step prioritized recovery actions separately for each species. The second step was undertaken through consideration of specific actions that benefit multiple species and populations. Results from the second step included tables of recovery actions listed in descending order of priority by geographic region (e.g., Delta, mainstem Sacramento River, Battle Creek) based on multiple species benefits (see Appendix C). These first two steps were the only steps taken to prioritize recovery actions that were presented in the Co-Manager Review Draft Recovery Plan. Based on feedback from co-managers, it was apparent that the priority with which recovery actions should be undertaken was not clear.

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To address this, we implemented a third step and prioritized each of the area- or watershed-specific recovery actions according to three categories. Priority 1 actions address the most important threats within an area (e.g., Pacific Ocean or Delta) or watershed; priority 2 actions address threats of moderate importance, and priority 3 actions are of lower importance to implement[7].

Actions were identified as priority 1, 2, or 3 based on the first two prioritization steps and on the best professional judgment of agency co-managers, including biologists from CDFW, DWR, USFWS, USFS, and NMFS.

A number of ecosystem and/or anadromous fish enhancement plans for the Central Valley, as well as input received from two recovery planning public workshops, held May 22nd and 24th, 2007 in Sacramento and Redding, respectively, have been used to identify recovery actions. These documents include:

- Final Restoration Plan for the AFRP (USFWS 2001)
- AFRP Planning Documents (AFRP Website 2005; AFRP Website 2006a; AFRP Website 2006b)
- Ecosystem Restoration Plan Planning Documents (CALFED 2006; CALFED 2007)
- Summary of Threats and Recovery Actions for Spring-run Chinook Salmon and Winter-run Chinook Salmon Recovery Actions. Sacramento Salmon and Steelhead Recovery Workshop (NMFS 2007c)
- Summary of Threats and Recovery Actions for Steelhead. Sacramento Salmon and Steelhead Recovery Workshop (NMFS 2007a)
- Steelhead Restoration and Management Plan for California (CDFW 1996)
- Lower Yuba River Revised Implementation Plan and Appendices (CALFED and YCWA 2005)
- Ecosystem Restoration Program Plan (ERPP) (CALFED 1999a)
- Restoring Central Valley Streams: A Plan for Action (CDFW 1993)
- Lower Yuba River Fisheries Management Plan (CDFW 1991a)

[7] In NMFS' Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead, October 2009, Appendix C, we described how we applied the recovery action priorities 1-3 described in NMFS recovery planning guidelines (55 FR 24296; June 15, 1990), which are also described in NMFS' Recovery Planning Guidance (NMFS 2010b), in developing recovery actions for each species addressed in this recovery plan. The recovery actions priorities 1-3 described here in this final recovery plan are based on grouping the recovery actions for all three listed species addressed in this recovery plan by area or watershed and prioritizing those actions as described here.

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- Initial Fisheries and In-Stream Habitat Management and Restoration Plan for the Lower American River (Water Forum 2001)
- CALFED Bay/Delta Program Multi-Species Conservation Strategy. Final Programmatic EIS/EIR Technical Appendix (CALFED 2000a)
- Potential for Re-establishing a Spring-Run Chinook Salmon Population in the Lower Feather River (MWD 2005)
- Central Valley Salmon – A perspective on Chinook and Steelhead in the Central Valley of California (Williams 2006)
- What caused the Sacramento River fall Chinook stock collapse? (Lindley *et al.* 2009)
- Insights into the Problems, Progress, and Potential Solutions for Sacramento River Basin Native Anadromous Fish Restoration (Vogel 2011).

The recovery actions for this plan are presented in the tables below according to the following geographic organization:

- Throughout California or the Central Valley
- Pacific Ocean
- San Francisco, San Pablo, and Suisun bays
- Delta
- Mainstem Sacramento River
- Northwestern California Diversity Group
- Basalt and Porous Lava Diversity Group
- Northern Sierra Nevada Diversity Group
- Mainstem San Joaquin River
- Southern Sierra Nevada Diversity Group.

The implementation schedules that follow outline actions for the recovery program for the Sacramento River winter-run Chinook salmon ESU, the Central Valley spring-run Chinook salmon ESU, and the California Central Valley steelhead DPS, as set forth in this recovery plan. The schedules are a guide for meeting the recovery goals outlined in this plan. They indicate action priorities, action numbers, action descriptions, and duration of actions; the parties potentially involved in either funding or carrying out actions; and estimated costs. The listing of a party in an implementation schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s).

Cost estimates are provided wherever practicable. In some cases, information essential to the development of even the roughest of estimates is unavailable, as described in detail below:

- There is no available information to estimate, even in the roughest of terms, the appropriate extent of an action:

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- The essential quality or quantity of a determinative feature of an action can only be estimated after site-specific investigations are completed; NMFS is unaware of any existing site-specific investigations. This includes:

Gravel Augmentation	Estimate of amount of necessary gravel augmentation (if any) unavailable. Per unit cost is $11 to $72/cubic yard (Appendix D).
Wetland Habitat Restoration	Estimate of amount of habitat to be restored unavailable. Per unit cost is $75 to $100,000/acre (Appendix D Table HI-7).
Riparian Habitat Restoration	Estimate of amount of habitat to be restored unavailable. As identified in Appendix D, per unit costs vary depending on whether fencing, planting, irrigation, or invasive week control are needed.
Floodplain Habitat Restoration	Estimate of amount of habitat to be restored unavailable. Per unit cost is $5,000 to $80,000/acre (Appendix D Table HI-4)
Side Channel Habitat Restoration/Re-connection	Estimate of amount of habitat to be restored unavailable. Per unit cost is $20,000 to $300,000/acre (Appendix D Table HI-5)
Sediment retention projects.	Extent and method of sediment retention unavailable. See Appendix D, tables HU-1 through HU-4 for per unit costs for road de-commissioning, road upgrades, landslide/gully stabilization, and planting in upland areas.
Habitat acquisition/easements	Estimate of amount of habitat for acquisition, lease, or easement unavailable. Land acquisition costs per acre for California are presented by county in Appendix D, Table HA-3, and generally range from $200 to $20,000/acre. Conservation easement costs range from $209 to $730/acre (Appendix D).
Water acquisition for instream flow	Estimate of amount of water to be purchased unavailable. Cost per unit ranges from $43 to $88/af/year for upstream of Delta water purchases (Appendix D)

- With regard to the Delta (DEL-2.31) and San Francisco Bay (SFB-2.4) actions designed to promote nitrification and retention of NH4 through marsh restoration, it is not scientifically practicable to estimate how much restoration is needed to achieve the appropriate NH4 concentrations.

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- For the actions calling for projects to minimize predation at weirs, diversions, and related structures outside of the Delta[8], it is impracticable to provide cost estimates given the unknown but likely large number of man-made structures in the bays, and the Sacramento and San Joaquin river systems, many of which will require site-specific studies and adaptive management to identify unique solutions. After initial investigation, it is likely that the solution at one structure may apply to other structures of the same type (e.g., boat docks), in which case the overall cost of identifying and implementing solutions will diminish. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about $38,000 annually (BDCP 2013)[9].
- For actions calling for fish passage improvements at small agricultural diversions on a particular river or creek, the total number of diversions is unknown, making it impracticable to provide a total cost. Per unit cost of providing passage at agricultural diversion dams ranges from $30,000 to $1,356,500 (see Appendix D, page 21, table HB-4).

- Information on the cost of an action is known only to a third party, but such information has not been provided to NMFS by the third party at time of this Recovery Plan's publication;
- The action is so novel that no comparable actions can be identified and the action involves development or application of a new technology for which it is impracticable to provide a reasonable guess at the action's cost;
- The recommended action is based on the broad directives/guidelines of existing government plans and goals, for which no cost-estimate currently exists, but, due to the breadth of the existing directives/guidelines and their lack of specificity, it is impracticable to estimate the cost of their implementation. Two actions that fall into this category are: (1) Implement recommended actions from the National Ocean Council's National Ocean Policy Implementation Plan dated April 2013 [action PAO-2.3]; and (2) Implement the USEPA's Action Plan for addressing water quality concerns in the Bay/Delta [DEL-1.25].

Under the aforementioned circumstances, NMFS is unable to estimate practicably the cost of the action; accordingly, costs are identified as "To Be Determined" ("TBD"). Cost estimates will be determined as the currently unavailable information becomes available. Wherever practicable, NMFS has attempted to identify the following: 1) per-unit costs (particularly where the

[8] The cost of minimizing predation at Delta structures was estimated at $50 million over 50 years (BDCP 2013). A similar type of cost analysis for which to base the cost of minimizing predation in San Francisco, San Pablo, and Suisun bays, and the Sacramento and San Joaquin river systems has not been conducted.

[9] BDCP (2013) estimated the annual cost of predator removal for 17 sites at roughly $640,000, therefore, each site would cost about $38,000 annually ($640,000/17).

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unavailable quantum of information is the amount of habitat which must be addressed); 2) the cost of interim activities (including initial studies), which are the only estimable portion of an action and will help to provide the previously unavailable essential information, thereby ultimately leading to the action's ultimate cost estimate; and/or 3) a plan for determining the ultimate cost estimate.

In an effort to identify only the additional cost of species recovery, we considered what is already required under local, State, or Federal regulation, or settlement agreements, to be required actions, and thereby estimated them at $0. For example, the cost of an action required by a Reasonable and Prudent Alternative action which has already been adopted by an action agency is listed as $0. Also, actions were assumed to have no additional cost to recovery if the action would be accomplished under the existing work programs of government agencies and would not require an agency or group to acquire funding beyond their existing budgets. Because several federal and state agencies have significant budgets directed to natural resource protection in general, and anadromous salmonids in particular, many of the actions identified in this recovery plan will be implemented through those existing programs; as such, many actions are identified to cost $0, since the action will not cause agency budgets to expand.

The Southwest Fisheries Science Center (SWFSC) produced a Technical Memorandum providing information on costs associated with restoration activities. To help comply with the requirement to provide estimates of recovery costs, that Technical Memorandum has been appended to this recovery plan (Appendix D). Data from publicly available sources were used to obtain estimates of restoration costs for a variety of restoration activities. All costs described in Appendix D pertain to direct expenditures on restoration and do not include economic opportunity costs (e.g., foregone profits associated with restrictions on livestock grazing, timber harvest and other activities). Appendix D offers ranges of costs applicable at the ESU scale. Actual costs may vary widely from one watershed to another and across the extent of the Central Valley Domain due to potential differences in regional labor costs, property values, availability of expert contractors and materials, and permitting issues, etc. Many cost estimates for restoration activities in the Central Valley are specifically based on CALFED Ecosystem Restoration Program (ERP) implementation and/or contracted costs (most notably fish screening projects, gravel augmentation, channel restoration, bank stabilization, land acquisition, conservation easements, proposed watershed effectiveness monitoring, and a 5-dam decommissioning and removal project), so are specific to the Central Valley and are referenced as such in the Technical Memorandum. Also, levee-related and water purchase/lease activity cost estimates for the Central Valley were included in the report, based on information from DWR, county water agencies, and ERP. Irrigation ditch activity costs, including water control structures, were developed from information from county water agencies in the Central Valley. The rest of Appendix D contains data from the northernmost part of California, Oregon, Washington, and Idaho.

NMFS estimates that recovery for listed Central Valley salmon and steelhead, like for most of the ESA-listed Pacific Northwest salmon and steelhead, could take 50 to 100 years. Because there is an extensive list of actions that need to be undertaken to recover the listed Central Valley salmonids, there are many uncertainties involved in predicting the course of recovery and in estimating total costs and time to recovery. Such uncertainties include biological and ecosystem

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responses to recovery actions. Obtaining and evaluating cost estimates for recovery actions can be challenging, and projecting costs into the future becomes increasingly imprecise. NMFS believes it is impracticable to accurately estimate all projected actions and associated costs over 50 to 100 years, given the large number of economic, biological, and social variables involved, and that it is more appropriate to initially focus on the first 25 years of implementation. Because of these variables, cost projections become increasingly inaccurate with time. Most actions can be accomplished within this 25 year time frame. For actions that extend beyond 25 years (these actions are specifically identified in the description of the respective actions below), the cost over the first 25 years is provided, and it is assumed for lack of better information that those costs will continue for the remaining duration of the action. The cost estimates for actions in later years are likely much less accurate than estimates during earlier years of implementation.

The duration of an action in the implementation tables refers to how long the action will take to complete, as opposed to when the action will be initiated. When the exact number of years that it would take to complete an action could not be estimated, more general estimates were provided. The duration for most actions was identified using general estimates as short-term (i.e., roughly 10 years or less) or long-term (i.e., 11 to 25 years in most cases, up to 100 years where specifically noted).

Abbreviations key for the following tables:
ACWA: Association of California Water Agencies
AMR: American River
ANC: Antelope Creek
BAC: Battle Creek
BCC: Big Chico Creek
BLM: U.S. Bureau of Land Management
BUC: Butte Creek
CDFW: California Department of Fish and Wildlife
CEV: Central Valley
CLC: Clear Creek
COR: Cosumnes River
Corps: U.S. Army Corps of Engineers
CVP: Central Valley Project
CVRWQCB: Central Valley Regional Water Quality Control Board
DEC: Deer Creek
DEL: Delta
DRN: Delta Restoration Network
DSC: Delta Stewardship Council
DWR: California Department of Water Resources
FER: Feather River
FERC: Federal Energy Regulatory Commission
GCID: Glenn Colusa Irrigation District
HGMP: Hatchery and Genetic Management Plan
MER: Merced River
MIC: Mill Creek
MID: Merced Irrigation District

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MOR: Mokelumne River
NGO: Non-governmental organization
NID: Nevada Irrigation District
NMFS: National Marine Fisheries Service
NFWF: National Fish and Wildlife Foundation
NRCS: Natural Resources Conservation Service
ODFW: Oregon Department of Fish and Wildlife
OID: Oakdale Irrigation District
PCWA: Placer County Water Agency
PG&E: Pacific Gas and Electric
PFMC: Pacific Fishery Management Council
PUC: Putah Creek
SAR: Sacramento River
SJR: San Joaquin River
SRCS: Spring-run Chinook salmon
STR: Stanislaus River
STC: Stony Creek
STE: Steelhead
SWP: State Water Project
SWRCB: State Water Resources Control Board
SWRFSC: NMFS Southwest Region Fisheries Science Center
SYRCL: South Yuba River Citizens League
TBD: To Be Determined
TCCA: Tehama-Colusa Canal Authority
THC: Thomes Creek
TID: Turlock Irrigation District
TNC: The Nature Conservancy
TUR: Tuolumne River
USBR: United States Bureau of Reclamation
USEPA: United States Environmental Protection Agency
USFS: United States Forest Service
USFWS: United States Fish and Wildlife Service
WRCS: Winter-run Chinook salmon
YCWA: Yuba County Water Agency
YUR: Yuba River

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5.1 California and Central Valley Recovery Actions

Table 5-1. California and Central Valley Recovery Actions.

Action Area	Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
California	Implement Federal, State, and local initiatives and programs to improve water conservation in order to reduce state-wide water use by 20 percent per capita by 2020. This effort should take into account regional differences and find ways to improve agricultural and urban water use efficiency.	1	CA-1.1	WRCS ,SRCS, STE	Federal, State, County, and local governments	1,4,5	Short-term	TBD	TBD				TBD because the State Conservation Plan for the "20X2020" goal did not include an overall cost of the effort and the cost of the program can reasonably only be estimated by the state; numerous savings associated with investing in water conservation were provided, but an overall cost-benefit analysis was not conducted because of the large number of variables in play (DWR *et al.* 2010).
California	Implement the Global Warming Solutions Act (AB 32), the Sustainable Communities and Climate Protection Act (SB 375) and other smart growth measures to foster	1	CA-1.2	WRCS , SRCS, STE	Federal, State, County, and local governments	1,4,5	Long-term (beyond 25 years)	TBD	TBD	TBD	TBD	TBD	TBD because the number and scope of smart growth projects that will be implemented is indeterminate; it

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Action Area	Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
	sustainable land use throughout California.												is assumed that smart growth and sustainable land use practices will need to be implemented in perpetuity in order to delist the species in this plan and keep them delisted.
Central Valley	Develop and implement an ecosystem based management approach that integrates harvest, hatchery, habitat, and water management, in consideration of ocean conditions and climate change (Lindley *et al.* 2009).	1	CEV-1.1	WRCS, SRCS, STE	NMFS, USFWS, CDFW, DWR, PFMC, SWRCB, USBR	1, 2, 5	Long-term	$1,086,360	$1,699,840	$1,965,015	$2,271,558	$2,625,921	$9,648,694
Central Valley	Support programs to provide educational outreach and local involvement in restoration and watershed stewardship, including programs like Salmonids in the Classroom, Aquatic Wild, Adopt a Watershed, school district environmental camps, and other programs teaching the effects of human land and water use on anadromous fish survival.	1	CEV-1.2	WRCS, SRCS, STE	NMFS, USFWS, USBR, USFS, CDFW, DWR	5	Long-term						Cost is provided in the education/outreach actions for specific watersheds.

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Action Area	Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Central Valley	Provide additional funding for increased law enforcement to reduce illegal take of anadromous fish, ecologically harmful stream alterations, and water pollution and to ensure adequate protection for juvenile fish at pumps and diversions.	1	CEV -1.3	WRCS, SRCS, STE	CDFW, NMFS	4	Long-term	$12 million	$12 million	$12 million	$12 million	$12 million	$60 million
Central Valley	Implement the recommendations and guidelines of the California Hatchery Scientific Review Group (http://cahatcheryreview.com/).	1	CEV -1.4	WRCS, SRCS, STE	NMFS, USFWS, CDFW, USBR, DWR	5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD[10]
Central Valley	Implement a comprehensive Central Valley steelhead monitoring plan to better understand their abundance and distribution.	1	CEV -1.5	STE	NMFS, USFWS, CDFW, DWR, USBR	1	Long-term	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$7,500,000
Central Valley	Evaluate the relationship between resident and anadromous forms of O. mykiss to better understand the role that resident fish play in species maintenance and persistence.	1	CEV -1.6	STE	NMFS, USFWS, CDFW	1	Short-term	<$500,000	<$500,000				Cost will depend on study methodology, experimental design, number of samples needed, and other factors,

[10] The Hatchery Scientific Review Group Cost (HSRG) did not develop cost estimates for their recommendations and guidelines. To implement the HSRG recommendations, hatchery coordination teams for each hatchery will be established; those teams will identify implementation costs.

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Action Area	Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
													but overall it is anticipated to cost <$1,000,000
Central Valley	Implement and evaluate actions to minimize the adverse effects of exotic (non-native invasive) species (plants and animals) on the aquatic ecosystems used by anadromous salmonids.	1	CEV-1.7	WRCS, SRCS, STE	Department of Boating and Waterways	1,2,4	Long-term	$51,000,000	$125,000,000	$125,000,000	$125,000,000	$125,000,000	$551,000,000
Central Valley	Develop and implement State and National levee vegetation policies to maintain and restore riparian corridors.	1	CEV-1.8	WRCS, SRCS, STE	Corps, DWR, CDFW, NMFS	1,4	Long-term	$0	$0	$0	$0	$0	$0
Central Valley	Incorporate ecosystem restoration including breaching and setting back levees into Central Valley flood control plans (i.e., FloodSafe Strategic Plan and the Central Valley Flood Protection Plan).	1	CEV-1.9	WRCS, SRCS, STE	NMFS, USFWS, Corps, USBR, CDFW, DWR,	1,4	Long-term	$0	$0	$0	$0	$0	$0
Central Valley	Establish partnerships and agreements that promote water transactions, water transfers, shared storage, and integrated operations that benefit both species needs and water supply reliability.	1	CEV-1.10	WRCS, SRCS, STE	SWRCB, NFWF, ACWA, DWR, USBR	1,4,5	Short-term	$2,500,000	$2,500,000	$0	$0	$0	$5,000,000
Central Valley	Annually evaluate the harvest rate of Central Valley spring-run Chinook salmon and Sacramento River winter-run Chinook salmon in the ocean salmon	1	CEV-1.11	WRCS, SRCS	NMFS, PFMC, CDFW, USFWS	2	Long-term	Up to $750,000 for genetic analysis and reporting (Garza	Up to 750,000 for genetic analysis and reporting (Garza	Up to 750,000 for genetic analysis and reporting (Garza	Up to 750,000 for genetic analysis and reporting (Garza	Up to 750,000 for genetic analysis and reporting (Garza	Up to $3,750,000 for genetic analysis and reporting (Garza 2013); Up to $3,450,000 for

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Action Area	Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
	fisheries (commercial and recreational) and modify fishing regulations as necessary to ensure that the fisheries impacts allow for the ESUs to recover.							2013); Up to $690,000 for sampling assuming two FTEs are needed to expand the existing sampling program[11]	2013); Up to $690,000 for sampling assuming two FTEs are needed to expand the existing sampling program	2013); Up to $690,000 for sampling assuming two FTEs are needed to expand the existing sampling program	2013); Up to $690,000 for sampling assuming two FTEs are needed to expand the existing sampling program	2013); Up to $690,000 for sampling assuming two FTEs are needed to expand the existing sampling program	sampling assuming two FTEs are needed to expand the existing sampling program
Central Valley	Continue to implement and improve comprehensive Chinook salmon monitoring to assess the viability of winter-run and spring-run.	1	CEV-1.12	WRCS,SRCS	CDFW, USFWS, DWR, USBR, NMFS	5	Long-term	$0	$0	$0	$0	$0	$0
Central Valley	Conduct a Central Valley-wide assessment of anadromous salmonid passage opportunities at large rim dams including the quality and quantity of upstream habitat, passage feasibility and logistics, and passage-related costs.	2	CEV-2.1	WRCS, SRCS, STE	NMFS, USFWS, USBR, USFS, CDFW, DWR	1,5	Short-term	$2,500,000	$2,500,000	$0	$0	$0	$5,000,000
Central Valley	Develop a Fishery Management and Evaluation Plan for inland fisheries to ensure that impacts of those fisheries on winter-run	2	CEV-2.2	WRCS, SRCS, STE	CDFW, NMFS	2	Short-term	$0	$0	$0	$0	$0	$0

[11] Based on the May 2012 State Occupational Employment and Wage Estimates for California provided by the Bureau of Labor Statistics, the mean annual wage for a biologist is $69,000 (http://www.bls.gov/oes/current/oes_ca.htm#19-0000).

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Action Area	Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
	Chinook salmon, spring-run Chinook salmon, and steelhead allow for these species to recover.												

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5.2 Pacific Ocean Recovery Actions

Table 5-2. Pacific Ocean Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Re-evaluate and modify management measures, annual conservation objectives, harvest forecasting techniques, NMFS consultation standards for ESA listed salmon stocks, and consider implementing an ecosystem-based salmon fishery management plan that considers multi-trophic interactions, ocean currents, upwelling patterns, ocean temperatures, and other relevant factors.	1	PAO-1.1	WRCS, SRCS	NMFS, PFMC, CDFW	1,5	~ 10 years	$1,220,150	$1,410,493	$0	$0	$0	$2,630,643
Enhance water quality in the ocean and along the coast by continuing to promote and implement sustainable practices on land in ways that will improve the health of ocean water quality.	2	PAO-2.1	WRCS, SRCS, STE	NMFS, USFWS, PFMC, CDFW, WDFW, ODFW, county planning	1,5	Long-term	$0	$0	$0	$0	$0	$0
CDFW and National Marine Sanctuary Program should consider the ecological requirements of salmon and steelhead when designating sanctuaries	2	PAO-2.2	WRCS, SRCS, STE	CDFW, NMFS	4	Long-term	$0	$0	$0	$0	$0	$0
Implement recommended actions from the National Ocean Council's National Ocean Policy Implementation Plan dated April 2013	2	PAO-2.3	WRCS, SRCS, STE	NMFS, USFWS, PFMC, CDFW, WDFW, ODFW, county planning	4	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, the Ocean Policy Implementation Plan contains broad directives/guidelines, for which no cost-estimate currently exists, but, due to the breadth of the existing

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
												directives/guidelines and their lack of specificity, it is impracticable to estimate the cost of their implementation.

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5.3 San Francisco, San Pablo, and Suisun Bay Recovery Actions

Table 5-3. San Francisco, San Pablo, and Suisun Bay Reocery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement projects that improve wastewater and stormwater treatment throughout Suisun, San Pablo, and San Francisco bays and surrounding residential and commercial areas.	1	SFB-1.1	WRCS, SRCS, STE	SWRCB	1,5	Short-term	$1,545,000,000	$1,786,020,000	$0	$0	$0	$3,331,020,000
Protect, enhance, and restore a complex portfolio of habitats throughout Suisun, San Pablo, and San Francisco bays to provide cover and prey resources for migrating salmonids.	1	SFB-1.2	WRCS, SRCS, STE	NMFS, USFWS, Corps, DWR, CDFW	1, 3	Long-term						>$100 million (San Francisco Estuary Partnership 2007)
Improve the timing and extent of freshwater flow to the San Francisco Bay region to the	1	SFB-1.3	WRCS, SRCS, STE	USBR, DWR, CDFW, USFWS, NMFS, SWRCB, DSC	1	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
benefit of juvenile and adult salmonids by modifying water operations in the Central Valley to support flows that mimic the natural hydrograph.												
Fund and implement San Francisco Estuary Program's Comprehensive Conservation and Management Program aimed at the Estuary's aquatic resources.	1	SFB-1.4	WRCS, SRCS, STE	San Francisco Estuary Partnership	1, 4	Short-and Long-term components						$60-$80 million[12]
Cities, counties, districts, joint powers authority or other political subdivisions of the State involved with water management in Suisun, San Pablo, and San Francisco bays should	2	SFB-2.1	WRCS, SRCS, STE	CVRWQCB, Agriculture industry	1, 5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on the number of farmed acres that need drainage improvements in order to comply with CVRWQCB regulations. The cost estimates for management

[12] The cost range of $60-$80 million was derived from the 2007 Comprehensive Conservation and Management Plan's Aquatic Resources section. The cost range was identified by summing the cost of actions that were not already covered by actions in this Recovery Plan.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
implement agricultural drainage management projects to treat, store, convey, and/or dispose of agricultural drainage.												practices may range from less than $20/acre to greater than $110/acre per year (CVRWQCB 2012)
Develop a long-term strategy for monitoring and regulating discharges from agricultural lands entering Suisun, San Pablo, and San Francisco bays.	2	SFB-2.2	WRCS, SRCS, STE	SWRCB	1,5	5 Years	$0	$0	$0	$0	$0	$0
Implement projects that would reduce anthropogenic inputs of NH4 to help achieve concentrations below 4 µmol L-1 in order to promote increased primary and secondary production (Dugdale *et al.* 2007).	2	SFB-2.3	WRCS, SRCS, STE	NMFS, USFWS, SWRCB, DWR, CDFW, Local agriculture groups	1,4,5	Long-term						$1 - $2 billion by 2020 to upgrade Sacramento County Regional Water Treatment Plant to reduce discharge limits for nitrogen, ammonia and pathogens[13].

[13] Source: Sacramento Business Journal; http://www.bizjournals.com/sacramento/news/2012/12/05/state-water-sacramento-waste-water-treat.html

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement tidal marsh restoration projects to promote nitrification and retention of NH4 (Dugdale *et al.* 2007).	2	SFB-2.4	WRCS, SRCS, STE	NMFS, USFWS, Corps, CDFW, DWR, Various NGOs	1, 5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD because it is not scientifically practicable to estimate how much restoration is needed to achieve the appropriate NH4 concentrations
Evaluate whether predator control actions (e.g., fishery management or directed removal programs) can be effective at minimizing predation on juvenile salmon and steelhead in Suisun, San Pablo, and San Francisco bays; continue implementation if effective.	2	SFB-2.5	WRCS, SRCS, STE	USFWS, NMFS, USBR, CDFW, DWR, Various NGOs	3	Long-term	$0-$15,000,000[14]	$0-$15,000,000	$0-$15,000,000	$0-$15,000,000	$0-$15,000,000	$0-$75,000,000

[14] If the action is limited to angling regulation changes, the cost is $0; the upper bound ($15,000,000) is based on the cost of the Columbia River pikeminnow bounty program (i.e., $3,000,000/year on average) as identified in NMFS (2011). This recovery plan is not calling for a predator bounty program in the Central Valley, but for the purposes of cost estimation, the Columbia River program's cost is assumed to represent an upper bound for what predator control could cost in the Central Valley.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement studies to develop quantitative estimates of predation on juvenile salmonids by non-native species throughout Suisun, San Pablo, and San Francisco bays.	2	SFB-2.6	WRCS, SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	3	Short-term	$200,000-$400,000	$0	$0	$0	$0	$200,000-$400,000
Implement projects to identify predation "hot spots" throughout Suisun, San Pablo, and San Francisco bays and minimize losses of juvenile salmonids at those locations.	2	SFB-2.7	WRCS, SRCS, STE	DWR, USBR, CDFW, NMFS, USFWS	1,3	Long-term	$5,000-$50,000 for initial hot spot identification ; see total cost for potential site-specific costs	TBD	TBD	TBD	TBD	$5,000-$50,000 for initial hot spot identification. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
												(BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about $38,000 annually (BDCP 2013).
Prevent in-bay disposal of contaminated sediments known to be detrimental to aquatic life.	2	SFB-2.8	WRCS, SRCS, STE	NMFS, Corps, USEPA	5	Long-term	$0	$0	$0	$0	$0	$0
Evaluate, and if feasible implement restoration projects that integrate upland, intertidal, and subtidal habitats; consider the following locations (from California State Coastal Conservancy *et al*. 2010): 1) San Pablo Bay: study potential resources and restoration activities in areas offshore from Sears Point, San Pablo	2	SFB-2.9	WRCS, SRCS, STE	California State Coastal Conservancy, CDFW, Corps, NMFS, USFWS	1	Long-term	TBD	TBD	TBD	TBD	TBD	$5,000-$50,000 for initial scoping and feasibility; total project cost TBD based on the type and amount of habitat that is restored. See Appendix D for unit costs.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Bay National Wildlife Refuge and Tubbs Island, and other restoration sites; 2) Corte Madera area: Muzzi Marsh, Corte Madera Ecological Reserve, Heard Marsh: existing wetlands and restored eelgrass, link to living shoreline project; 3) Richardson Bay: wetland restoration linked to existing oyster/eelgrass populations; 4) Breuner Marsh and Point Molate: link to Point San Pablo eelgrass bed; 5) Eastshore State Park: wetland restoration linked with oyster and eelgrass restoration, creek daylighting; 6) Central and North Bay Islands: link rocky habitat with eelgrass												

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
and oyster beds; and 7) South Bay Salt Pond sites; Eden Landing and other sites: link to southernmost eelgrass population, native oyster restoration.												
Develop and implement education and outreach programs to encourage stewardship of Suisun, San Pablo, and San Francisco bay habitats.	2	SFB-2.10	WRCS, SRCS, STE	NMFS, USFWS, CDFW, DWR	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Develop and implement studies to identify the significance and spatial distribution of marine mammal predation on	3	SFB-3.1	WRCS, SRCS, STE	NMFS, USFWS, USBR, Corps, CDFW, DWR	1,3	Short-term	$1.5 million - TBD					$1.5 million minimum up to TBD [15].

[15] Based on an internet search, no projects have studied pinniped predation on juvenile salmon; as such there is no cost estimate to base the cost of this action on. The cost of studying pinniped predation on adult salmon is roughly estimated at $300,000 annually (Rub 2013); we assume that studying pinniped predation on juvenile salmon is more complicated than adults and thus will be at least as expensive. If the project were conducted for five years, the cost would be at least $1.5 million.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
adult and juvenile anadromous salmonids in Suisun, San Pablo, and San Francisco bays.												
On an annual basis, update the Office of Oil Spill Prevention and Response's Environmental Sensitivity Index maps and GIS maps to include the most current information on locations of sensitive or valued existing or restored subtidal habitats	3	SFB-3.2	WRCS, SRCS, STE	CDFW	3	Long-term	$0	$0	$0	$0	$0	$0

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5.4 Delta Recovery Actions

Table 5-4. Delta Recovery Actions. Adaptively manage these suite of actions to achieve, at a minimum, through-Delta survival objectives of 57% for winter-run, 54% for spring-run, and 59% for steelhead originating from the Sacramento River; and 38% for spring-run and 51% for steelhead originating from the San Joaquin River (NMFS 2012b).

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop, implement, and enforce new Delta flow objectives that mimic historic natural flow characteristics, including increased freshwater flows (from both the Sacramento and San Joaquin rivers) into and through the Delta and more natural seasonal and interannual variability.	1	DEL-1.1	WRCS, SRCS, STE	BDCP agencies and stake holders	1	Long-term, beginning in year 5	$0	$0	$0	$0	$0	$0
Reduce hydrodynamic and biological impacts of exporting water through Jones and Banks pumping plants.	1	DEL-1.2	WRCS, SRCS, STE	USBR, DWR, CDFW, NMFS	1	Long-term						$8.6 billion to $14.5 billion in capital costs (Stapler 2013); $85 million/year operating cost (Medellín-Azuara *et. al* 2013)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Provide pulse flows of approximately 17,000 cfs or higher as measured at Freeport periodically during the winter-run emigration season (i.e., December-April) to facilitate outmigration past Chipps Island.	1	DEL-1.3	WRCS, SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR, SWRCB	1	Long-term	$0	$0	$0	$0	$0	$0
Conduct landscape-scale restoration of ecological functions throughout the Delta to support native species and increase long-term overall ecosystem health and resilience (Whipple *et al.* 2012).	1	DEL-1.4	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	Long-term						$600 million to $13 billion

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop and implement a targeted research and monitoring program to better understand the behavior, movement, and survival of steelhead, spring-run Chinook salmon, and winter-run Chinook salmon emigrating through the Delta from the Sacramento and San Joaquin rivers.	1	DEL-1.5	WRCS, SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	5	Long-term, up to 50 years						$627 million over 50 years[16].

[16] This number is derived from the total estimated cost of monitoring and research as identified in the May 2013 administrative draft of BDCP. It is assumed that the cost estimate provided for BDCP research and monitoring provides a very rough approximation of the cost of action DEL-1.7.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Provide access to new floodplain habitat in the South Delta for migrating salmonids from the San Joaquin system.	1	DEL-1.6	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~20 years						~$950,000,000 [17]
Restore, improve and maintain salmonid rearing and migratory habitats in the Delta and Yolo Bypass to improve juvenile salmonid survival and promote population diversity.	1	DEL-1.7	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	Long-term						Cost of this action is covered by actions DEL – 1.5 and DEL – 1.6.
Restore 17,000 to 20,000 acres of floodplain habitat (NMFS 2009b).	1	DEL-1.8	WRCS, SRCS, STE	USBR, DWR	1	Year 1 through 25	$0	$0	$0	$0	$0	$0

[17] Assumes relocation of approximately 40 miles of existing lower San Joaquin River area levees over 50 years; cost estimate and associated assumptions taken from BDCP revised administrative draft dated May 2013

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Restore Liberty Island, Cache Slough, and the lower Yolo bypass (NMFS 2009b).	1	DEL-1.9	WRCS, SRCS, STE	USBR, DWR	1	Year 1 through 25	$0	$0	$0	$0	$0	$0
Enhance floodplain habitat in lower Putah Creek and along the toe drain (NMFS 2009b).	1	DEL-1.10	WRCS, SRCS, STE	USBR, DWR	1	Year 1 through 25	$0	$0	$0	$0	$0	$0
Implement the Putah Creek Enhancement Project (NMFS 2009b).	1	DEL-1.11	WRCS, SRCS, STE	USBR, DWR	1	Year 1 through 25	$0	$0	$0	$0	$0	$0
Implement the Lisbon Weir Fish Passage Enhancement Project (NMFS 2009b).	1	DEL-1.12	WRCS, SRCS, STE	USBR, DWR	1	Year 1 through 25	$0	$0	$0	$0	$0	$0
Implement the Prospect Island Tidal Habitat Restoration Project.	1	DEL-1.13	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	$16 million	$16 million				$32 million (Riordan 2013) Cost covered by Fish Restoration Program Agreement between CDFW and DWR.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement the Chipps Island Tidal Marsh Restoration Project.	1	DEL-1.14	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	TBD	TBD				<= $15 million[18]
Implement the Eastern Decker Island Tidal Marsh Restoration Project.	1	DEL-1.15	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	TBD	TBD				TBD, based on area of restoration and whether cost can be offset by re-use of excavated material[19]

[18] Chipps Island has 732 acres available for restoration; assuming $20,100/acre for tidal marsh restoration, the maximum cost estimate is roughly $15 million.

[19] Decker Island was formed in the early 1900s when dredged material from the Sacramento River was deposited there. As such, the island is one of the highest places above sea level in the Delta. Restoration of Decker Island to provide fish habitat will involve considerable excavation, and there may or may not be value associated with the excavated material.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement the Southport Floodplain Restoration Project.	1	DEL-1.16	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	$55-$160 million (West Sacramento Area Flood Control Agency 2011)					$55-$160 million (West Sacramento Area Flood Control Agency 2011)
Implement the Dutch Slough Tidal Marsh Restoration Project.	1	DEL-1.17	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	$25 - $30 million in 2005 dollars (California State Coastal Conservancy 2006)					$25 - $30 million in 2005 dollars (California State Coastal Conservancy 2006)
Minimize the frequency, magnitude, and duration of reverse flows in Old and Middle River to reduce the likelihood that fish will be diverted from the San Joaquin or Sacramento rivers into the southern or central Delta (NMFS 2009b).	1	DEL-1.18	WRCS, SRCS, STE	USBR, DWR	1	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Continue to evaluate head of Old River barrier operations to identify and then implement the best alternative for maximizing survival of juvenile steelhead and spring-run Chinook salmon emigrating from the San Joaquin River.	1	DEL-1.19	WRCS, SRCS, STE	USBR, DWR	1	Short-term	$0	$0	$0	$0	$0	$0
Modify Delta Cross Channel gate operations and evaluate methods to control access to Georgiana Slough and other migration routes into the Interior Delta to reduce diversion of listed juvenile fish from the Sacramento River and the San Joaquin River into the southern or central Delta (NMFS (2009b).	1	DEL-1.20	WRCS, SRCS, STE	USBR, DWR	1	Year 1 through 25	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Through additional releases in the San Joaquin River system, augment flows in the southern Delta and curtail exports during critical migration periods (April-May), consistent with a ratio or similar approach.	1	DEL-1.21	WRCS, SRCS, STE	USBR, DWR, MID, Turlock Irrigation District, SWRCB	1	Long-term	$0	$0	$0	$0	$0	$0, no additional cost because additional releases will likely occur via SWRCB water quality objectives; and the export curtailments already occur through the RPA in the CVP/SWP Biological Opinion (NMFS 2009b)
Curtail exports when protected fish are observed at the export facilities to reduce mortality from entrainment and salvage (NMFS (2009b).	1	DEL-1.22	WRCS, SRCS, STE	USBR, DWR	1,5	Year 1 through 25	$0	$0	$0	$0	$0	$0
Improve fish screening and salvage operations to reduce mortality from entrainment and salvage (NMFS (2009b).	1	DEL-1.23	WRCS, SRCS, STE	USBR, DWR	1,5	Year 1 through 25	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Establish a Delta operations technical group to assist in determining real-time operational measures, evaluating the effectiveness of the actions, and modifying them if necessary (NMFS (2009b).	1	DEL-1.24	WRCS, SRCS, STE	USBR, DWR	1,5	Year 1 through 25	$0	$0	$0	$0	$0	$0
Implement the USEPA's Action Plan for addressing water quality concerns in the Bay/Delta (USEPA 2012).	1	DEL-1.25	WRCS, SRCS, STE	USEPA, SWRCB	1,5	Long-term						TBD[20]
Design and implement a project(s) to: (1) allow adult salmonids (and sturgeon) from the Sacramento Deep Water Ship Channel	1	DEL-1.26	WRCS, SRCS, STE	Corps	1	Short-term	TBD; this action requires a yet to be determined unique engineering solution. Initial feasibility	TBD				TBD; this action requires a yet to be determined unique engineering solution. Initial feasibility

[20] The action plan contains seven components, six of which have dedicated funding and would result in no additional cost. A component calling for advanced water quality monitoring and assessment will require some additional funding, but it was not practicable until the multiple entities involved in this component have coordinated to conduct a funding assessment; a funding assessment for this component is planned.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
(SDWSC) to pass the channel gates and enter the Sacramento River (or block adult salmonids from entering the SDWSC); and (2) minimize fish passage from the Sacramento River into the SDWSC.							study is assumed to cost at least $50,000.					study is assumed to cost at least $50,000.
Identify and implement projects designed to improve passage and habitat conditions in the Stockton Deep Water Ship Channel.	1	DEL-1.27	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	1	Long-term	$0	$0	$0	$0	$0	$0
Implement projects to minimize predation at weirs, diversions, and related structures in the Delta.	1	DEL-1.28	WRCS, SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	3	Long-term	$5 million	$5 million	$5 million	$5 million	$5 million	$50 million over 50 years (BDCP 2013)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Establish Vernalis flow criteria that incorporate the flow schedules of the San Joaquin River and tributaries in order to increase juvenile salmonid outmigration survival.	1	DEL-1.29	WRCS, SRCS, STE	USBR, DWR, CDFW, NMFS, USFWS, MID, TID, SWRCB	1	Long-term	$0	$0	$0	$0	$0	$0
Implement integrated flood control improvements along McCormack-Williamson Tract that benefit flood management, aquatic and terrestrial habitats, and species and ecological processes.	2	DEL-2.1	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	$5,000,000	$5,000,000	$0	$0	$0	$10,000,000
Implement restoration projects for Lindsey and Barker sloughs.	2	DEL-2.2	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	$400,000 to $3,400,000 (Solano Land Trust *et al*. 2006)					$400,000 to $3,400,000 (Solano Land Trust *et al*. 2006)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Evaluate the potential effects of reconnecting Elk Slough to the Sacramento River, and if the evaluation suggests that habitat conditions for salmonids would improve, then implement a project to carry out the reconnection (Siegel 2007).	2	DEL-2.3	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	$2,600,000	$2,600,000	$0	$0	$0	$5,200,000
Improve habitat for juvenile salmonids in Elk, Sutter, and Steamboat sloughs (Siegel 2007).	2	DEL-2.4	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	TBD, based on type and extent of habitat improvements ; initial study is expected to cost at least $50,000.	TBD				TBD, based on type and extent of habitat improvements; initial study is expected to cost at least $50,000.
Re-establish hydrologic connectivity between historical Stone Lakes floodplain and the Sacramento River with a design that minimizes juvenile stranding.	2	DEL-2.5	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	TBD; unaware of similar projects to base cost on; initial feasibility study would cost at least $50,000	TBD				TBD; unaware of similar projects to base cost on; initial feasibility study would cost at least $50,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Restore tidal wetlands and associated habitats at Brannan Island State Park, northeast tip of Sherman Island, along Seven-Mile slough, and the southwest tip of Twitchell Island.	2	DEL-2.6	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	TBD, based on type and extent of habitat improvements; initial study is expected to cost at least $50,000.	TBD				TBD, based on type and extent of habitat improvements; initial study is expected to cost at least $50,000.
Implement the Grizzly Slough Floodplain and Riparian Habitat Restoration Project.	2	DEL-2.7	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years						$250,000 - $4,000,000[21]

[21] DWR website identifies 50 additional acres for floodplain restoration at Grizzly Slough (http://www.water.ca.gov/floodsafe/fessro/environmental/dee/grizzlyslough.cfm).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement the Meins Landing Tidal Habitat Restoration Project.	2	DEL-2.8	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	TBD, based on extent and type of habitat restoration; initial study is expected to cost at least $50,000.	TBD				TBD, based on extent and type of habitat restoration; initial study is expected to cost at least $50,000.
Implement the Hill Slough Tidal Habitat Restoration Project.	2	DEL-2.9	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	TBD, based on extent and type of habitat restoration; initial study is expected to cost at least $50,000.	TBD				TBD, based on extent and type of habitat restoration; initial study is expected to cost at least $50,000.
Implement the Tule Red Restoration Project.	2	DEL-2.10	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	TBD, based on extent and type of habitat restoration; initial study is expected to cost at least $50,000.	TBD				TBD, based on extent and type of habitat restoration; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement the Rush Ranch Tidal Habitat Restoration Project.	2	DEL-2.11	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS	1	~10 years	TBD, based on extent and type of habitat restoration; initial study is expected to cost at least $50,000.	TBD				TBD, based on extent and type of habitat restoration; initial study is expected to cost at least $50,000.
Evaluate whether predator control actions (e.g., fishery management or directed removal programs) can be effective at minimizing predation on juvenile salmon and steelhead in the Delta.	2	DEL-2.12	WRCS, SRCS, STE	CDFW, Sport fishing community	3	Long-term						Cost covered by the cost of SFB-2.5 ($0-$75,000,000).
Modify existing water control structures to maintain flows through isolated ponds in the Yolo Bypass to minimize fish stranding, particularly following the cessation of flood flows over the Fremont Weir.	2	DEL-2.13	WRCS, SRCS, STE	TCCA, USBR, DWR, CDFW, NMFS, USFWS	1	Short-term	TBD, based on type and number of modifications; initial study is expected to cost at least $50,000.	TBD				TBD, based on type and number of modifications; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Modify Reclamation District 2068 levees to provide rearing and predator refuge habitat for juvenile salmonids.	2	DEL-2.14	WRCS, SRCS, STE	Corps	1	~10 years	TBD	TBD				TBD based on the amount and type of habitat to be restored.
Utilize bio-technical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip rap.	2	DEL-2.15	WRCS, SRCS, STE	Corps	1	Long-term	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement to stop illegal rip rap applications in the Delta.	2	DEL-2.16	WRCS, SRCS, STE	CDFW, NMFS, Corps	1,4	Long-term						Cost is covered under action # COC-2.9 ($1,750,000)
Curtail further development in active Delta floodplains through zoning restrictions, county master plans and other Federal, State, and county planning and regulatory processes, and land protection agreements.	2	DEL-2.17	WRCS, SRCS, STE	Contra Costa, Solano, Yolo, Sacramento, and San Joaquin counties. DRN, DSC	1	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Prioritize and screen Delta diversions.	2	DEL-2.18	WRCS, SRCS, STE	DSC, DRN, Corps, DWR, USBR, USFWS, CDFW, NMFS, local counties	1	Long-term	$100,000 for monitoring program; screening costs for Delta Diversions are TBD.	$0	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is estimated at $20 million (San Francisco Estuary Partnership 2007).
Implement management actions for addressing invasive aquatic species including those described in the California Aquatic Invasive Species Management Plan.	2	DEL-2.19	WRCS, SRCS, STE	Department of Boating and Waterways	1	Long-term	$51,000,000	$125,000,000	$125,000,000	$125,000,000	$125,000,000	$551,000,000
Implement projects that improve wastewater and stormwater treatment throughout the Delta and surrounding residential and commercial areas.	2	DEL-2.20	WRCS, SRCS, STE	NMFS, USFWS, SWRCB, CVRWCB, DWR, CDFW, Local governments	1, 5	Long-term						Cost is covered under action SFB-2.3 ($1 - $2 billion by 2020 to upgrade Sacramento County Regional Water Treatment Plant to reduce discharge limits for

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
												nitrogen, ammonia and pathogens[22]).
Review and potentially update the through-Delta survival rate objectives included in this recovery plan as new information is obtained.	2	DEL-2.21	WRCS, SRCS, STE	NMFS, CDFW, DSC, USFWS	1	Long-term	$0	$0	$0	$0	$0	$0
Develop regional agreements on geographic boundaries for estimating through-Delta survival, and appropriate technologies for collecting the required empirical data.	2	DEL-2.22	WRCS, SRCS, STE	NMFS, CDFW, DSC, USFWS	5	Long-term	$0 for agreement development; TBD for technology development	$0 for agreement development; TBD for technology development	$0 for agreement development; TBD for technology development	$0 for agreement development; TBD for technology development	$0 for agreement development; TBD for technology development	$0 for agreement development; TBD for technology development

[22] Source: Sacramento Business Journal; http://www.bizjournals.com/sacramento/news/2012/12/05/state-water-sacramento-waste-water-treat.html

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Explore and support the development of existing or innovative approaches and tools for centralized tracking of restoration efforts in the Delta.	2	DEL-2.24	WRCS, SRCS, STE	Delta Conservancy, DWR, USBR, CDFW, NMFS Delta land owners	1,5	Long-term	$0	$0	$0	$0	$0	$0
Coordinate efforts to identify and highlight funding needs for restoration planning, monitoring, tracking, synthesis and adaptive management in the near and long term.	2	DEL-2.25	WRCS, SRCS, STE	Delta Conservancy, DWR, USBR, CDFW, NMFS Delta land owners	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop outreach strategies and mechanisms to ensure the Delta community, the legislature, appropriate agencies and the public are regularly updated on actions related to restoration and recovery.	2	DEL-2.26	WRCS, SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR, Various NGOs	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop and implement education and outreach programs to encourage river stewardship.	2	DEL-2.27	WRCS, SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR, Various NGOs	1,5	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Cities, counties, districts, joint powers authority or other political subdivisions involved with water management should implement agricultural drainage management projects to treat, store, convey, and/or dispose of agricultural drainage.	2	DEL-2.28	WRCS, SRCS, STE	CVRWQ CB, Delta farmers	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on the number of farmed acres that need drainage improvements in order to comply with CVRWQCB regulations. The cost estimates for management practices may range from less than $20/acre to greater than $110/acre per year (CVRWQCB 2012)
Continue development of a long-term strategy for monitoring and regulating discharges from agricultural lands to protect waters within the Central Valley, including	2	DEL-2.29	WRCS, SRCS, STE	CVRWQ CB	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
enforcing the regulations.												
Increase monitoring and enforcement in the Delta to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants (SWRCB 2007).	2	DEL-2.30	WRCS, SRCS, STE		1,5	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)
Implement projects that would reduce anthropogenic inputs of NH4 to help achieve concentrations below 4 µmol L-1 in order to promote increased primary and secondary production (Dugdale *et al.* 2007).	2	DEL-2.31	WRCS, SRCS, STE	Sacramento Regional County Sanitation District	1	Long-term						Cost is covered under action SFB-2.3 ($1 to $2 billion by 2020).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Continue to operate the Suisun Marsh Salinity Control Structure with the boat lock open in order to allow fish passage in and out of Suisun Marsh.	3	DEL-3.1	WRCS, SRCS, STE	DWR and USBR	1,5	Long-term	$0	$0	$0	$0	$0	$0

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5.5 Mainstem Sacramento River Recovery Actions

Table 5-5. Mainstem Sacramento River Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop and implement a program to reintroduce winter-run Chinook salmon, spring-run Chinook salmon, and steelhead to historic habitats upstream of Shasta Dam. The program should include feasibility studies, habitat evaluations, fish passage design studies, and a pilot reintroduction phase prior to implementation of the long-term reintroduction program.	1	SAR-1.1	WRCS, SRCS, STE	USBR, NMFS, CDFW, DWR, USFWS, PG&E, FERC	1,5	Long-term:	$200,000	$4,000,000	$15,000,000	$17,000,000	$14,000,000	$50,200,000
Restore and maintain riparian and floodplain ecosystems along both banks of the Sacramento River to provide a diversity of habitat types including riparian forest, gravel bars and bare cut banks, shady vegetated banks, side	1	SAR-1.2	WRCS, SRCS, STE	USBR, NMFS, CDFW, DWR, USFWS	1,4	~10 years	$19,532,500	$22,579,570	$0	$0	$0	$42,112,070

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
channels, and sheltered wetlands, such as sloughs and oxbow lakes following the guidance of the Sacramento River Conservation Area Handbook (Resources Agency of the State of California 2003).												
Identify and implement any required projects to assure the M&T Ranch water diversion is adequately screened to protect winter-run Chinook salmon, spring-run Chinook salmon, and steelhead.	1	SAR-1.3	WRCS, SRCS, STE	NMFS, USBR, USFWS, and M&T Ranch	1,5	< 5 years	$9,500,000	$0	$0	$0	$0	$9,500,000
Develop and implement a river flow management plan for the Sacramento River downstream of Shasta and Keswick dams that considers the effects of climate change and balances beneficial uses with the flow and water temperature	1	SAR-1.4	WRCS, SRCS, STE	NMFS, USBR, USFWS, DWR, CDFW	1,5	Short-term	$740,150	$0	$0	$0	$0	$740,150

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
needs of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead. The flow management plan should consider the importance of instream flows as well as the need for floodplain inundation (Williams *et al.* 2009).												
Install NMFS-approved, state-of-the-art fish screens at the Tehama Colusa Canal diversion. Implement term and condition 4c from the biological opinion on the Red Bluff Pumping Plant Project, which calls for monitoring, evaluating, and adaptively managing the new fish screens at the Tehama Colusa Canal diversion to ensure the screens are working properly and impacts to listed species are minimized (NMFS	1	SAR-1.5	WRCS, SRCS, STE	DWR, USBR, TCCA	1,4,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
2009c).												
Develop and implement a long-term gravel augmentation plan consistent with CVPIA to increase and maintain spawning habitat for winter-run Chinook salmon, spring-run Chinook salmon, and steelhead downstream of Keswick Dam.	1	SAR-1.6	WRCS, SRCS, STE	CDFW, NMFS, USBR, USFWS	1,5	Long-term	$380,000	$439,280	Up to ~$500,000	Up to ~$500,000	Up to ~$500,000	Up to ~$2,319,280
Develop and implement a secondary fish trapping location for the Livingston Stone NFH winter-run Chinook salmon supplementation	1	SAR-1.7	WRCS, SRCS, STE	NMFS, USFWS, USBR	1,5	Long-term						Up to $27,400,000 to build secondary facility[23]; Assuming the facility will require two to ten FTE's, operational costs

[23] The Minto Salmon and Steelhead Collection Facility on western Oregon's North Santiam River was rebuilt at a cost of $27,400,000 (http://www.cbbulletin.com/426310.aspx).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
program to provide increased opportunity to capture a spatially representative sample and target numbers of broodstock.												will range from approximately $138,600 to $693,000 per year[24]
Study the merits and investigate feasibility of modifying the altered channel morphology at Turtle Bay in Redding to eliminate the gravel "sink" created by historic gravel mining activities. If the study suggests that it is feasible to modify the channel morphology such that it is beneficial to spawning gravel augmentation efforts, then implement the channel modification project.	1	SAR-1.8	WRCS, SRCS, STE	USFWS, NMFS, DFG, USBR	1	Long-term	>$110,000					>$110,000[25]

[24] Based on the May 2012 State Occupational Employment and Wage Estimates for California provided by the Bureau of Labor Statistics, the mean annual wage for a biologist is $69,000 (http://www.bls.gov/oes/current/oes_ca.htm#19-0000).

[25] A channel morphology study on the Yuba River was estimated at between $110,000 and $150,000; because action SAR-1.8 calls for studying the channel morphology and potentially modifying the channel, the Turtle Bay action will be at least as expensive as the Yuba project.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Investigate mechanisms to influence/stimulate anadromy in *O. mykiss* in the upper Sacramento River.	1	SAR-1.9	STE	NMFS SWRFSC, CDFW	1,5	~5 years	$100,000 - $1,000,000	$0	$0	$0	$0	$100,000 - $1,000,000
Operate and maintain temperature control curtains in Lewiston and Whiskeytown Reservoirs to minimize warming of water from the Trinity River and Clear Creek.	1	SAR-1.10	WRCS, SRCS, STE	USBR	1,5	Long-term	$150,000 for inspections. Up to $~17,000 to repair one rip in the curtain; repair cost TBD based on inspections	$150,000 for inspection. Up to $~17,000 to repair one rip in the curtain; repair cost TBD based on inspections	$150,000 for inspection. Up to $~17,000 to repair one rip in the curtain; repair cost TBD based on inspections	$150,000 for inspection. Up to $~17,000 to repair one rip in the curtain; repair cost TBD based on inspections	$150,000 for inspection. Up to $~17,000 to repair one rip in the curtain; repair cost TBD based on inspections	$750,000 for inspection; repair costs TBD based on inspections. Whiskeytown curtain was replaced in 2012 at a cost of $3.5 million. Replacement needed roughly every 15 years. Lewiston curtain is less susceptible to damage than Whiskeytown, but if it needs to be replaced, cost would be ~$1.5 million.
Avoid full power peaking at Trinity and Carr Power plants during sensitive periods for water temperatures to reduce water temperatures in the Sacramento River. Evaluate impacts of power	1	SAR-1.11	WRCS, SRCS, STE	USBR, USFWS, NMFS	5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD; NMFS is in the process of obtaining the information from USBR.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
peaking operations in the Trinity River, Sacramento River and Clear Creek.												
In an adaptive management context, implement short- and long-term solutions to minimize the loss of adult Chinook salmon and steelhead in the Yolo bypass, and Colusa and Sutter-Butte basins. Solutions include: • Re-operating, to the extent feasible, the Knights Landing outfall gates to help prevent listed fish from entering the Colusa Basin (short-term); • Monitoring the Colusa and Sutter-Butte basins during winter and spring for adult salmon presence, and conducting fish rescues as necessary (short-term);	1	SAR-1.12	WRCS, SRCS, STE	CDWF, DWR, USFWS, NMFS, USBR, GCID, RD 108	1	Short- and long-term components	If fish rescues are needed, cost is estimated at ~$100,000 based on the 2013 rescue. Providing and/or improving fish passage through the Yolo Bypass and Sutter Bypass is required by the 2009 CVP/SWP biological opinion and therefore is estimated at $0. NMFS is in the process of obtaining cost information for this	Same as for FY1-5.	Same as for FY1-5.	Same as for FY1-5.	Same as for FY1-5.	If fish rescues are needed, cost is estimated at ~$100,000 based on the 2013 rescue. Providing and/or improving fish passage through the Yolo Bypass and Sutter Bypass is required by the 2009 CVP/SWP biological opinion and therefore is estimated at $0. NMFS is in the process of obtaining cost information for this action from DWR

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
• Evaluating other potential Colusa Basin Drain entry points for adult salmon along the Sacramento River above Knights Landing, and implementing fish exclusion solutions if necessary (short-term); • Providing and/or improving fish passage through the Yolo Bypass and Sutter Bypass allowing for improved adult salmonid re-entry into the Sacramento River (long-term); and • Installing fish exclusion devices at strategic locations to reduce migration of listed, adult salmonids into the Colusa Basin Drain complex (long-term); locations include,							action from DWR					

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
but are not limited to: • in the Yolo Bypass Tule Canal or Knights Landing Ridge Cut, downstream of Wallace Weir; • just upstream of the Knights Landing outfall gates (Colusa Basin side), provided that the reoperation of the Knights Landing outfall gates and/or the exclusionary device downstream of Wallace Weir fail to block migration of adults into the Colusa Basin Drain; and • at the Knights Landing outfall gates (Sacramento River side), provided that the reoperation of the Knights Landing outfall gates is ineffective.												
Identify management targets for Yolo and Sutter bypass inundation timing,	1	SAR-1.13	WRCS, SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR,	1	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
frequency, magnitude, and duration that will maximize the growth and survival of juvenile winter-run Chinook salmon and spring-run Chinook salmon; and then manage the bypasses to those targets.				SWRCB								
Ensure that river bank stabilization projects along the Sacramento River utilize bio-technical techniques that restore riparian habitat, rather than solely using the conventional technique of adding rip rap.	2	SAR-2.1	WRCS, SRCS, STE	Corps, USBR, NMFS, USFWS, DWR, CDFW,	1,5	Long-term	$0	$0	$0	$0	$0	$0
Curtail further development in active Sacramento River floodplains through zoning restrictions, county master plans, and other Federal, State, and county planning and regulatory processes.	2	SAR-2.2	WRCS, SRCS, STE	Corps, NMFS, USFWS, DWR, CDFWS, Local governments	1,4,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Increase monitoring and enforcement to minimize illegal streambank alterations along the Sacramento River.	2	SAR-2.3	WRCS, SRCS, STE	Corps, SWRCB, CDFW	1,5	Long-term						Cost is covered under action # COC-2.9
Develop and implement education and outreach programs to encourage river stewardship along the Sacramento River. Implement outreach projects to educate the public regarding the salmon life cycle including how to identify a salmon redd.	2	SAR-2.4	WRCS, SRCS, STE	USBR, NMFS, USFWS, CDFW, DWR, Various NGOs	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Improve wastewater and stormwater treatment in residential, commercial, and industrial areas within the Sacramento River watershed.	2	SAR-2.5	WRCS, SRCS, STE	NMFS, USFWS, SWRCB, CVRWCB, DWR, CDFW, Local governments	1, 5	Long-term						Cost partially covered in DEL-2.20 ($1-$2 billion). Other costs TBD based on site-specific evaluations, each of which could range up to $100,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Increase monitoring and enforcement to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants entering the Sacramento River.	2	SAR-2.6	WRCS, SRCS, STE	Corps, SWRCB, USBR, CDFW	4,5	Long-term	$350,000[26]	$350,000	$350,000	$350,000	$350,000	$1,750,000
Develop a long-term strategy for reducing water quality impacts to the Sacramento River from agricultural lands. The strategy should include incentive-based projects to promote implementation of best management practices as well as enforcement actions to ensure compliance with existing regulations.	2	SAR-2.7	WRCS, SRCS, STE	SWRCB, CVRWQCB, USEPA	5	Long-term	$0	$0	$0	$0	$0	$0

[26] Assuming 1 new full time equivalent at $70,000/year, based on the average salary for a California Fish and Game warden as identified on the Bureau of Labor statistics website (http://www.bls.gov/oes/current/oes_ca.htm#19-0000).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement projects that promote native riparian (e.g., willows) species including eradication projects for non-native species (e.g., Arundo, tamarisk).	2	SAR-2.8	WRCS, SRCS, STE	NMFS, USBR Districts, DWR, Corps	5	Long-term	$0	$0	$0	$0	$0	$0
Implement studies designed to quantify the amount of predation on winter-run Chinook salmon, spring-run Chinook salmon, and steelhead by non-native species in the Sacramento River. If the studies identify predator species and/or locations contributing to low salmonid survival, then evaluate whether predator control actions (e.g., fishery management or directed removal programs) can be effective at minimizing predation on juvenile salmon and steelhead in	2	SAR-2.9	WRCS, SRCS, STE	NMFS SWRFSC, CDFW	2	Long-term						Cost covered by the cost of SFB-2.5 ($0-$75,000,000).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
the Sacramento River; continue implementation if effective.												
Implement projects to minimize predation at weirs, diversions, and related structures in the Sacramento River.	2	SAR-2.10	WRCS, SRCS, STE	NMFS, CDFW, DWR, USFWS, USBR, Corps	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs.	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
												cost about $38,000 annually (BDCP 2013).
Improve instream refuge cover in the Sacramento River for salmonids to minimize predatory opportunities for striped bass and other non-native predators.	2	SAR-2.11	WRCS, SRCS, STE	USCOE, DWR, NMFS	1,3,4	Long-term	TBD, based on the # of sites, # of miles, type of material, location of source material (onsite vs. imported), and placement method. Initial scoping to address those issues would cost at least $50,000. See Table H1-2 in Appendix D for cost per unit for various projects.	TBD	TBD	TBD	TBD	TBD, based on the # of sites, amount of material needed, type of material, location of source material (onsite vs. imported), and placement method. Initial scoping to address those issues would cost at least $50,000. See Table H1-2 in Appendix D for cost per unit for various projects.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop an incentive-based entrainment monitoring program in the Sacramento River designed to work cooperatively with diverters to develop projects or actions in order to minimize pumping impacts.	2	SAR-2.12	WRCS, SRCS, STE	USFWS, USBR, Family Alliance, DWR, CDFW, farmers, local govt, Northern California Water Association	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop and apply alternative diversion technologies that reduce entrainment.	2	SAR-2.13	WRCS, SRCS, STE	USBR and agricultural interests	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD. •This action involves development of a new technology such that is impracticable to provide a reasonable estimate of the action's cost.
Maintain remedial actions to reduce heavy metal containments from Iron Mountain Mine.	2	SAR-2.14	WRCS, SRCS, STE	USEPA, NMFS, DFG, USBR	5	Long-term	$0	$0	$0	$0	$0	$0
Restore the current Lake Red Bluff footprint to riparian habitat, consistent with flood control needs.	2	SAR-2.15	WRCS, SRCS, STE	USFS, USBR, USFWS	1	Short-term	$5,000-$6,750,000, depending on whether just a small portion or the entire footprint is restored.	$0	$0	$0	$0	$5,000-$6,750,000, depending on whether just a small portion or the entire footprint is restored.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop criteria and a process for phasing out the Livingston Stone winter-run Chinook salmon hatchery program as winter-run recovery criteria are reached. This hatchery program is expected to play a continuing role as a conservation hatchery to help recover winter-run Chinook salmon.	2	SAR-2.16	WRCS, SRCS, STE	USFWS, NMFS, CDFW	5	Short-term	$0	$0	$0	$0	$0	$0
Evaluate and reduce stranding of juvenile Chinook in side channels in the reach from Keswick Dam to Colusa, due to flow reductions from Keswick Reservoir, by increasing or stabilizing releases from the reservoir.	2	SAR-2.17	WRCS, SRCS, STE	USBR, USFWS, DFG	1,5	Short-term	$0	$0	$0	$0	$0	$0
Using an adaptive approach and pilot studies, determine if instream habitat for juvenile rearing is limiting salmonid populations, by placing juvenile-rearing-enhancement	2	SAR-2.18	WRCS, SRCS, STE	NMFS SWRFSC, DFG, USFWS	1	Short-term	TBD based on the scope of pilot and full studies; pilot study is assumed to cost at least $50,000; overall cost	TBD	$0	$0	$0	TBD based on the scope of pilot and full studies; pilot study is assumed to cost at least $50,000; overall cost will also depend on the amount and type of instream habitat that is

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
structures in the Sacramento River. If found to be limiting, add large woody debris / coarse organic material to the upper, middle and lower reaches of Sacramento River to increase the quantity and quality of juvenile rearing habitat.							will also depend on the amount and type of instream habitat that is restored, if any.					restored, if any.
Assess the impacts to development, migration, and predation on juvenile salmonids from artificial light sources (e.g., Sundial Bridge) and take appropriate action based on the findings.	2	SAR-2.19	WRCS, SRCS, STE	DFG, local govt.	1,5	Short-term	$0	$0	$0	$0	$0	$0

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5.6 Northwestern California Diversity Group Recovery Actions

5.6.1 Clear Creek Recovery Actions

Table 5-6. Clear Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration (years)	~Cost FY 1-5	~Cost FY 6-10	~Cost FY 11-15	~Cost FY 16-20	~Cost FY 21-25	Total ~Cost
Operate the Clear Creek segregation weir to create reproductive isolation between fall-run Chinook salmon and spring-run Chinook salmon.	1	CLC -1.1	SRCS STE	USFWS	1,4	Long-term	$0	$0	$0	$0	$0	$0
Develop a new spawning gravel budget and implement a long-term gravel augmentation plan in Clear Creek, including acquisition of a long-term gravel supply (per CVPIA and RPA action I.1.3 of the 2009 Biological Opinion for the long-term operations of the CVP and SWP (NMFS 2009b).	1	CLC -1.2	SRCS STE	USBR, USFWS	1,5	Long-term	$0	$0	$0	$0	$0	$0
Manage releases from Whiskeytown Dam with instream flow schedules and criteria to provide suitable water temperatures for all life stages, reduce stranding and isolation, protect incubating eggs from being dewatered, and promote habitat quality and availability as described in RPA action I.1.6 of the 2009 Biological Opinion for the long-term operations of the CVP and SWP (NMFS 2009b).	1	CLC -1.3	SRCS STE	USBR, USFWS, Clear Creek Technical Team	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration (years)	~Cost FY 1-5	~Cost FY 6-10	~Cost FY 11-15	~Cost FY 16-20	~Cost FY 21-25	Total ~Cost
Develop water temperature models to improve Clear Creek water temperature management as described in RPA action I.1.5 of the 2009 Biological Opinion for the long-term operations of the CVP and SWP (NMFS 2009b).	1	CLC -1.4	SRCS STE	USBR, USFWS, NMFS	5	Short-term	$0	$0	$0	$0	$0	$0
Adaptively manage Whiskeytown Reservoir releases and water temperatures to evaluate whether anadromy in *O. mykiss* can be increased, without causing adverse impacts to other species.	1	CLC -1.5	STE	USBR, USFWS, NMFS	1	Long-term	$0	$0	$0	$0	$0	$0
Implement channel maintenance flows in Clear Creek called for in the CVP/SWP biological opinion (NMFS 2009b, Action I.1.2).	1	CLC -1.6	SRCS STE	USBR, USFWS, NMFS	1	Long-term	$0	$0	$0	$0	$0	$0
Enhance watershed resiliency in Clear Creek by identifying and implementing projects that would reduce the potential for, and magnitude of wildfires, including projects to restore meadows and forested areas.	2	CLC -2.1	STE	NMFS, USFWS, USBR, CDFW, BLM	1,5	Long-term	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBE	TBD	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.
Implement the Clear Creek pulse flows called for in the CVP/SWP biological opinion (NMFS 2009b, Action I.1.1), utilizing adaptive management to adjust pulse timing, magnitude, and/or duration, as needed, to be most effective at attracting adult spring-run Chinook salmon.	2	CLC -2.2	SRCS STE	USBR and Clear Creek Technical Team	1,4,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration (years)	~Cost FY 1-5	~Cost FY 6-10	~Cost FY 11-15	~Cost FY 16-20	~Cost FY 21-25	Total ~Cost
Implement floodplain restoration projects, potentially including the Lower Clear Creek Floodway Rehabilitation Project (Phase 3C).	2	CLC-2.3	SRCSSTE	Shasta Resource Conservation District, BLM, Lower Clear Creek Watershed Group, City of Redding	1,5	Part of the Lower Clear Creek Floodway Rehabilitation Project has been completed. Additional projects could occur over the next 10 years.	TBD, based on amount of floodplain habitat restored; initial study is expected to cost at least $50,000.	TBD	$0	$0	$0	TBD, based on amount of floodplain habitat restored; initial study is expected to cost at least $50,000.
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in Clear Creek.	2	CLC-2.4	SRCSSTE	NMFS, Corps, USBR, Resource Conservancy, CDFW, DWR, BLM, Landowners, Local governments, NGOs	1,4,5	Short-term	$62,400	$0	$0	$0	$0	$62,400
Develop programs and implement projects for Clear Creek that promote natural river processes, including projects that restore floodplain habitat (e.g., Cloverview project and Paige Bar floodplain lowering project), add riparian habitat and instream cover, and control non-native invasive plant species.	2	CLC-2.5	SRCSSTE	Corps, USFWS, DWR, CDFW, BLM, Local agencies, NGOs	1,5	Long-term	<$5,000,000	<$5,000,000	<$5,000,000	<$5,000,000	$0	<$20,000,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration (years)	~Cost FY 1-5	~Cost FY 6-10	~Cost FY 11-15	~Cost FY 16-20	~Cost FY 21-25	Total ~Cost
Develop education and outreach programs to encourage river stewardship in Clear Creek.	2	CLC -2.6	SRCS STE	USFWS, USFS, USEPA, Resource Conservation District, BLM, CDFW, Landowners	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Continue to minimize sources of sediment delivered to Clear Creek from roads and other near stream development by out-sloping roads, constructing diversion prevention dips, replacing under-sized culverts and applying other erosion prevention guidelines.	2	CLC -2.7	SRCS STE	NMFS, USFWS, USFS, CDFW, BLM	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop a long-term operation and maintenance agreement for the segregation weir in Clear Creek.	2	CLC -2.8	SRCS STE	NMFS, USFWS, SWRCB, BLM, CDFW, Local governments	1,5	Short-term	$0	$0	$0	$0	$0	$0
Ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met in Clear Creek for all potential pollutants.	3	CLC -3.1	SRCS STE	SWRCB, CVRWQCBs, Local agriculture groups	1,4	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration (years)	~Cost FY 1-5	~Cost FY 6-10	~Cost FY 11-15	~Cost FY 16-20	~Cost FY 21-25	Total ~Cost
Utilize bio-technical techniques that integrate riparian restoration into bank stabilization projects that may be implemented in the future, instead of conventional rip rap.	3	CLC -3.2	SRCS STE	Corps, USBR, NMFS, USFWS, BLM, CDFW, CBDA	1,5	Long-term	$0	$0	$0	$0	$0	$0
Curtail further development in active Clear Creek floodplains through zoning restrictions, county master plans, and other Federal, State, and county planning and regulatory processes.	3	CLC -3.3	SRCS STE	Corps, NMFS, USFWS, USFS, BLM, CDFW, Local governments	1,4,5	Long-term	$0	$0	$0	$0	$0	$0
Permanently protect Clear Creek riparian and floodplain habitat through easements and/or land acquisition.	3	CLC -3.4	SRCS STE	County, BLM,. CDFW, Tribal, Local owners	1,5	Long-term	TBD, based on specific easements and land acquisitions ; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD, based on specific easements and land acquisitions ; initial study is expected to cost at least $50,000.
Monitor and evaluate the sport fishing regulations for Clear Creek to ensure they are consistent with the recovery of spring-run Chinook salmon and steelhead. Work with the Fish and Game Commission to modify the regulations as needed.	3	CLC -3.5	SRCS STE	NMFS, CDFW	2	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration (years)	~Cost FY 1-5	~Cost FY 6-10	~Cost FY 11-15	~Cost FY 16-20	~Cost FY 21-25	Total ~Cost
Negotiate agreements with Federal and State agencies to provide additional instream flows in Clear Creek.	3	CLC-3.6	SRCSSTE	NMFS, Corps, USBR, Resource Conservation Districts, CDFW, DWR, Water districts, Landowners, Local governments, NGOs	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of water. Cost per unit is $43 - $88/af/year for upstream of Delta water purchases (Appendix D)

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5.6.2 Cottonwood/Beegum Creek Recovery Actions

Table 5-7. Cottonwood/Beegum Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY 6-10	~ Cost FY 11-15	~ Cost FY 16-20	~ Cost FY 21-25	Total ~ Cost
Enhance watershed resiliency in Beegum Creek and the greater Cottonwood watershed by identifying and implementing projects that would reduce the potential for, and magnitude of a catastrophic wildfire, restore meadows to potentially increase summer flows and reduce local water temperatures, or increase riparian shade.	2	CBC-2.1	SRCS STE	NMFS, USFWS, USFS, CDFW, DWR, Cottonwood Creek Watershed Group	1,5	Long-term	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBE	TBD	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.
Develop and implement a spawning gravel augmentation plan in Beegum Creek.	2	CBC-2.2	SRCS STE	NMFS, USFWS, USFS, CDFW, DWR, Cottonwood Creek Watershed Group	1,5	Long-term	$50,000 for plan development; gravel augmentation costs TBD	TBD	TBD	TBD	TBD	$50,000-TBD
Protect/enhance existing riparian habitat and corridors in Beegum Creek and the greater Cottonwood watershed .	2	CBC-2.3	SRCS STE	NMFS, USFWS, USFS, CDFW, DWR, Cottonwood Creek Watershed Group	1	Long-term	$5,000-$50,000 for initial scoping; habitat protection costs TBD	TBD	TBD	TBE	TBD	$5,000-$50,000 for initial scoping; habitat protection costs TBD, based on amount of habitat protected or enhanced. As identified in Appendix D, per unit

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY 6-10	~ Cost FY 11-15	~ Cost FY 16-20	~ Cost FY 21-25	Total ~ Cost
												costs vary depending on whether fencing, planting, irrigation, or invasive weed control are needed.
Apply NMFS gravel mining criteria to all gravel mining projects in Beegum Creek and the greater Cottonwood watershed.	2	CBC-2.4	SRCS STE	NMFS, USFWS, USFS, CDFW, DWR, Cottonwood Creek Watershed Group	1,5	Long-term	$0	$0	$0	$0	$0	$0
Integrate riparian habitat restoration into bank protection and other stream side development projects in Beegum Creek and the greater Cottonwood watershed.	2	CBC-2.5	SRCS STE	NMFS, USFWS, USFS, CDFW, DWR, Cottonwood Creek Watershed Group	1	Long-term	$0	$0	$0	$0	$0	$0
Implement a non-native plant (e.g. Arundo) eradication plan in Beegum Creek and the greater Cottonwood watershed.	3	CBC-3.1	SRCS STE	NMFS, USFWS, USFS, CDFW, DWR, Cottonwood Creek Watershed Group	1	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY 6-10	~ Cost FY 11-15	~ Cost FY 16-20	~ Cost FY 21-25	Total ~ Cost
Utilize bio-technical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip rap in Beegum Creek and the greater Cottonwood watershed.	3	CBC-3.2	SRCS STE	NMFS, USFWS, USFS, CDFW, DWR, Cottonwood Creek Watershed Group	1	Long-term	$0	$0	$0	$0	$0	$0
Curtail further development in active Beegum and the greater Cottonwood watershed floodplains through zoning restrictions, county master plans, and other Federal, State, and county planning and regulatory processes.	3	CBC-3.3	SRCS STE	NMFS, USFWS, USFS, CDFW, DWR, Cottonwood Creek Watershed Group, Local governments	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop education and outreach programs to encourage river stewardship in the Beegum and the greater Cottonwood Creek watershed.	3	CBC-3.4	SRCS STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Districts, CDFW, DWR, Landowners, Cottonwood Creek Watershed Group	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY 6-10	~ Cost FY 11-15	~ Cost FY 16-20	~ Cost FY 21-25	Total ~ Cost
Permanently protect Cottonwood and Beegum Creek riparian habitat through easements and/or land acquisition	3	CBC-3.5	SRCS STE	NMFS, USFWS, USFS, CDFW, DWR, Cottonwood Creek Watershed Group	1,5	Long-term	TBD, based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD, based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Continue to implement projects designed to minimize chronic road-related erosion on public and private lands in the Cottonwood and Beegum watersheds.	3	CBC-3.6	SRCS STE	NMFS, USFWS, USFS, CDFW, Cottonwood Creek Watershed Group	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop cooperative water use agreements with landowners and Federal and State agencies to provide additional instream flows or purchase water rights in Cottonwood Creek.	3	CBC-3.7	SRCS STE	NMFS, Corps, USBR, Resource Conservation Districts, CDFW, DWR, Water districts, Landowners, Local governments, NGOs	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of water. Cost per unit is $43 - $88/af/year for upstream of Delta water purchases (Appendix D)
Develop a baseline monitoring program for Beegum Creek to evaluate water quality throughout the watershed to identify areas of concern.	3	CBC-3.8	SRCS STE	NMFS, USFWS, SWRCB, DWR, CDFW, Local governments	1,5	3 Years	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY 6-10	~ Cost FY 11-15	~ Cost FY 16-20	~ Cost FY 21-25	Total ~ Cost
Encourage voluntary landowner participation in Beegum Creek in educational opportunities such as water quality short courses, field demonstrations and distribution of water quality "Fact Sheets".	3	CBC-3.9	SRCS STE	NMFS, USFWS, USEPA, Resource Conservation Districts, CDFW, DWR, Landowners	2	Long-term	$32,260	$32,260	$32,260	$32,260	$0	$129,040
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in Beegum Creek.	3	CBC-3.10	SRCS STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW, Landowners	1,5	Short-term	$62,400	$0	$0	$0	$0	$62,400
Implement projects to minimize predation at weirs, diversion dams, and related structures in Cottonwood/Beegum Creek.	3	CBC-3.11	SRCS STE	NMFS, CDFW, DWR, USFWS, USBR, Corps	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs.	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY 6-10	~ Cost FY 11-15	~ Cost FY 16-20	~ Cost FY 21-25	Total ~ Cost
												identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about $38,000 annually (BDCP 2013).
Improve instream refuge cover for salmonids in Cottonwood/Beegum Creek to minimize predatory opportunities for striped bass and other non-native predators.	3	CBC-3.12	SRCS STE	NMFS, USFWS, CDFW, DWR	1,3	Short-term	TBD, based on the # of sites, # of miles, type of material, location of source material (onsite vs. imported), and placement method. Cost of initial study to address these issues is $5,000-$50,000. See Table H1-2 in Appendix D for cost per unit for various projects.	$0	$0	$0	$0	TBD, based on the # of sites, amount of material needed, type of material, location of source material (onsite vs. imported), and placement method. Cost of initial study to address these issues is $5,000-$50,000. See Table H1-2 in Appendix D for cost per unit for various projects.
Implement projects to increase floodplain habitat availability in Beegum Creek and the greater Cottonwood watershed to improve juvenile rearing habitat	3	CBC-3.13	SRCS STE	NMFS, USFWS, CDFW, DWR	1	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of floodplain habitat restored. $5,000-$50,000 for initial scoping study.

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5.6.3 Thomes Creek Recovery Actions

Table 5-8. Thomes Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Conduct a feasibility study on potential channel modifications that would improve upstream migration conditions in Thomes Creek.	3	THC-3.1	STE, SRCS	NMFS, USFWS, CDFW	1,5	5 Years	$50,000-$200,000					$50,000-$200,000
Design and implement a Thomes Creek anadromous fish passage study.	3	THC-3.2	STE, SRCS	NMFS, USFWS, CDFW	1,5	5 Years	$0	$0	$0	$0	$0	$0
Evaluate and improve passage at the Corning Canal siphon and at the two small seasonal push-up diversion dams near Paskenta and Henlyville.	3	THC-3.3	STE, SRCS	NMFS, USFWS, CDFW, DWR, Irrigation districts	1	5 years	$80,000-$382,000/project (CDFW 2004b)					$80,000-$382,000/project (CDFW 2004b)
Flow consolidation through reduction of braided channels in Thomes Creek.	3	THC-3.4	STE, SRCS	NMFS, USFWS, CDFW	1,5	Short-term	$5,000-$50,000 for initial scoping and feasibility; full project cost TBD based on initial study.					$5,000-$50,000 for initial scoping and feasibility; full project cost TBD based on initial study.
Enhance watershed resiliency in Thomes Creek by identifying and implementing projects that	3	THC-3.5	STE, SRCS	NMFS, USFWS, CDFW	1,5	Long-term	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBE	TBD	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.

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would reduce the potential for, and magnitude of a catastrophic wildfire, restore meadows to potentially increase summer flows and reduce local water temperatures, or increase riparian shade.												
Develop and implement a spawning gravel augmentation plan in Thomes Creek.	3	THC-3.6	STE, SRCS	NMFS, USFWS, USBR, CDFW, DWR	1,5	Long-term	$50,000 for plan development; gravel augmentation costs TBD	TBD	TBD	TBD	TBD	$50,000-TBD
Conduct West Tehama riparian and floodplain conditions inventory.	3	THC-3.7	STE, SRCS	NMFS, USFWS, Tehama County Resource Conservation Districts, CDFW	1	Complete	$0	$0	$0	$0	$0	$0
Implement projects to increase floodplain habitat availability in Thomes Creek to improve juvenile rearing habitat	3	THC-3.8	STE, SRCS	NMFS, USFWS, CDFW	1,4	Long-term	TBD, based on amount of floodplain habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD, based on amount of floodplain habitat restored; initial study is expected to cost at least $50,000.
Re-establish natural channel morphology in Thomes Creek by: (1) applying NMFS gravel mining criteria to all gravel mining projects; (2) integrating natural morphological	3	THC-3.9	STE, SRCS	NMFS, USFWS, Resource Conservation Districts, CDFW, DWR	1,5	Long-term	$0	$0	$0	$0	$0	$0

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features and functions into bank protection and other stream side development projects; and (3) implementing non-native plant (e.g. Arundo) eradication plan.												
Continue to implement projects designed to minimize chronic road-related erosion on public and private lands in the Thomes Creek watershed.	3	THC-3.10	STE, SRCS	NMFS, USFWS, USFS, CDFW, DWR	1,5	Long-term	$0	$0	$0	$0	$0	$0

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5.6.4 Stony Creek Recovery Actions

Table 5-9. Stony Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Enhance watershed resiliency in Stony Creek by identifying and implementing projects that would reduce the potential for, and magnitude of a catastrophic wildfire, restore meadows to potentially increase summer flows and reduce local water temperatures, or increase riparian shade.	3	STC-3.1	STE	NMFS, USFWS, CDFW, DWR	1,5	Long-term	TBD based on amount and type of habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBE	TBD	TBD based on amount and type of habitat restored; initial study is expected to cost at least $50,000.
Develop and implement a spawning gravel augmentation plan in Stony Creek, which includes habitats above Black Butte Dam after passage is provided.	3	STC-3.2	STE	NMFS, USFWS, USBR, CDFW, DWR	1,5	Long-term	$50,000 for plan development; gravel augmentation costs TBD	TBD	TBD	TBD	TBD	$50,000-TBD
Evaluate water releases from Black Butte Dam, water exchanges with the Tehama-Colusa Canal and interim and long term water diversion solutions at RBDD.	3	STC-3.3	STE	Yolo Basin Working Group	1,5	5 years	$0					$0
Continue to implement projects designed to minimize chronic road-related erosion on public and private lands in the Stony Creek watershed.	3	STC-3.4	STE	NMFS, USFWS, USFS, CDFW	1	Long-term	$0	$0	$0	$0	$0	$0
Develop a baseline monitoring program for Stony Creek to evaluate water quality throughout the	3	STC-3.5	STE	NMFS, USFWS, USFS, CDFW	1	Short-term	$0	$0	$0	$0	$0	$0

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watershed to identify areas of concern.												
Encourage voluntary landowner participation in Stony Creek in educational opportunities such as water quality short courses, field demonstrations and distribution of water quality "Fact Sheets".	3	STC-3.6	STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, CHS, DWR, CDFW	2	Long-term	$76,140	$76,140	$76,140	$76,140	$0	$304,560
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in Stony Creek.	3	STC-3.7	STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, CHS, DWR, CDFW	1	Short-term	$62,400	$0	$0	$0	$0	$62,400
Improve water temperature conditions in Stony Creek by identifying and implementing projects that would increase stream flows and increase shaded riverine habitat.	3	STC-3.8	STE	NMFS, USFWS, CDFW, DWR	1,4	Short-term	TBD	$0	$0	$0	$0	TBD based on the amount of water acquired and/or the amount of shaded habitat restored. Estimate of amount of water to be purchased unavailable. Cost per unit ranges from $43 to $88/af/year for upstream of Delta water purchases (Appendix D). Estimate of amount shaded habitat to be restored unavailable. As identified in Appendix D, per unit costs vary depending on whether fencing, planting, irrigation, or invasive week control are needed. Initial scoping study to determine project details estimated at $5,000-$50,000.

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Implement projects to increase floodplain habitat availability in Stony Creek to improve juvenile rearing habitat.	3	STC-3.9	STE	NMFS, USFWS, CDFW, DWR	1,4	Long-term	TBD, based on amount of floodplain habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD, based on amount of floodplain habitat restored; initial study is expected to cost at least $50,000.
Install water temperature recorders at select locations in Stony Creek; develop recommendations for minimum instream flow based on temperature needs.	3	SCT-3.10	STE	NMFS, USFWS, CDFW, DWR	1	5 Years	$0					$0
Monitor and evaluate sport-fishing impacts in Stony Creek to ensure that the fishery allows for the recovery of steelhead; modify regulations as necessary.	3	STC-3.11	STE	NMFS, CDFW	2	Long-term	$0	$0	$0	$0	$0	$0

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5.6.5 Putah Creek Recovery Actions

Table 5-10. Putah Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Conduct an anadromous fish passage feasibility study in Putah Creek that assesses upstream habitat conditions and operational alternatives.	2	PUC-2.1	STE	NMFS, USFWS, USFS, CDFW, DWR, Yolo Basin Working Group	1,5	5 Years	$25,000-$200,000					$25,000-$200,000
Develop a cooperative program to provide water for target flows in Putah Creek from additional Lake Berryessa releases or reductions in water diversions at Solano Diversion Dam and in the creek downstream of the dam.	2	PUC-2.2	STE	NMFS, USFWS, USBR, CDFW, DWR	1,5	Long-term	$0	$0	$0	$0	$0	$0
Implement actions specified by the Putah Creek Council directed at restoring instream and riparian habitat.	2	PUC-2.3	STE	NMFS, USFWS, CDFW, DWR	1	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of habitat restored. As identified in Appendix D, per unit costs vary depending on whether fencing, planting, irrigation, or invasive weed control are needed.
Permanently protect Putah Creek riparian habitat through	2	PUC-2.4	STE	NMFS, USFWS, CDFW, DWR, NRCS	1,5	Long-term	TBD, based on specific easements and	TBD	TBD	TBD	TBD	TBD, based on specific easements and land

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
easements and/or land acquisition							land acquisitions; initial study is expected to cost at least $50,000.					acquisitions; initial study is expected to cost at least $50,000.
Implement projects that improve wastewater and stormwater treatment throughout the Putah Creek watershed.	2	PUC-2.5	STE	NMFS, USFWS, USEPA, SWRCB, DWR, CDFW, Local governments	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of water to be treated and whether existing treatment facilities need to be upgraded or new facilities are required.. $5,000-$50,000 for initial evaluation.
Implement projects to maintain and increase floodplain habitat availability in Putah Creek to improve juvenile rearing habitat	2	PUC-2.6	STE	NMFS, USFWS, USBR, CDFW, DWR, Yolo Basin Working Group	1,4	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of floodplain habitat restored; initial study is expected to cost at least $50,000.
Develop and implement a spawning gravel augmentation plan in Putah Creek.	2	PUC-2.7	STE	NMFS, USFWS, CDFW, DWR	1,5	Long-term	$50,000 for plan development; gravel augmentation costs TBD	TBD	TBD	TBD	TBD	$50,000-TBD (based on gravel augmentation costs)
Increase monitoring and enforcement in Putah Creek to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin	2	PUC-2.8	STE	SWRCB, RWQCBs, Local agriculture groups	1,5	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Plan) are met throughout the Putah Creek watershed for all potential pollutants (SWRCB 2007).												
Monitor and evaluate sport-fishing impacts in Putah Creek to ensure that the fishery allows for the recovery of steelhead; modify regulations as necessary.	3	PUC-3.1	STE	NMFS, CDFW	2	Long-term	$0	$0	$0	$0	$0	$0
Evaluate whether predator control measures can be effective at minimizing predation of juvenile steelhead in Putah Creek; implement measures found to be effective.	3	PUC-3.2	STE	USFWS, NMFS, USBR, CDFW, DWR, Various NGOs	1,3,4	Long-term	TBD	TBD	TBD	TBD	TBD	Cost covered by the cost of SFB-2.5 ($0-$75,000,000).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement projects to minimize predation at weirs, diversion dams, and related structures in Putah Creek.	3	PUC-3.3	STE	NMFS, CDFW, DWR, USFWS, USBR, Corps	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs.	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about $38,000 annually (BDCP 2013).
Improve instream refuge cover for salmonids in Putah Creek to minimize predatory opportunities for striped bass and other non-native	3	PUC-3.4	STE	USFWS, NMFS, USBR, CDFW, DWR	1,3	Long-term	TBD, based on the # of sites, # of miles, type of material, location of source material (onsite vs. imported), and	TBD	TBD	TBD	TBD	TBD, based on the # of sites, # of miles, type of material, location of source material (onsite vs. imported), and placement

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
predators.							placement method. Initial scoping to address those issues would cost at least $50,000. See Table H1-2 in Appendix D for cost per unit for various projects.					method. Cost of initial study to address these issues is $5,000-$50,000. See Table H1-2 in Appendix D for cost per unit for various projects.
Encourage voluntary landowner participation in Putah Creek in educational opportunities such as water quality short courses, field demonstrations and distribution of water quality "Fact Sheets".	3	PUC-3.5	STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Districts, DWR, CDFW, Landowners	2	Long-term	$76,140	$76,140	$76,140	$76,140	$0	$304,560
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in Putah Creek.	3	PUC-3.6	STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Districts, DWR, CDFW, Landowners	1,5	Short-term	$62,400	$0	$0	$0	$0	$62,400

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5.7 Basalt and Porous Lava Diversity Group Recovery Actions

5.7.1 Cow Creek Recovery Actions

Table 5-11. Cow Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop and implement actions to reduce or eliminate passage impediments in Cow Creek.	2	COC-2.1	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, Cow Creek Watershed Management Group	1	5 Years	TBD based on the number and type of impediments. Per unit cost of providing passage at agricultural diversion dams ranges from $30,000 to $1,356,500 (see Appendix D, page 21, table HB-4). Initial evaluation of passage impediments estimated to cost up to $50,000.	$0	$0	$0	$0	TBD based on the number and type of impediments. Per unit cost of providing passage at agricultural diversion dams ranges from $30,000 to $1,356,500 (see Appendix D, page 21, table HB-4). Initial evaluation of passage impediments estimated to cost up to $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Install water temperature recorders at select locations in Cow Creek; develop recommendations for minimum instream flow based on temperature needs.	2	COC-2.2	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, Cow Creek Watershed Management Group	1	5 Years	$0	$0	$0	$0	$0	$0
Conduct a Cow Creek diversion mapping study and install screens and ladders at agricultural diversions where necessary.	2	COC-2.3	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, Cow Creek Watershed Management Group	1,5	5 Years	$50,000 for mapping study; Per unit cost of providing passage at agricultural diversion dams ranges from $30,000 to $1,356,500 (see Appendix D, page 21, table HB-4)	$0	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is estimated at $20 million (San Francisco Estuary Partnership 2007).
Develop and apply alternative diversion technologies that eliminate entrainment in Cow Creek.	2	COC-2.4	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, Cow Creek Watershed Management Group	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD. This action involves development of a new technology such that is impracticable to provide a reasonable estimate of the action's cost.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Enhance watershed resiliency in Cow Creek by identifying and implementing projects that would reduce the potential for, and magnitude of, a catastrophic wildfire, and restore forested areas within the watershed including riparian areas.	2	COC-2.5	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, Cow Creek Watershed Management Group	1,5	Long-term	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.
Implement actions specified in the Cow Creek Watershed Management Plan directed at restoring riparian habitat.	2	COC-2.6	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, Cow Creek Watershed Management Group	1,4	Long-term	~$235,000 for restoring 10 acres and developing best management practices	$300,000 for monitoring and identification of new restoration sites; if new sites are identified, each is estimated to cost ~$213,000 /10 acres.	$300,000 for monitoring and identification of new restoration sites; if new sites are identified, each is estimated to cost ~$213,000 /10 acres.	$300,000 for monitoring and identification of new restoration sites; if new sites are identified, each is estimated to cost ~$213,000 /10 acres.	$300,000 for monitoring and identification of new restoration sites; if new sites are identified, each is estimated to cost ~$213,000 /10 acres.	>~$1,435,000
Identify stream reaches in Cow Creek that have been most altered by anthropogenic factors and reconstruct a natural channel geometry scaled to current channel forming flows.	2	COC-2.7	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, Cow Creek Watershed Management Group	1,5	Long-term	$4,217,625	$0	$0	$0	$0	$4,217,625

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Curtail further development in the active Cow Creek floodplains through zoning restrictions, county master plans, and other Federal, State, and county planning and regulatory processes.	2	COC-2.8	STE	NMFS, USFWS, Corps, CDFW, DWR, Local governments	1,5	Long-term	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement of illegal rip rap applications in Cow Creek.	2	COC-2.9	STE	Corps, SWRCB	1,5	Long-term	$350,000[27]	$350,000	$350,000	$350,000	$350,000	$1,750,000
Develop education and outreach programs to encourage river stewardship in Cow Creek, such as water quality short courses, field demonstrations and distribution of water quality "Fact Sheets".	2	COC-2.10	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, Cow Creek Watershed Management Group	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000

[27] Assuming 1 new full time equivalent at $70,000/year, based on the average salary for a California Fish and Game warden as identified on the Bureau of Labor statistics website (http://www.bls.gov/oes/current/oes_ca.htm#19-0000).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Cooperatively negotiate long-term agreements with local landowners to maintain and restore riparian communities along lower reaches of Cow Creek (CALFED 2000).	2	COC-2.11	STE	NMFS, USFWS, Corps, USBR, Resource Conservation Districts, CDFW, DWR, Water districts, Landowners, Local governments	1,5	Long-term	$0	$0	$0	$0	$0	$0
Permanently protect Cow Creek riparian habitat through easements and/or land acquisition	2	COC-2.12	STE	NMFS, USFWS, Corps, USBR, Resource Conservation Districts, CDFW, DWR, Water districts, Landowners, Local governments	1,5	Long-term	TBD, based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD, based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Develop and implement a spawning gravel augmentation plan in Cow Creek.	2	COC-2.13	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, Cow Creek Watershed Management Group	1,4	Long-term	$50,000 for plan development; gravel augmentation costs TBD	TBD	TBD	TBD	TBD	$50,000-TBD (gravel augmentation costs)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Monitor, evaluate, and adaptively manage the Cow Creek rainbow trout stocking program to minimize the potential for adverse impacts to steelhead.	2	COC-2.14	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, Cow Creek Watershed Management Group	1,5	3 Years	$0	$0	$0	$0	$0	$0
Implement projects to increase floodplain habitat availability in Cow Creek to improve juvenile rearing habitat	2	COC-2.15	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, Cow Creek Watershed Management Group	1	Long-term	TBD, based on amount of floodplain habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD, based on amount of floodplain habitat restored; initial study is expected to cost at least $50,000.
Implement projects to increase flows in Cow Creek and tributaries.	2	COC-2.16	STE	NMFS, USFWS, Western Shasta Resource Conservation, CDFW, DWR, SWRCB, Cow Creek Watershed Management Group	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD because the estimate of amount of water to be purchased is unavailable. Cost per unit for upstream of Delta water purchases ranges from $43 to $88/af/year (Appendix D). Cost of an initial study to determine the amount of water needed is at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement the water quality action options described in the Cow Creek Watershed Management Plan.	2	COC-2.17	STE	USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW, Cow Creek Watershed Management Group	1	Long-term	$0	$0	$0	$0	$0	$0
Continue to implement projects designed to minimize chronic road-related erosion on public and private lands in the Cow Creek watershed.	2	COC-2.18	STE	NMFS, USFWS, USFS, CDFW, Cow Creek Watershed Management Group	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop a baseline monitoring program for Cow Creek to evaluate water quality throughout the watershed to identify areas of concern.	2	COC-2.19	STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW, Cow Creek Watershed Management Group	1	2 Years	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in Cow Creek.	2	COC-2.20	STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW, Landowners, Cow Creek Watershed Management Group	1,5	Short-term	$62,400	$0	$0	$0	$0	$62,400
Decommission the Kilarc-Cow Creek hydroelectric project (FERC Project No. 606).	2	COC-2.21	STE	PG&E, FERC, NMFS, CDFW, Cow Creek Watershed Management Group	1	Short-term	$0					$0
Monitor and evaluate sport-fishing impacts in Cow Creek to ensure that the fishery allows for the recovery of steelhead; modify regulations as necessary.	2	COC-3.1	STE	NMFS, CDFW	2	Long-term	$0	$0	$0	$0	$0	$0

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5.7.2 Battle Creek Recovery Actions

Table 5-12. Battle Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Fully fund and implement the Battle Creek Restoration Project through Phase 2	1	BAC-1.1	WRCS, SRCS, STE	USBR, CDFW, NMFS, PG&E, USFWS	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop and implement a winter-run Chinook salmon reintroduction plan to re-colonize historic habitats made accessible by the Battle Creek Restoration Project.	1	BAC-1.2	WRCS	CDFW, USFWS, NMFS, watershed stakeholders, USBR	1,5	15	$1,000,000-$1,333,333	$1,000,000-$1,333,333	$1,000,000-$1,333,333	$0	$0	$3,000,000-$3,999,999
Implement the Battle Creek Salmon and Steelhead Restoration Project Adaptive Management Plan.	1	BAC-1.3	WRCS, SRCS, STE	CDFW, USFWS, NMFS, watershed stakeholders, USBR	1,5	Short-term	$0	$0	$0	$0	$0	$0
Enhance watershed resiliency in Battle Creek by developing a strategy to identify and prioritize vegetation and fuels treatments that would reduce the potential extent and/or the magnitude of high severity wildfires.	1	BAC-1.4	WRCS, SRCS, STE	USBR, NMFS, USFWS, CDFW	1,5	Long-term	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBE	TBD	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Ensure that timber cutting operations on private lands in the Battle Creek watershed follow the State Forest Practice rules.	1	BAC-1.5	WRCS, SRCS, STE	USBR, NMFS, USFWS, FERC, CDFW, SWRCB, SPI	1,5	Long-term	$0	$0	$0	$0	$0	$0
Implement a water quality monitoring program throughout the Battle Creek watershed to identify areas of concern. The program should monitor for sediment loading and include detection of chemical/nutrient inputs from illegal plant cultivation operations.	1	BAC-1.6	WRCS, SRCS, STE	USBR, NMFS, USFWS, FERC, CDFW, SWRCB	1,5	5	$0	$0	$0	$0	$0	$0
Develop an Adaptive Management Plan for Coleman National Fish Hatchery and continue to integrate hatchery operations with Battle Creek Salmon and Steelhead Restoration Project activities.	1	BAC-1.7	WRCS, SRCS, STE	CDFW, USFWS, NMFS, watershed stakeholders, USBR	1,4,5	Short-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Evaluate the scientific merits of moving Coleman National Fish Hatchery operations for the production of steelhead and late-fall Chinook salmon to minimize adverse impacts to listed species. If warranted, then follow with an assessment of the feasibility of moving the programs.	1	BAC-1.8	WRCS, SRCS, STE	CDFW, USFWS, NMFS, watershed stakeholders, USBR	1,3,5	Short-term evaluation; long-term implementation	TBD	TBD	TBD	TBD	TBD	TBD; The cost of the evaluation and, if necessary, the feasibility assessment will be identified by the Coleman Hatchery Coordination Team that will be formed according to the recommendation from the Hatchery Scientific Review Group.
Finalize the Biological Opinion for the artificial propagation at Coleman National Fish Hatchery.	1	BAC-1.9	WRCS, SRCS, STE	FWS, NMFS	1,5	1 year	$0	$0	$0	$0	$0	$0
Evaluate the need to upgrade PG&E facilities in order to reduce the potential for outages and harmful flow fluctuations. If outages and flow fluctuations are important stressors after completion of the Battle Creek Salmon and Steelhead Restoration	1	BAC-1.10	WRCS, SRCS, STE	Corps, USFWS, NMFS, CDFW, PG&E	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD based on whether or not facilities need to be upgraded. Evaluation of facilities estimated to cost up to $100,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Project, then PG&E facilities should be upgraded.												
Develop and utilize the Battle Creek Fisheries Management Plan.	1	BAC-1.11	WRCS, SRCS, STE	CDFW, USFWS, NMFS	1,5	Short-term	$0	$0	$0	$0	$0	$0
Improve fish passage at natural (rock or wood) fish barriers in the watershed including the ones immediately upstream and downstream of Eagle Canyon, and at the mouth of Digger Creek.	1	BAC-1.12	WRCS, SRCS, STE	CDFW, USFWS, NMFS	1,5	Short-term	$500,000					$500,000
Develop and apply alternative water diversion technologies that eliminate entrainment in Battle Creek.	2	BAC-2.1	WRCS, SRCS, STE	FWS, CDFW	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD. This action involves development of a new technology such that is impracticable to provide a reasonable estimate of the action's cost.
Implement a study designed to evaluate the impact of predation on spring-run Chinook salmon and steelhead in	2	BAC-2.2	WRCS, SRCS, STE	FWS, CDFW, NMFS	1,3,5	Long-term						Cost covered by the cost of SFB-2.5 ($0-$75,000,000).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Battle Creek. If the study suggests that predation is an important stressor in Battle Creek, then implement projects to minimize predation, potentially including predator removal and/or harvest management.												
Implement projects to minimize predation at weirs, diversion dams, and related structures in Battle Creek.	2	BAC-2.3	WRCS, SRCS, STE	NMFS, CDFW, DWR, USFWS, USBR, Corps, PG&E	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs.	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
												site will cost about $38,000 annually (BDCP 2013).
The Corps, DWR, CDFW, BLM, USFWS, NMFS, private land owners, and Resource Conservation Districts should continue to focus on retaining, restoring and creating continuous riparian corridors within their jurisdictions in Battle Creek in order to improve natural river function and provide predator refuge habitat.	2	BAC-2.4	WRCS, SRCS, STE	DWR, BLM, TNC, USFWS, CDFW	1,5	Long-term	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$150,000 -$675000
Increase monitoring and enforcement in order to eliminate/minimize illegal plant cultivation operations and anadromous fish poaching in the Battle Creek watershed.	2	BAC-2.5	WRCS, SRCS, STE	CDFW	1,5	Long-term						Cost is covered under action # COC-2.9
Permanently protect Battle Creek riparian habitat through	2	BAC-2.6	WRCS, SRCS, STE	DWR, BLM, TNC, USFWS, CDFW	1,5	Long-term	TBD, based on specific easements and land	TBD	TBD	TBD	TBD	TBD, based on specific easements and land acquisitions; initial

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
easements and/or land acquisition.							acquisitions; initial study is expected to cost at least $50,000.					study is expected to cost at least $50,000.
Ensure through the FERC process and monitoring that the hydroelectric project at Lassen Lodge on the South Fork of Battle Creek avoids or minimizes any adverse impacts to listed anadromous salmonids.	2	BAC-2.7	WRCS, SRCS, STE	FERC, USFS, NMFS, CDFW	1,3,5	Short-term	$0	$0	$0	$0	$0	$0
Utilize bio-technical techniques for river bank stabilization instead of conventional rip rap in Battle Creek.	3	BAC-3.1	WRCS, SRCS, STE	Corps, USFWS	1,5	Long-term	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement to minimize illegal streambank alterations in Battle Creek.	3	BAC-3.2	WRCS, SRCS, STE	CDFW, Corps, USFWS	1,5	Long-term						Cost is covered under action # COC-2.9

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5.8 Northern Sierra Nevada Diversity Group Recovery Actions

5.8.1 Antelope Creek Recovery Actions

Table 5-13. Antelope Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Restore instream flows during upstream and downstream migration periods through water exchange agreements and provide alternative water supplies to Edwards Ranch and Los Molinos Mutual Water Company in exchange for instream fish flows.	1	ANC-1.1	SRCS, STE	NMFS, USFWS, CDFW, Edwards Ranch, Los Molinos Mutual Water Company	1	Long-term	$0	$0	$0	$0	$0	$0
Restore connectivity of the migration corridor during upstream and downstream migration periods by implementing Edwards and Penryn fish passage and entrainment improvement projects and identify and	1	ANC-1.2	SRCS, STE	CDFW, Edwards Ranch	1	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
construct a defined stream channel for upstream and downstream fish migration												
Create and restore side channel habitats to increase the quantity and quality of off-channel rearing (and spawning) areas in Antelope Creek.	2	ANC-2.1	SRCS, STE	NMFS, CDFW	1	Short-term	TBD based on the amount of side channel habitat restoration. Unit cost is $20,000 to $300,000/acre (Appendix D). $5,000-$50,000 for initial evaluation.	TBD based on the amount of side channel habitat restoration. Unit cost is $20,000 to $300,000/acre (Appendix D). $5,000-$50,000 for initial evaluation.	TBD based on the amount of side channel habitat restoration. Unit cost is $20,000 to $300,000/acre (Appendix D). $5,000-$50,000 for initial evaluation.	TBD based on the amount of side channel habitat restoration. Unit cost is $20,000 to $300,000/acre (Appendix D). $5,000-$50,000 for initial evaluation.	TBD based on the amount of side channel habitat restoration. Unit cost is $20,000 to $300,000/acre (Appendix D). $5,000-$50,000 for initial evaluation.	TBD based on the amount of side channel habitat restoration. Unit cost is $20,000 to $300,000/acre (Appendix D). $5,000-$50,000 for initial evaluation.
Federal, State, and local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring and creating riparian and floodplain habitat in Antelope Creek.	2	ANC-2.2	SRCS, STE	NMFS, USFWS, CDFW, DWR, Irrigation districts	1	Short-term	TBD based on type and amount of habitat restored; initial study is expected to cost at least $50,000.	TBD	$0	$0	$0	TBD based on type and amount of habitat restored; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Improve passage conditions at Paynes crossing to allow upstream passage during low flows.	2	ANC-2.3	SRCS, STE	NMFS, USFWS, USFS, CDFW, DWR	1	Long-term	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement of illegal rip rap applications in Antelope Creek.	2	ANC-2.4	SRCS, STE	Corps, SWRCB	1	Long-term						Cost is covered under action # COC-2.9
Develop education and outreach programs to encourage river stewardship in Antelope Creek.	2	ANC-2.5	SRCS, STE	NMFS, USFWS, USFS, CDFW, DWR, NGOs	5	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Evaluate the quality and quantity of spawning habitat in Antelope Creek and rehabilitate spawning habitat as needed.	2	ANC-2.6	SRCS, STE	NMFS, USFWS, CDFW, DWR	1	Long-term	$50,000 for plan development; rehabilitation costs TBD	TBD	TBD	TBD	TBD	$50,000-TBD
Develop and implement TMDL's for all pollutants in Antelope Creek	2	ANC-2.7	SRCS, STE	NMFS, USFWS, USFS, CDFW	1	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Increase monitoring and enforcement in the Antelope Creek watershed to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants.	2	ANC-2.8	SRCS, STE	SWRCB, RWQCBs, Local agriculture groups	1	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)
Develop a baseline monitoring program in Antelope Creek to evaluate water quality throughout the watershed to identify areas of concern.	2	ANC-2.9	SRCS, STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW	1	3 Years	$0	$0	$0	$0	$0	$0
Enhance watershed resiliency in Antelope Creek by developing a strategy to identify and prioritize vegetation and fuels treatments that would reduce the potential extent and/or the	2	ANC-2.10	SRCS, STE	NMFS, USFWS, USFS, CDFW	1	Long-term	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBE	TBD	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
magnitude of high severity wildfires.												
Continue to implement projects designed to minimize chronic road-related erosion on public and private lands in the Antelope Creek watershed.	2	ANC-2.11	SRCS, STE	NMFS, USFWS, USFS, CDFW	1	Long-term	$0	$0	$0	$0	$0	$0
Utilize bio-technical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip rap in Antelope Creek.	2	ANC-2.12	SRCS, STE	NMFS, USFWS, Corps, USBR, DWR, CDFW, CBDA	1	Long-term	$0	$0	$0	$0	$0	$0
Implement projects that cooperatively work with landowners to modify existing diversions in Antelope Creek so that fish do not become entrained in agricultural fields.	2	ANC-2.13	SRCS, STE	NMFS, USFWS, CDFW, DWR, Landowners, Irrigation districts	1,5	Short-term	TBD	TBD	$0	$0	$0	TBD, based on the type of diversion modification. If a fish screen is the solution, the cost will generally range from $2 to $10 thousand per cfs (Appendix D). $5,000-$50,000 for initial evaluation.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Monitor and evaluate the sport fishing regulations for Antelope Creek to ensure they are consistent with the recovery of spring-run Chinook salmon and steelhead, and work with the Fish and Game Commission to modify the regulations as needed.	2	ANC-3.1	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	2	Long-term	$0	$0	$0	$0	$0	$0

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5.8.2 Mill Creek Recovery Actions

Table 5-14. Mill Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Modify Ward, Upper, and Cemetery Ditch Siphon diversions and associated structures in Mill Creek in order to minimize entrainment and provide unimpeded passage for adult and juvenile Chinook salmon and steelhead. The modifications should meet the fish passage design criteria developed by NMFS as well as the criteria developed by CDFW.	1	MIC-1.1	SRCS, STE	NMFS, CDFW, Los Molinos Mutual Water Company, DWR, USFWS, Mill Creek Conservancy, TNC	1,5	Short-term	$2,672,672	$0	$0	$0	$0	$2,672,672
Analyze previous Mill Creek flow studies (i.e., Alley 1996; Harvey-Arrison 2009) to identify the flow regime in the flow control reach (i.e., downstream of Upper Diversion to the confluence with the Sacramento River) that best supports the life stages of spring-run Chinook salmon and steelhead that occur in that reach; conduct an additional flow study if necessary.	1	MIC-1.2	SRCS, STE	NMFS, CDFW, Los Molinos Mutual Water Company, DWR, USFWS, Mill Creek Conservancy, TNC, NFWF	1,5	Short-term	$200,000	$0	$0	$0	$0	$200,000
Develop and implement instream flow agreements with Mill Creek diverters designed to provide flows that best support the life stages of spring-run Chinook salmon and steelhead that occur in the flow control reach (i.e., downstream of Upper Diversion to the confluence with the Sacramento River).	1	MIC-1.3	SRCS, STE	NMFS, CDFW, Los Molinos Mutual Water Company, DWR, USFWS, Mill Creek Conservancy, TNC, NFWF	1,5		TBD	TBD	TBD	TBD	TBD	TBD, based on amount of water. Cost per unit is $43 - $88/af/year for upstream of Delta water purchases (Appendix D)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
The agreements can include approaches such as groundwater exchange, water leases, acquiring water rights, and other water management options.												
Continue to implement projects designed to minimize chronic road-related erosion on public and private lands in the upper Mill Creek watershed. On National Forest Service (NFS) lands, this action should follow the prioritization criteria and strategies identified in the Long-term Strategy for Anadromous Fish-producing Watersheds in the Lassen National Forest (USFS 2001).	1	MIC-1.4	SRCS, STE	USFS, NMFS, USFWS, CDFW, DWR, Mill Creek Conservancy, TNC	1,4,5	Long-term	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement in order to eliminate/minimize illegal plant cultivation operations and anadromous fish poaching in the Mill Creek watershed.	1	MIC-1.5	SRCS, STE	NMFS, CDFW, SWRCB	2,4							Cost is covered under action # COC-2.9
Conduct real time flow and water temperature monitoring in Mill Creek in order to inform real time management decisions.	1	MIC-1.6	SRCS, STE	CDFW, USGS, DWR, Los Molinos Mutual Water Company	1,5		$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Build partnerships with land owners and/or permittees in the Mill Creek watershed to develop grazing strategies that promote meadow restoration, protect and improve streamside vegetation, and minimize bank disturbance.	2	MIC-2.1	SRCS, STE	NMFS, USFWS, CDFW, DWR, Mill Creek Conservancy, TNC	1,5		$47,520	$0	$0	$0	$0	$47,520
Implement a water quality monitoring program throughout the Mill Creek watershed to identify areas of concern.	2	MIC-2.2	SRCS, STE	NMFS, USFWS, CDFW, DWR, SWRCB, USEPA	1,4,5	Long-term	$0	$0	$0	$0	$0	$0
Develop education and outreach programs to encourage river stewardship in Mill Creek. Collaborate with the Mill Creek Watershed Conservancy in watershed management activities and any other public education events related to river stewardship.	2	MIC-2.3	SRCS, STE	CDFW, Mill Creek Conservancy, TNC, USFWS, NMFS, Los Molinos Mutual Water Company	2		$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Ensure that timber cutting operations in the Mill Creek watershed follow the State Forest Practice rules.	2	MIC-2.4	SRCS, STE	CDFW, CalFire, Board of Forestry, NMFS, USFWS, USFS	1,5		$0	$0	$0	$0	$0	$0
Enhance watershed resiliency in Mill Creek by developing a strategy to identify and prioritize vegetation and fuels treatments that would reduce the potential extent and/or the magnitude of high severity wildfires.	2	MIC-2.5	SRCS, STE	USFS, CalFire, NMFS, USFWS, , CDFW, Mill Creek Conservancy	1,5	Long-term	TBD based on amount and type of habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBE	TBD	TBD based on amount and type of habitat restored; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Investigate whether there are areas in the Mill Creek valley reach where it would be feasible to implement floodplain restoration projects in order to improve habitat conditions for juvenile rearing. If there are floodplain restoration opportunities, those projects should be prioritized and implemented as funding becomes available.	2	MIC-2.6	SRCS, STE	NMFS, USFWS, CDFW, DWR, Mill Creek Conservancy, TNC	1,5	Short-term	$50,000 for investigation; cost of floodplain restoration TBD based on amount of habitat to be restored. Per unit cost of floodplain habitat restoration is $5,000 to $80,000/acre (Appendix D Table HI-4)	TBD	$0	$0	$0	$50,000-TBD
Monitor and evaluate the sport fishing regulations for Mill Creek to ensure they are consistent with the recovery of spring-run Chinook salmon and steelhead, and modify the regulations as needed. Establish and enforce hook size restrictions intended to allow trout fishing, but minimize angling impacts on salmon.	2	MIC-2.7	SRCS, STE	CDFW, Fish and Game Commission, NMFS	2,4		$0	$0	$0	$0	$0	$0
Identify stream reaches in Mill Creek that have been most altered by anthropogenic factors and develop restoration actions that restore natural river processes.	2	MIC-2.8	SRCS, STE	NMFS, USFWS, CDFW, DWR, Mill Creek Conservancy, TNC	1,5		$4,217,625	$0	$0	$0	$0	$4,217,625

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Curtail further development in the active Mill Creek floodplains through zoning restrictions, county master plans, and other Federal, State, and county planning and regulatory processes.	2	MIC-2.9	SRCS, STE	Local governments, NMFS, USFWS, CDFW, DWR, Mill Creek Conservancy, TNC	1,4	Long-term	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement to minimize illegal streambank alterations in Mill Creek.	2	MIC-2.10	SRCS, STE	CDFW, NMFS, Corps, SWRCB	1,5	Long-term						Cost is covered under action # COC-2.9
Permanently protect riparian habitat along Mill Creek through easements and/or land acquisition.	2	MIC-2.11	SRCS, STE	CDFW, USFWS, NMFS, Mill Creek Conservancy, TNC	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Develop and implement actions to remove feral cows in the Black Rock area of Mill Creek.	2	MIC-2.12	SRCS, STE	CDFW, USFWS, NMFS, Mill Creek Conservancy, TNC	1,5	Short-term	TBD	$0	$0	$0	$0	TBD, based on number of cows. Cost per cow removed is $150 (Bratcher 2013).

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5.8.3 Deer Creek Recovery Actions

Table 5-15. Deer Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop and implement instream flow agreements with the Deer Creek Irrigation District and the Stanford-Vina Ranch Irrigation Company designed to provide flows that best support all life stages of spring-run Chinook salmon and steelhead. The agreements can include approaches such as groundwater exchange, water leases, and other water management options.	1	DEC-1.1	SRCS, STE	Corps, SWRCB, DCID, SVRIC	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of water. Cost per unit is $43 - $88/af/year for upstream of Delta water purchases (Appendix D)
Modify the Cone-Kimball Diversion, Stanford-Vina Dam, and the Deer Creek Irrigation District Dam in order to provide unimpeded passage for adult and juvenile Chinook salmon and steelhead. The modifications should meet the fish passage design criteria developed by NMFS and CDFW.	1	DEC-1.2	SRCS, STE	NMFS, USFWS, USFS, CDFW, DWR, NGOs	1,5	Short-term	$10,925,000	$12,629,300	$0	$0	$0	$23,554,300

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
In coordination with technical advisors from the natural resource agencies, implement the Deer Creek Flood Improvement Project, and other projects to increase Deer Creek floodplain habitat availability.	1	DEC-1.3	SRCS, STE	NMFS, USFWS, CDFW, DWR	1,4	Short-term	$1,860,000	$0	$0	$0	$0	$1,860,000
Continue to implement projects designed to minimize chronic road-related erosion on public and private lands in the upper Deer Creek watershed. On National Forest Service lands, this action should follow the prioritization criteria and strategies identified in the Long-term Strategy for Anadromous Fish-producing Watersheds in the Lassen National Forest (USFS 2001).	1	DEC-1.4	SRCS, STE	NMFS, USFWS, USFS, CDFW	1,4	Long-term	$0	$0	$0	$0	$0	$0
Conduct an instream flow study to identify the flow regime in lower Deer Creek that best supports migration and rearing of spring-run Chinook salmon and steelhead.	1	DEC-1.5	SRCS, STE	CDFW, Deer Creek Irrigation Company, Stanford-Vina, SWRCB, DWR, Deer Creek Watershed Conservancy	1,5	Long-term	$1,600,000	$0	$0	$0	$0	$1,600,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Based on instream flow study results, develop an adaptive management strategy to provide a flow regime in the lower watershed that best supports spring-run Chinook salmon and steelhead during fish migration and rearing periods.	1	DEC-1.6	SRCS, STE	CDFW, Deer Creek Irrigation Company, Stanford-Vina, SWRCB, DWR, Deer Creek Watershed Conservancy	1,5	Long-term	$0	$0	$0	$0	$0	$0
Conduct real time flow and water temperature monitoring in Deer Creek in order to inform real time management decisions.	1	DEC-1.7	SRCS, STE	NMFS, USFWS, USGS, CDFW, DWR	1,5	Long-term	$0	$0	$0	$0	$0	$0
Implement a Deer Creek monitoring program to identify the abundance and the temporal and spatial distributions of immigrating and holding spring-run Chinook salmon and steelhead. These data would help ensure that suitable flows and water temperatures are being provided when and where the fish are immigrating and holding. Additionally, the data would help estimate the abundance of both species.	1	DEC-1.8	SRCS, STE	CDFW, SPI	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Increase monitoring and enforcement in order to eliminate/minimize illegal plant cultivation operations and anadromous fish poaching in the Deer Creek watershed.	1	DEC-1.9	SRCS, STE	CDFW, Deer Creek Irrigation Company, Stanford-Vina, Deer Creek Watershed Conservancy	1,4,5	Long-term						Cost is covered under action # COC-2.9
Study feasibility of consolidating diversion points (e.g., Stanford Vina and Cone-Kimball diversions) to minimize the number of diversions on Deer Creek. Based on this study, consolidate diversions where feasible.	2	DEC-2.1	SRCS, STE	NMFS, CDFW, Deer Creek Watershed Conservancy, Deer Creek Irrigation Company, Stanford-Vina, SWRCB, DWR	1,5	10 Years	$50,000	$750,000	$0	$0	$0	$800,000
Assess the feasibility and need for modifying the lower Deer Creek falls fish ladder, to improve its function for allowing upstream passage to the upper six miles of anadromous habitat. Implement modifications as needed.	2	DEC-2.2	SRCS, STE	NMFS, USFWS, USFS, CDFW	1,5	5 Years	$0	$0	$0	$0	$0	$0
Enhance watershed resiliency in Deer Creek by developing and implementing a strategy to identify and prioritize vegetation and fuels treatments that would reduce the potential extent and/or the magnitude of high severity wildfires.	2	DEC-2.3	SRCS, STE	SWRCB, RWQCBs, Local agriculture groups	1,4,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount and type of habitat restored; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Build partnerships with land owners and/or permittees in the Deer Creek watershed to develop grazing strategies that promote meadow restoration, protect and improve streamside vegetation, and minimize bank disturbance.	2	DEC-2.4	SRCS, STE	NMFS, CDFW, Deer Creek Watershed Conservancy, USFWS	1,5	Long-term	$47,520	$0	$0	$0	$0	$47,520
Maintain an up-to-date Highway 32 Contingency Spill Plan to ensure immediate emergency response strategy and continue to develop alternatives to reduce the potential for hazardous material spills along Deer Creek.	2	DEC-2.5	SRCS, STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW	4,5	Long-term	$0	$0	$0	$0	$0	$0
Work with California Department of Transportation (Caltrans) to ensure that proposed changes to the existing Highway 32 road alignment would not contribute to potentially unacceptable effects to anadromous fish and/or their habitat (e.g. increases in fine grained sediment, increased risk of hazardous spills).	2	DEC-2.6	SRCS, STE	NMFS, USFWS, USFS, CDFW	4,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop education and outreach programs to encourage river stewardship in Deer Creek. Continue educational outreach and support and assist Deer Creek Watershed Conservancy (DCWC) in watershed management activities (AFRP Website 2005).	2	DEC-2.7	SRCS, STE	NMFS, USFWS, USFS, CDFW	2,5	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Continue implementing a water quality monitoring program throughout the Deer Creek watershed to identify areas of concern. The monitoring program should include detection of chemical/nutrient inputs from illegal plant cultivation operations.	2	DEC-2.8	SRCS, STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW	1,4	2 Years	$0	$0	$0	$0	$0	$0
To recruit and provide a continuous supply of spawning gravels into Deer Creek, re-design the Highway 32 culvert crossing at the South Fork of Calf Creek to allow for unimpeded bedload transport.	2	DEC-2.9	SRCS, STE	Caltrans, NMFS, CDFW, Deer Creek Watershed Conservancy, Deer Creek Irrigation Company, Stanford-Vina	1,5	Long-term	$50,000	$0	$0	$0	$0	$50,000
Ensure that timber cutting operations on private lands in the Deer Creek watershed follow the State Forest Practice rules.	2	DEC-2.10	SRCS, STE	Board of Forestry, Deer Creek Watershed Conservancy, SPI, Collins Pine Timber Co	1,4,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Monitor and evaluate the sport fishing regulations for Deer Creek to ensure they are consistent with the recovery of spring-run Chinook salmon and steelhead, and work with the Fish and Game Commission to modify the regulations as needed. Work with CDFW and the Fish and Game Commission to establish and enforce hook size restrictions intended to allow trout fishing, but minimize angling impacts on salmon.	2	DEC-2.11	SRCS, STE	CDFW, NMFS, Deer Creek Watershed Conservancy	2,4	Long-term	$0	$0	$0	$0	$0	$0
Identify stream reaches in Deer Creek that have been most altered by anthropogenic factors and promote development of actions that contribute to the restoration of riparian vegetation and natural river processes.	2	DEC-2.12	SRCS, STE	CDFW, NMFS, Deer Creek Watershed Conservancy, SPI, Collins Pine Timber Co	1,5	Long-term	$0	$0	$0	$0	$0	$0
Curtail further development in the active Deer Creek floodplains through zoning restrictions, county master plans, and other Federal, State, and county planning and regulatory processes.	2	DEC-2.13	SRCS, STE	Local governments, Corps, NMFS, CDFW, grazing interests, Deer Creek Watershed Conservancy	1,4	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Increase monitoring and enforcement to minimize illegal streambank alterations in Deer Creek.	2	DEC-2.14	SRCS, STE	CDFW, Corps, SWRCG, NMFS	1,4,5	Long-term						Cost is covered under action # COC-2.9
Permanently protect Deer Creek riparian habitat through easements and/or land acquisition.	2	DEC-2.15	STE	NMFS, USFWS, DWR, CDFW	1,5	Long-term	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Monitor, evaluate, and adaptively manage the upper Deer Creek rainbow trout stocking program to minimize the potential for adverse impacts to spring-run Chinook salmon or steelhead.	2	DEC-2.16	SRCS, STE	CDFW, NMFS	4,5	5 Years	$0	$0	$0	$0	$0	$0
Evaluate the scientific merits of improving the Upper Falls fish ladder on Deer Creek to allow steelhead access to the upper watershed. The existing ladder will remain closed and improvements to it will not be undertaken unless Deer Creek habitat modeling verifies that: (1) steelhead spawning and rearing habitats below the Upper Falls are limiting steelhead recovery; and (2)	2	DEC-2.17	SRCS, STE	CDFW, NMFS, USBR (Shasta Mitigation)	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
spawning and rearing habitats above the Upper Falls are suitable and necessary to recover the Deer Creek steelhead population.												
Ensure that through the FERC relicensing process for the Fire Mountain Lodge Hydroelectric Project, detailed mitigation and design criteria are implemented to reduce the potential for impacts into downstream anadromous habitat.	3	DEC-3.1	SRCS, STE	FERC, NMFS, USFS	1,5	Long-term	$0	$0	$0	$0	$0	$0

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5.8.4 Big Chico Creek Recovery Actions

Table 5-16. Big Chico Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement fish passage improvement projects at the recreational pools in Bidwell Park.	1	BCC-1.1	SRCS, STE	NMFS, USFWS, CDFW, DWR, Big Chico Watershed Alliance	1	5 Years	$500,000	$0	$0	$0	$0	$500,000
Re-establish spring-run Chinook salmon and steelhead passage at low and moderate flows through Iron Canyon.	1	BCC-1.2	SRCS, STE	City of Chico, USFWS, CDFW, NMFS, Big Chico Creek Ecological Reserve, Chico State University, Butte County, Sierra Nevada Conservancy	1	5 years	$1,000,000					$1,000,000
Continue to implement projects designed to minimize chronic road-related erosion on public and private lands in the Big Chico Creek watershed.	2	BCC-2.1	SRCS, STE	NMFS, USFWS, USFS, CDFW	1,5	Long-term	$0	$0	$0	$0	$0	$0
Enhance watershed resiliency in Big Chico Creek by identifying and implementing projects that would reduce the potential for, and magnitude of, a catastrophic wildfire, and restore forested areas within the watershed including riparian areas.	2	BCC-2.2	SRCS, STE	NMFS, USFWS, CDFW, DWR, Big Chico Watershed Alliance	1,5	Long-term	TBD based on amount and type of habitat restored; initial study is expected to cost at least	TBD	TBD	TBE	TBD	TBD based on amount and type of habitat restored; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
							$50,000.					
Implement projects to increase Big Chico Creek floodplain habitat availability to improve habitat conditions for juvenile rearing	2	BCC-2.3	SRCS, STE	NMFS, USFWS, CDFW, DWR, Big Chico Watershed Alliance	1	Long-term	TBD based on amount of habitat restored; initial study is expected to cost at least $50,000. Per unit cost is $5,000 to $80,000/acre (Appendix D Table HI-4)	TBD	TBD	TBD	TBD	TBD based on amount of habitat restored; initial study is expected to cost at least $50,000. Per unit cost is $5,000 to $80,000/acre (Appendix D Table HI-4)
Identify stream reaches in Big Chico Creek that have been most altered by anthropogenic factors and reconstruct a natural channel geometry scaled to current channel forming flows.	2	BCC-2.4	SRCS, STE	NMFS, USFWS, CDFW, DWR, Big Chico Watershed Alliance	1,5	5 Years	$4,217,625	$0	$0	$0	$0	$4,217,625
Curtail further development in the active Big Chico Creek floodplains through zoning restrictions, county master plans, HCPs, and other Federal, State, and county planning and regulatory processes.	2	BCC-2.5	SRCS, STE	NMFS, USFWS, USFS, Corps, CDFW, DWR, Local governments	1,3, 5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Increase monitoring and enforcement of illegal rip rap applications in Big Chico Creek.	2	BCC-2.6	SRCS, STE	Corps, SWRCB	1,5	Long-term						Cost is covered under action # COC-2.9
Develop education and outreach programs to encourage river stewardship in Big Chico Creek.	2	BCC-2.7	SRCS, STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Districts, Landowners, Local Schools	1	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Increase monitoring and enforcement in Big Chico Creek to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants (SWRCB 2007).	2	BCC-2.8	SRCS, STE	SWRCB, RWQCBs, Local agriculture groups	1,5	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)
Develop a baseline monitoring program to evaluate water quality throughout the watershed to identify areas of concern.	2	BCC-2.9	SRCS, STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, CDFW	1,5	3 Years	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts.	2	BCC-2.10	SRCS, STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, CDFW, DWR, Landowners	1,5	Long-term	$62,400	$0	$0	$0	$0	$62,400

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5.8.5 Butte Creek Recovery Actions

Table 5-17. Butte Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Identify and establish minimum instream flow requirements for Butte Creek that support all life stages of spring-run Chinook salmon and steelhead.	1	BUC-1.1	SRCS, STE	SWRCB, RWQCBs, Local agriculture groups	1	Long-term	$0	$0	$0	$0	$0	$0
Install and maintain real-time flow and water temperature monitoring gages in Butte Creek in order to help make real-time management decisions.	1	BUC-1.2	SRCS, STE	CDFW, DWR, USFWS, NMFS, SWRCB	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop an entrainment monitoring program in Butte Creek to determine the level of take at individual diversions. Prioritize diversions based on this monitoring and screen those	1	BUC-1.3	SRCS, STE	NMFS, USFWS, CDFW, DWR	1,3,5	5 years	$100,000 for monitoring program; costs of screens for Butte Creek TBD	$0	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is estimated at $20 million (San Francisco Estuary Partnership 2007).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
that are determined to have substantial impacts.												
Implement projects that consolidate and screen existing diversions in Butte Creek where feasible.	1	BUC-1.4	SRCS, STE	NMFS, USBR, CDFW, DWR, Irrigation districts, Water districts	1,3,5	Long-term	$50,000	$750,000	$0	$0	$0	$800,000
Develop information to better understand the interaction between surface water and groundwater in the Butte Creek watershed in order to evaluate the potential impacts of water management options (e.g., groundwater sales; conjunctive use) in the watershed on the Butte Creek flow regime.	1	BUC-1.5	SRCS, STE	SWRCB, CDFW, DWR Irrigation districts	4,5	Short-term	$0	$0				$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement projects that improve water temperature management in Butte Creek, including facility modifications to the DeSabla-Centerville Hydroelectric Project.	1	BUC-1.6	SRCS, STE	PG&E, NMFS, CDFW, FERC, SWRCB	1	Short-term	TBD. NMFS is in the process of obtaining the cost from PG&E.					TBD. NMFS is in the process of obtaining the cost from PG&E.
Improve the segregation of Butte Creek spring-run and fall-run Chinook salmon during spawning by development and installation of a more robust separation device or removable weir at or near the Parrott-Phelan diversion dam. The segregation device should allow adult steelhead passage.	1	BUC-1.7	SRCS	CDFW, NMFS, USFWS, PG&E	1	Short-term	< $500,0000					<$500,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement programs and measures designed to control non-native predatory fish in Butte Sink and the Sutter Bypass, including harvest management techniques and programs for non-native predators (e.g., striped bass, largemouth bass, and smallmouth bass).	2	BUC-2.1	SRCS, STE	NMFS, USFWS, CDFW, DWR	2,3	Long-term	TBD	TBD	TBD	TBD	TBD	Cost covered by the cost of SFB-2.5 ($0-$75,000,000).
Increase instream cover in Butte Creek in order to minimize predatory opportunities for striped bass and other non-native predators on anadromous salmonids.	2	BUC-2.2	SRCS, STE	Corps, USFWS, NMFS, CDFW	1,3	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on the # of sites, amount of material needed, type of material, location of source material (onsite vs. imported), and placement method. Cost of initial study to address these issues is $5,000-$50,000. See Table H1-2 in Appendix D for cost per unit for various projects
Implement flow ramping protocols in Butte Creek to protect all life	2	BUC-2.3	SRCS, STE	NMFS, USFWS, CDFW, DWR, PG&E, FERC	1,4	Long-term	TBD	TBD	TBD	TBD	TBD	TBD in the FERC licensing process

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
stages of spring-run Chinook salmon and steelhead.												
Develop and implement a strategy that prioritizes projects with the intent of promoting Butte Creek watershed resiliency and reducing the potential for wildfires.	2	BUC-2.4	SRCS, STE	NMFS, USFWS, CDFW, Butte Creek Watershed Conservancy, PG&E	1,4	Long-term	$0	$0	$0	$0	$0	$0
Identify stream reaches in Butte Creek that have been most altered by anthropogenic factors and develop and implement actions that restore natural river processes; conduct associated public outreach projects. One specific issue that should be addressed by this action is the number of temporary passage	2	BUC-2.5	SRCS, STE	NMFS, USFWS, CDFW, DWR	1	Long-term	$4,217,625	$0	$0	$0	$0	$4,217,625

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
impediments installed to create swimming holes in Butte Creek near Chico.												
Develop and implement programs and projects that focus on maintaining and restoring riparian corridors within the Butte Creek watershed.	2	BUC-2.6	SRCS, STE	NMFS, USFWS, USFS, CDFW, DWR, Local governments	1,4	Long-term	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$150,000 -$675000
Utilize bio-technical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip rap in Butte Creek.	2	BUC-2.7	SRCS, STE	Corps, USBR, NMFS, USFWS, DWR, CDFW, CBDA	1	Long-term	$0	$0	$0	$0	$0	$0
Curtail further development in active Butte Creek floodplains through zoning restrictions, county master plans, and	2	BUC-2.8	SRCS, STE	Corps, NMFS, USFWS, DWR, CDFW, Local governments	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
other Federal, State, and county planning and regulatory processes.												
Develop education and outreach programs to encourage river stewardship in the Butte Creek watershed.	2	BUC-2.9	SRCS, STE	NMFS, USFWS, CDFW, DWR, CSU Chico, Landowners, schools	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Permanently protect riparian habitat in Butte Creek through easements and/or land acquisition	2	BUC-2.10	SRCS, STE	CDFW, Landowners, USFWS	1	Long-term	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Increase monitoring and enforcement in order to minimize illegal streambank alterations in Butte Creek, including high bank gold mining.	2	BUC-2.11	SRCS, STE	Corps, DWR, SWRCB	1,4,5	Long-term						Cost is covered under action # COC-2.9

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Increase water quality monitoring and enforcement in Butte Creek to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants (SWRCB 2007).	2	BUC-2.12	SRCS, STE	SWRCB, RWQCBs, Local agriculture groups	5	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in Butte Creek.	2	BUC-2.13	SRCS, STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Dist, SWRCB, DWR, CDFW, Landowners	5	Long-term	$62,400	$0	$0	$0	$0	$62,400
Implement projects to increase Butte Creek floodplain habitat availability to improve habitat	2	BUC-2.14	SRCS, STE	NMFS, USFWS, CDFW, DWR	1,4	Long-term	TBD based on amount of habitat restored; initial study is expected to cost at least $50,000. Per unit cost is $5,000 to $80,000/acre (Appendix D Table	TBD	TBD	TBD	TBD	TBD based on amount of habitat restored; initial study is expected to cost at least $50,000. Per unit cost is $5,000 to $80,000/acre (Appendix D Table

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
conditions for juvenile rearing							HI-4).					HI-4).
Monitor and evaluate the sport fishing regulations for Butte Creek to ensure they are consistent with the recovery of spring-run Chinook salmon and steelhead, and work with the Fish and Game Commission to modify the regulations as needed.	2	BUC-2.15	SRCS, STE	NMFS, CDFW	2	Long-term	$0	$0	$0	$0	$0	$0
Develop, implement and evaluate a Butte Creek water management option for the PG&E DeSabla-Centerville Hydroelectric Project to determine the flow conditions that optimize coldwater holding habitat and spawning	2	BUC-2.16	SRCS, STE	CDFW, PG&E, FERC, NMFS	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD in the FERC licensing process

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
distribution for spring-run Chinook salmon.												
Maintain state-of-the-art fish passage facilities at diversions in Butte Creek and DWR weir 2 to meet NMFS and CDFW fish passage criteria.	2	BUC-2.17	SRCS, STE	Irrigation districts, DWR	1,4	Long-term	$100,000	$100,000	$100,000	$100,000	$100,000	$500,000 over 25 years; ~$20,000 for each year after that. Estimate of $20,000/year is based on DWR (2004b).
Implement projects to minimize predation at weirs, diversion dams, and related structures in Butte Creek.	3	BUC-3.1	SRCS, STE	NMFS, CDFW, DWR, USFWS, USBR, Corps	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs.	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
												structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about $38,000 annually (BDCP 2013).

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5.8.6 Feather River Recovery Actions

Table 5-18. Feather River Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Establish reproductive isolation between fall-run Chinook salmon and spring-run Chinook salmon naturally spawning in the Feather River.	1	FER-1.1	SRCS	DWR, USFWS, NMFS, CDFW, FERC	1	Long-term	$0	$0	$0	$0	$0	$0 because this is an action required by a settlement agreement in FERC relicensing proceedings for DWR's Oroville Facilities hydroelectric project.
Develop and implement hatchery and genetic management plans for the spring-run Chinook salmon, steelhead, and fall-run Chinook salmon hatchery programs at the Feather River Fish Hatchery.	1	FER-1.2	SRCS, STE	DWR, USFWS, NMFS, CDFW, SWRCB, CVRWQCB, FERC	1,5	Long-term	$0	$0	$0	$0	$0	$0 because this is an action required by a settlement agreement in FERC relicensing proceedings for DWR's Oroville Facilities hydroelectric project.
Identify and implement actions intended to minimize straying of Feather River Hatchery salmon and steelhead.	1	FER-1.3	SRCS, STE	DWR, YCWA, USFWS, NMFS, CDFW, SWRCB, CVRWQCB, and FERC	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	The cost of hatchery measures are included in FER-1.2; the cost of any flow management measures are TBD in FERC licensing proceedings for projects on the Feather and Yuba Rivers.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop a spawning gravel budget, identify gravel depleted areas, and implement an augmentation plan in the Feather River.	1	FER-1.4	SRCS, STE	DWR, CDFW, USFWS, NMFS, SWRCB, and FERC	1	Long-term	$0	$0	$0	$0	$0	$0 because this is an action required by a settlement agreement in FERC relicensing proceedings for DWR's Oroville Facilities hydroelectric project.
Implement and maintain projects to increase side channel habitats in order to improve steelhead spawning habitat availability and quality.	1	FER-1.5	STE	DWR, CDFW, USFWS, NMFS, and FERC	1,4	Long-term	$0	$0	$0	$0	$0	$0 because this is an action required by a settlement agreement in FERC relicensing proceedings for DWR's Oroville Facilities hydroelectric project.
Operate the Feather River Hatchery programs for spring-run Chinook salmon and steelhead as conservation hatchery programs, and develop criteria and a process for phasing out the programs as recovery criteria are reached.	1	FER-1.6	SRCS, STE	NMFS, USFWS, CDFW, DWR	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement projects to minimize predation at weirs, diversion dams, and related structures in the Feather River.	1	FER-1.7	SRCS, STE	NMFS, CDFW, DWR, USFWS, USBR, Corps	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs.	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about $38,000 annually (BDCP 2013).
Implement the lower Feather River Corridor Management Plan and other projects that promote natural river processes (e.g., floodplain and riparian restoration). Federal, State, and local agencies should	1	FER-1.8	SRCS, STE	DWR, CDFW, Corps	1,4	Long-term	TBD	TBD	TBD	TBD	TBD	TBD. NMFS is in the process of obtaining the cost information from DWR.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
use their authorities to develop and implement programs and projects that focus on retaining, restoring and creating active floodplain and riparian corridors within their jurisdiction in the Feather River watershed.												
Implement projects to improve near shore refuge cover for salmonids in the Feather River to minimize predatory opportunities for striped bass and other non-native predators.	1	FER-1.9	SRCS, STE	DWR, CDFW, Corps	1,3,4	Short-term	TBD	TBD				TBD, based on the # of sites, amount of material needed, type of material, location of source material (onsite vs. imported), and placement method. Cost of initial study to address these issues is $5,000-$50,000. See Table H1-2 in Appendix D for cost per unit for various projects
Manage releases from Oroville Dam with instream flow schedules and criteria to provide suitable water temperatures for all life	1	FER-1.10	SRCS, STE	NMFS, USFWS, CDFW, DWR, SWRCB, FERC	1,5	Long-term	$0	$0	$0	$0	$0	$0, because this is an action required by a settlement agreement in FERC relicensing proceedings for DWR's Oroville Facilities hydroelectric project.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
stages, reduce stranding and isolation, protect incubating eggs from being dewatered, and promote habitat availability.												
Implement a habitat expansion plan that meets the criteria of the Habitat Expansion Agreement, or develop and implement a program to reintroduce spring-run Chinook salmon and steelhead to historic habitats upstream of Oroville Dam in the North Fork Feather River. The program should include feasibility studies, habitat evaluations, fish passage design studies, and a pilot reintroduction phase prior to implementation of the long-term	2	FER-2.1	SRCS, STE	NMFS, USFWS, CDFW, DWR, PG&E, USFS, FERC	1,5	Long-term	$200,000	$4,000,000	$15,000,000	$17,000,000	$14,000,000	$50,200,000 (Cost estimate is for reintroducing spring-run Chinook salmon and steelhead to the North Fork Feather River.)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
reintroduction program.												
Implement a habitat expansion plan that meets the criteria of the Habitat Expansion Agreement, or implement actions to enhance habitat conditions and improve access within the north fork Feather River upstream of Oroville Dam, including increasing minimum flows, providing passage at upstream dams, and assessing feasibility of passage improvement at natural barriers.	2	FER-2.2	SRCS, STE	NMFS, USFWS, CDFW, DWR, PG&E, USFS, FERC	1,4,5	Long-term	TBD	TBD	TBD	TBD	TBD	$50,000 for habitat evaluation and identification of specific enhancement actions; cost of actions TBD
Implement a study designed to develop quantitative estimates of	2	FER-2.3	SRCS, STE	NMFS, USFWS, CDFW, DWR	3,4	5 Years	$200,000-$400,000	$0	$0	$0	$0	$200,000-$400,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
predation on spring-run Chinook salmon and steelhead in the Feather River.												
Implement programs and measures designed to minimize predation on juvenile salmonids in the Feather River, including harvest management techniques and programs for non-native predators (e.g., striped bass, largemouth bass, and smallmouth bass).	2	FER-2.4	SRCS, STE	NMFS, USFWS, CDFW, DWR	2,3,4	Long-term						Cost covered by the cost of SFB-2.5 ($0-$75,000,000).
Curtail further development in the active Feather River floodplains through zoning restrictions, county master plans, and other Federal, State, and county planning and regulatory processes.	2	FER-2.5	SRCS, STE	Corps, NMFS, USFWS, DWR, CDFW, Local governments	1,4,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Utilize fish friendly designs (e.g., levee setbacks, inclusion of riparian vegetation) for levee construction and maintenance.	2	FER-2.6	SRCS, STE	Corps, SWRCB	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop education and outreach programs to encourage river stewardship in the Feather River, including how to identify and avoid damaging salmon and steelhead redds.	2	FER-2.7	SRCS, STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Districts, DWR, CDFW, CSU Chico, Landowners, schools, Feather River Nature Center	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Permanently protect Feather River riparian and floodplain habitat through easements and/or land acquisition.	2	FER-2.8	SRCS, STE	NMFS, CDFW, DWR, Corps	1,5	Long-term	TBD based on amount specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD based on amount specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Monitor and evaluate the sport fishing regulations for the Feather River to ensure they are consistent with the recovery of	2	FER-2.9	SRCS, STE	NMFS, CDFW	2	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
spring-run Chinook salmon and steelhead.												
Negotiate agreements with landowners and Federal and State agencies to provide additional instream flows or purchase water rights in the Feather River.	2	FER-2.10	SRCS, STE	USFWS, NMFS, Corps, USBR, Resource Conservation Districts, CDFW, DWR, Water districts, Landowners, Local governments, NGOs	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of water. Cost per unit is $43 - $88/af/year for upstream of Delta water purchases (Appendix D)
Evaluate pulse flow benefits in the Feather River for adult immigration and juvenile outmigration during peak migration periods for years with low water availability; if pulse flows are determined to be effective for attracting adult spring-run Chinook salmon and steelhead or for improving survival during juvenile	2	FER-2.11	SRCS, STE	DWR, USFWS, NMFS, CDFW, FERC, YCWA, PG&E, NID	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD in FERC license proceedings.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
outmigration, implement the most beneficial pulse flow regime.												
Develop an entrainment and predator monitoring program in the Feather River to determine the level of take at individual diversions and screen those with the highest take level relative to screen cost.	2	FER-2.12	SRCS, STE	NMFS, CDFW, Irrigation districts, Water districts	1,3,5	5 years	$100,000 for monitoring program; screening costs are TBD.	$0	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is estimated at $20 million (San Francisco Estuary Partnership 2007).
Modify Sunset Pumps to provide unimpeded upstream passage of adult steelhead and Chinook salmon (and sturgeon) and to minimize predation of juveniles moving downstream.	2	FER-2.13	SRCS, STE	DWR	1,3,5	Short-term	$50,000 to identify and design a preferred modification; cost of modification TBD after the initial study.	$0	$0	$0	$0	$50,000 to identify and design a preferred modification; cost of modification TBD after the initial study.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop a baseline monitoring program in the Feather River to evaluate water quality throughout the watershed to identify areas of concern and disseminate the information to resource managers.	2	FER-2.14	SRCS, STE	DWR, CDFW	1,5	3 Years	$0	$0	$0	$0	$0	$0
Develop and apply alternative diversion technologies that eliminate entrainment in the Feather River.	3	FER-3.1	SRCS, STE	NMFS, CDFW, Irrigation districts, Water districts	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD. This action involves development of a new technology such that is impracticable to provide a reasonable estimate of the action's cost.
Implement pollution control programs and projects to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met in the Feather River for all potential pollutants.	3	FER-3.2	SRCS, STE	SWRCB, CVRWQCB, Local agriculture groups	1,5	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Pursue grant funding or cost-share payments for landowners to prepare plans and implement best-management practices to reduce water quality impacts in the Feather River watershed.	3	FER-3.3	SRCS, STE	USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW	1,5	Long-term	$62,400	$0	$0	$0	$0	$62,400

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5.8.7 Yuba River Recovery Actions

Table 5-19. Yuba River Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop and implement a program to reintroduce spring-run Chinook salmon and steelhead to historic habitats upstream of Englebright Dam. The program should include feasibility studies, habitat evaluations, fish passage design studies, and a pilot reintroduction phase prior to implementation of the long-term reintroduction program.	1	YUR-1.1	SRCS, STE	NMFS, USFWS, USFS, CDFW, Corps, PG&E, NIC, YCWA, FERC	1, 4	Long-term: Evaluations beginning in year 1 , Pilot	$200,000	$4,000,000	$15,000,000	$17,000,000	$14,000,000	$50,200,000
Improve spawning habitat in the Englebright Dam Reach (Englebright Dam [RM 24] downstream to the Deer Creek confluence	1	YUR-1.2	SRCS, STE	NMFS, USFWS, Corps, CDFW	1	Long-term	$5.9 million for spawning rehabilitation (DWR and PG&E 2010)	$800,000 for maintenance	$800,000 for maintenance	$800,000 for maintenance	$800,000 for maintenance	$9, 900,000 over 25 years; $800,000 for each additional 5-year block.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
[RM 23]) through habitat rehabilitation and a long-term gravel injection program (Pasternack 2009).												
Develop programs and implement projects that promote natural river processes, including projects that add riparian habitat and instream cover.	1	YUR-1.3	SRCS, STE	YCWA, Corps, CDFW, SYRCL, USFS, USFWS	1	Long-term	$4,217,625	$0	$0	$0	$0	$4,217,625
Modify Daguerre Point Dam to provide unobstructed volitional upstream passage of adult steelhead and Chinook salmon (and sturgeon) and to minimize predation of juveniles moving downstream.	1	YUR-1.4	SRCS, STE	YCWA, Corps, CDFW, SYRCL, USFWS	1,4	Long-term	Cost estimates for fish passage alternatives range from $2.5 million to construct an engineered channel to $97 million to remove the dam (DWR and Corps 2003).	Operation and maintenance costs range from $50,000 to $2,000,000 per year (DWR and Corps 2003)	Operation and maintenance costs range from $50,000 to $2,000,000 per year (DWR and Corps 2003)	Operation and maintenance costs range from $50,000 to $2,000,000 per year (DWR and Corps 2003)	Operation and maintenance costs range from $50,000 to $2,000,000 per year (DWR and Corps 2003)	$3.5 million to $137 million based on DWR and Corps (2003) estimates, and assuming construction during years 1-5 and operation and maintenance costs during years 6-25.
Develop and implement a large woody material restoration	2	YUR-2.1	SRCS, STE	NMFS, USFWS, Corps, USBR, DWR, CDFW	1	Long-term	$750,000 - $2,000,000	$750,000 - $2,000,000	$750,000 - $2,000,000	$750,000 - $2,000,000	$750,000 - $2,000,000	$3,750,000 - $10,000,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
program along the lower Yuba River utilizing sources of wood that enter upstream reservoirs.												
Increase floodplain habitat availability in the lower Yuba River.	2	YUR-2.2	SRCS, STE	CDFW, USFWS, NMFS, YCWA	1	Long-term	TBD	TBD	TBD	TBD	TBD	TBD based on several factors including: (1) how much floodplain habitat is to be restored; (2) the amount of material that needs to be removed; (3) whether the removed material can be sold and at what price; and (4) whether the newly available floodplain is planted or vegetation is allowed to colonize naturally. Initial evaluation to address these factors estimated at up to $200,000.
Curtail further development in active Yuba River floodplains through zoning restrictions, county master plans, and other Federal, State, and	2	YUR-2.3	SRCS, STE	YCWA, Corps, CDFW, SYRCL, USFS, FERC, USFWS	1	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
county planning and regulatory processes.												
Create and restore side channel habitats to increase the quantity and quality of off-channel rearing and spawning areas in the Yuba River.	2	YUR-2.4	SRCS, STE	YCWA, Corps, CDFW, SYRCL, USFS, FERC, USFWS	1	Short-term	TBD	TBD				TBD based on the amount of side channel habitat restoration. Unit cost is $20,000 to $300,000/acre (Appendix D). Initial evaluation estimated at $5,000-$50,000
Federal, State, and local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring and creating river riparian corridors within their jurisdiction in the Yuba River watershed.	2	YUR-2.5	SRCS, STE	NMFS, USWS, FERC, CDFW, DWR, YCWA	1	Long-term	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$150,000 - $675000
Permanently protect Yuba River riparian and floodplain habitat through easements and/or land	2	YUR-2.6	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR, Yuba Watershed Council	1	Long-term	TBD based on specific easements and land acquisitions; initial study is expected	TBD	TBD	TBD	TBD	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
acquisition.							to cost at least $50,000.					
Implement flow fluctuation and ramping rates found to be protective of embryos and juveniles.	1	YUR-2.7	SRCS, STE	YCWA, NMFS, USFWS, Corps, CDFW, DWR, PG&E, NID, SYRCL, Yuba Watershed Council	1	Long-term	Costs TBD in FERC licensing proceedings	Costs TBD in FERC licensing proceedings	Costs TBD in FERC licensing proceedings	Costs TBD in FERC licensing proceedings	Costs TBD in FERC licensing proceedings	Costs TBD in FERC licensing proceedings
Implement programs and measures designed to minimize predation by non-native fish in the Yuba River, including harvest management techniques and programs for non-native predators (e.g., striped bass, largemouth bass, and smallmouth bass).	2	YUR-2.8	SRCS, STE	NMFS, USFWS, CDFW, DWR, YCWA, South Yuba and Brophy Water Districts	2,3	Long-term						Cost covered by the cost of SFB-2.5 ($0-$75,000,000).
Improve efficiency of screening devices at Hallwood-Cordua and Brophy-South Yuba water diversions, and	2	YUR-2.9	SRCS, STE	NMFS, CDFW, YCWA, South Yuba and Brophy Water Districts	1,4	Short-term	$200,000	$0	$0	$0	$0	$200,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
construct screens at unscreened diversions												
Evaluate whether salmonid straying between the Feather and Yuba rivers can be minimized through flow management.	2	YUR-2.10	SRCS, STE	NMFS, USFWS, Corps, DWR, YCWA	1,4	Short-term	$5,000 for initial study to develop goals, objectives, experimental design, and statistical analysis; cost of the evaluation is TBD based on the initial study.	TBD	TBD	TBD	TBD	$5,000 for initial study to develop goals, objectives, experimental design, and statistical analysis; cost of the evaluation is TBD based on the initial study.
Monitor and evaluate the sport fishing regulations for the Yuba River to ensure they are consistent with the recovery of spring-run Chinook salmon and steelhead.	2	YUR-2.11	SRCS, STE	NMFS, CDFW,SYRCL, Yuba Watershed Council	2	Short-term	$0	$0	$0	$0	$0	$0
Relocate the riverside motocross recreation area outside of the Yuba River's active floodplain.	3	YUR-3.1	SRCS, STE	CDFW, Yuba County, Yuba Watershed Council	2	5 Years	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Utilize bio-technical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip rap in the Yuba River.	3	YUR-3.2	SRCS, STE	NMFS, USFWS, USBR, DWR, CDFW, CBDA	1	Long-term	$0	$0	$0	$0	$0	$0
Identify the benefits, risks, and costs associated with various techniques and locations for spatially segregating spring-run Chinook salmon and fall-run Chinook salmon during spawning in the Yuba River. If the benefits sufficiently outweigh the risks and costs, then implement a project to segregate spring- and fall-run Chinook salmon.	3	YUR-3.3	SRCS, STE	NMFS, CDFW, YCWA, Yuba Watershed Council, PG&E	1	Short-term	$10,000 for benefit, risk, and cost evaluation. Cost of segregation TBD based on the evaluation.	$0	$0	$0	$0	$10,000 for benefit, risk, and cost evaluation. Cost of segregation TBD based on the evaluation.

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5.8.8 Dry Creek Recovery Actions

Table 5-20. Dry Creek Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Conduct an anadromous fish passage assessment in Dry Creek and implement projects to fix any obstructions.	3	DRC-3.1	STE	NMFS, USFWS, USFS, CDFW, DWR, Yuba Watershed Council, Bear River Watershed Group	1	5 Years	$50,000-$200,000, fish passage project(s) cost TBD by the assessment.	$0	$0	$0	$0	$50,000-$200,000, fish passage project(s) cost TBD by the assessment.
Enhance watershed resiliency in Dry Creek by identifying and implementing projects that would reduce the potential for, and magnitude of, a catastrophic wildfire, and restore forested areas within the watershed including riparian areas.	3	DRC-3.2	STE	NMFS, USFWS, USFS, CDFW, DWR, Yuba Watershed Council, Bear River Watershed Group	1	Long-term	TBD based on amount and type of habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBE	TBD	TBD based on amount and type of habitat restored; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Continue to implement projects designed to minimize chronic road-related erosion on public and private lands in the Dry Creek watershed.	3	DRC-3.3	STE	NMFS, USFWS, National Park Service, SWRCB, DWR, CDFW, Dry Creek Conservancy, Placer County, Sierra College	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop education and outreach programs to encourage river stewardship in Dry Creek.	3	DRC-3.4	STE	NMFS, USFWS, National Park Service, SWRCB, DWR, CDFW, Dry Creek Conservancy, Placer County, Sierra College	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in the Dry Creek watershed.	3	DRC-3.5	STE	NMFS, USFWS, National Park Service, SWRCB, DWR, CDFW, Dry Creek Conservancy, Placer County, Sierra College	1,5	Long-term	$62,400	$0	$0	$0	$0	$62,400
Develop a long-term strategy for monitoring and regulating discharges from agricultural lands in the Dry Creek watershed to protect waters within the Central Valley, including enforcing the regulations.	3	DRC-3.6	STE	SWRCB, NRCS, Placer County	1,5	Long-term	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement in Dry Creek to ensure that the water quality criteria established in the Central	3	DRC-3.7	STE	SWRCB, CVRWQCB, Local agriculture groups	1,5	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants.												
Conduct a hydrologic analysis of the Dry Creek watershed that explores conjunctive use opportunities to reduce water allocations that are dependent on surface water.	3	DRC-3.8	STE	NMFS, USFWS, National Park Service, SWRCB, DWR, CDFW, Dry Creek Conservancy, Placer County, Sierra College	1	Long-term	$275,550	$0	$0	$0	$0	$275,550
Evaluate gravel resources on Dry Creek and provide gravel at any identified locations.	3	DRC-3.9	STE	NMFS, USFWS, National Park Service, SWRCB, DWR, CDFW, Dry Creek Conservancy, Placer County, Sierra College	1,5	Short-term	$5,000-$50,000 for evaluation; gravel augmentation costs TBD based on the evaluation.	$0	$0	$0	$0	$5,000-$50,000 for evaluation; gravel augmentation costs TBD based on the evaluation.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Curtail further development in the active Dry Creek floodplains through zoning restrictions, county master plans, and other Federal, State, and county planning and regulatory processes.	3	DRC-3.10	STE	NMFS, USFWS, National Park Service, SWRCB, DWR, CDFW, Dry Creek Conservancy, Placer County, Sierra College	1,5	Long-term	$0	$0	$0	$0	$0	$0
Utilize bio-technical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip rap in Dry Creek.	3	DRC-3.11	STE	NMFS, USFWS, Corps, USBR, CDFW, DWR, CBDA	1	Long-term	$0	$0	$0	$0	$0	$0
Permanently protect Dry Creek riparian habitat through easements and/or land acquisition	3	DRC-3.12	STE		1,5	Long-term	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Monitor and evaluate the sport fishing regulations for Dry Creek to ensure they are consistent with the recovery of steelhead.	3	DRC-3.13	STE	NMFS, CDFW	2	Long-term	$0	$0	$0	$0	$0	$0
Implement programs and measures designed to control non-native predatory fish in Dry Creek (NMFS 2007b), including harvest management techniques and programs for non-native predators (e.g., striped bass, largemouth bass, and smallmouth bass).	3	DRC-3.14	STE	NMFS, USFWS, CDFW, DWR	1,3	Long-term						Cost covered by the cost of SFB-2.5 ($0-$75,000,000).
Implement projects to minimize predation at weirs, diversion dams, and related structures in Dry Creek.	3	DRC-3.15	STE	NMFS, CDFW, DWR, USFWS, USBR, Corps	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
							site-specific costs.					specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about $38,000 annually (BDCP 2013).
Improve instream refuge cover for salmonids in Dry Creek to minimize predatory opportunities for striped bass and other non-native predators.	3	DRC-3.16	STE	NMFS, USFWS, CDFW, DWR	1,3	Long-term	TBD, based on the # of sites, # of miles, type of material, location of source material (onsite vs. imported), and placement method. Initial scoping to address those issues would cost at least $50,000. See Table H1-2 in Appendix D for cost per unit for various projects.	TBD	TBD	TBD	TBD	TBD, based on the # of sites, amount of material needed, type of material, location of source material (onsite vs. imported), and placement method. Cost of initial study to address these issues is $5,000-$50,000. See Table H1-2 in Appendix D for cost per unit for various projects

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5.8.9 Auburn Ravine Recovery Actions

Table 5-21. Auburn Ravine Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Install a fish ladder at Gold Hill Dam and screen the diversion canal.	2	AUR-2.1	SRCS, STE	SWRCB, CVRWQCB, Local farmers, SARSAS	1,5	5 Years	<$1 million	$0	$0	$0	$0	<$1 million
Develop an entrainment monitoring program in Auburn Ravine and Coon Creek to determine the level of take at individual diversions. Prioritize diversions based on this monitoring and screen those that are determined to have substantial impacts at the population level.	2	AUR-2.2	STE	NMFS, USFWS, CDFW, DWR, Placer County, Irrigation districts, SARSAS	1,3,5	5 years	$100,000 for monitoring program; screening costs for Auburn Ravine are TBD.	$0	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is estimated at $20 million (San Francisco Estuary Partnership 2007).
Develop and apply alternative diversion technologies that eliminate entrainment in Auburn Ravine and Coon Creek.	2	AUR-2.3	STE	NMFS, USFWS, CDFW, DWR, Placer County, Irrigation districts, SARSAS	1	Long-term	TBD	TBD	TBD	TBD	TBD	TBD. •This action involves development of a new technology such that is impracticable to provide a reasonable estimate of the action's cost.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement projects that consolidate and screen existing diversions in Auburn Ravine and Coon Creek where feasible.	2	AUR-2.4	STE	NMFS, USBR, CDFW, DWR, Irrigation districts, Water districts, SARSAS	1,3,5	Long-term	$200,000	$200,000	$0	$0	$0	$400,000
Conduct a hydrologic analysis of the Auburn/Coon Creek watershed that explores conjunctive use opportunities to reduce water allocations that are dependent on surface water.	2	AUR-2.5	STE	NMFS, USFWS, Corps, USBR, CDFW, DWR, SARSAS, PCWA	5	Long-term	$275,550	$0	$0	$0	$0	$275,550
Enhance watershed resiliency in Auburn Ravine and Coon Creek by identifying and implementing projects that would reduce the potential for, and magnitude of, a catastrophic wildfire, and restore forested areas within the watershed including riparian areas.	2	AUR-2.6	STE	NMFS, USFWS, USFS, CDFW, DWR, Placer County, SARSAS, PCWA	1	Long-term	TBD based on amount and type of habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBE	TBD	TBD based on amount and type of habitat restored; initial study is expected to cost at least $50,000.
Continue to implement projects designed to minimize chronic road-related erosion on public and private lands in the	2	AUR-2.7	STE	NMFS, USFWS, USFS, CDFW, Placer County, SARSAS	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Auburn Ravine and Coon Creek watershed.												
Develop a baseline monitoring program in Auburn Ravine and Coon Creek to evaluate water quality throughout the watershed to identify areas of concern.	2	AUR-2.8	STE	NMFS, USFWS, USEPA, SWRCB, DWR, CDFW, Placer County, SARSAS	5	3 Years	$0	$0	$0	$0	$0	$0
Develop education and outreach programs to encourage river stewardship in the Auburn Ravine/Coon Creek watershed.	2	AUR-2.9	STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW, Landowners, Placer County, SARSAS, PCWA	2	Long-term	$76,140	$76,140	$76,140	$76,140	$0	$304,560

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in the Auburn Ravine/Coon Creek watershed.	2	AUR-2.10	STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW, Placer County, Local farmers	5	Long-term	$62,400	$0	$0	$0	$0	$62,400
Develop a long-term strategy for monitoring and regulating discharges from agricultural lands in the Auburn Ravine/Coon Creek watershed to protect waters within the Central Valley, including enforcing the regulations.	2	AUR-2.11	STE	SWRCB, Local farmers	5	Long-term	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement in Auburn Ravine and Coon Creek to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met (SWRCB 2007).	2	AUR-2.12	STE	SWRCB, CVRWQCB, Local agriculture groups	1,5	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Identify stream reaches in Auburn Ravine and Coon Creek that have been most altered by anthropogenic factors and reconstruct a natural channel geometry scaled to current channel forming flows.	2	AUR-2.13	STE	NMFS, USFWS, CDFW, DWR, SARSAS	5	5 Years	$4,217,625	$0	$0	$0	$0	$4,217,625
Curtail further development in the active Auburn Ravine and Coon Creek floodplains through zoning restrictions, county master plans, and other Federal, State, and county planning and regulatory processes.	2	AUR-2.14	STE	NMFS, USFWS, Corps, USFS, DWR, CDFW, Local governments	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop State and national levee vegetation policies to maintain and restore riparian corridors in Auburn Ravine and Coon Creek (Corps vegetation management policy and FloodSAFE).	2	AUR-2.15	STE	NMFS, USFWS, Corps, USBR, CDFW, DWR	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement programs and projects that focus on retaining, restoring and creating river riparian corridors within their jurisdiction in the Auburn Ravine/Coon Creek watershed.	2	AUR-2.16	STE	NMFS, USFWS, Corps, USBR, USFS, DWR, CDFW, Local agencies, NGOs	1,5	Short-term	TBD	TBD	$0	$0	$0	TBD based on amount of riparian habitat to be restored. As identified in Appendix D, per unit costs vary depending on whether fencing, planting, irrigation, or invasive week control are needed. Initial scoping study estimated to cost $5,000-$50,000.
Utilize bio-technical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip rap in Auburn Ravine and Coon Creek.	2	AUR-2.17	STE	NMFS, USFWS, Corps, USBR, DWR, CDFW, CBDA	1	Long-term	$0	$0	$0	$0	$0	$0
Permanently protect Auburn and Coon Creek riparian habitat through easements and/or land acquisition	2	AUR-2.18	STE	NMFS, USFWS, CDFW, DWR, SARSAS	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Implement programs and measures in Auburn Ravine and Coon Creek designed to control non-native predators.	2	AUR-2.19	STE	NMFS, USFWS, CDFW, DWR, SARSAS	1,3	Long-term	Cost covered by the cost of SFB-2.5 ($0-$75,000,000).	TBD	TBD	TBD	TBD	Cost covered by the cost of SFB-2.5 ($0-$75,000,000).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement projects to minimize predation at weirs, diversion dams, and related structures in Auburn Ravine and Coon Creek.	2	AUR-2.20	STE	NMFS, CDFW, DWR, USFWS, USBR, Corps, SARSAS	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs. P	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about $38,000 annually (BDCP 2013).
Improve instream refuge cover for salmonids in Auburn Ravine and Coon Creek to help minimize predation.	2	AUR-2.21	STE	NMFS, USFWS, CDFW, DWR, SARSAS	1,3	Long-term	TBD, based on the # of sites, # of miles, type of material, location of source material (onsite vs. imported), and placement method. Initial scoping to address those issues would cost at least $50,000. See Table H1-2 in Appendix D for cost per unit for various projects.	TBD	TBD	TBD	TBD	TBD, based on the # of sites, # of miles, type of material, location of source material (onsite vs. imported), and placement method. Initial scoping to address those issues would cost at least $50,000. See Table H1-2 in Appendix D for cost per unit for various projects.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Monitor and evaluate the sport fishing regulations for Auburn Ravine and Coon Creek to ensure they are consistent with the recovery of steelhead.	3	AUR-3.1	STE	NMFS, CDFW	1,2	Long-term	$0	$0	$0	$0	$0	$0

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5.8.10 American River Recovery Actions

Table 5-22. American River Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop and implement a steelhead reintroduction plan to re-colonize historic habitats above Nimbus and Folsom Dams: Conduct feasibility study; Conduct habitat evaluations; Conduct 3-5 year pilot testing program; and Implement long-term fish passage.	1	AMR-1.1	STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW, FERC, PG&E, PCWA	1,5	Long-term: Evaluations beginning in year 1	$200,000	$4,000,000	$15,000,000	$17,000,000	$14,000,000	$50,200,000
Implement physical and structural modifications to the American River Division of the CVP in order to improve water temperature management (See RPA action II.3 in the 2009 Biological Opinion for the long-term operations of the CVP and SWP) (NMFS 2009b).	1	AMR-1.2	STE	NMFS, USFWS, Corps, USBR, DWR, CDFW, CBDA, Water Forum	1,4	Long-term	$0	$0	$00	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop an annual water temperature management plan for the lower American River (NMFS 2009b).	1	AMR-1.3	STE	USFWS, USBR, CDFW, DWR, Water Forum	1,5	Long-term	$0	$0	$0	$0	$0	$0
Implement the flow management related actions (i.e., RPA actions II.1 and II.4) identified in the reasonable and prudent alternative from the 2009 Biological Opinion for the long-term operations of the CVP and SWP (NMFS 2009b).	1	AMF-1.4	STE	USFWS, USBR, CDFW, DWR, Water Forum	1,4	Long-term	$0	$0	$0	$0	$0	$0
Implement a long-term gravel management program in the lower American River to provide suitable spawning habitat per CVPIA.	1	AMR-1.5	STE	USFWS, USBR, Water Forum	1,4	Long-term	$1,000,000[28]	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$5,000,000
Implement a long-term wood management program to provide habitat	1	AMR-1.6	STE	USFWS, USBR, CDFW, Water Forum	1,4,5	Long-term)	$100,000	$200,000	$250,000	$300,000	$300,000	$1,150,000

[28] Based on cost of 2013-2016 CVPIA funded gravel augmentation project for the American River.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
complexity and predator refuge habitat.												
Implement the recommendations of the 2012 California Hatchery Scientific Review Group Report regarding the steelhead program at Nimbus Hatchery.	1	AMR-1.7	STE	USBR, CDFW	4,5	Long-term	$0	$0	$0	$0	$0	$0
Develop and implement a HGMP for the steelhead program at Nimbus Hatchery (NMFS 2009b).	1	AMR-1.8	STE	USBR, CDFW	2,5	Long-term	$0	$0	$0	$0	$0	$0
Develop a baseline monitoring program in the American River watershed to evaluate water quality throughout the watershed to identify areas of concern.	2	AMR-2.1	STE	NMFS, USFWS, USEPA, SWRCB, DWR, CDFW	1,5	3 Years	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement in the American River watershed to ensure that the water quality	2	AMR-2.2	STE	SWRCB, CVRWQCB	1,4	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants.												
Implement projects that improve wastewater and stormwater treatment in residential, commercial, and industrial areas throughout the American River watershed.	2	AMR-2.3	STE	NMFS, CDFW, SWRCB, Water Forum, Sacramento County and cities germane to this issue.	4,5	Long-term	TBD	TBD	TBD	TBD	TBD	Cost partly covered in DEL-2.20 ($1-$2 billion). Other costs TBD based on site-specific evaluations, each of which could range up to $100,000.
Develop education and outreach programs to encourage river stewardship in the American River watershed.	2	AMR-2.4	STE	Corps, NMFS, USFWS, DWR, CDFW, American River Conservancy, Local government, Water Forum	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Develop and implement programs and projects that focus on retaining, restoring and creating river riparian corridors within their	2	AMR-2.5	STE	NMFS, USFWS, Corps, USBR, USFS, DWR, CDFW, Local agencies, NGOs	1,4	Long-term	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$150,000 -$675,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
jurisdiction in the American River watershed.												
Permanently protect American River riparian habitat through easements and/or land acquisition	2	AMR-2.6	STE	Local govt, Corps, SAFCA, CDFW	1,5	short-term	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Utilize bio-technical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip rap in the American River.	2	AMR-2.7	STE	Corps, USBR, NMFS, USFWS, DWR, CDFW, CBDA	1	Long-term	$0	$0	$0	$0	$0	$0
Curtail further development in active American River floodplains through zoning restrictions, county master plans, and other Federal, State, and county planning and regulatory processes.	2	AMR-2.8	STE	Corps, NMFS, USFWS, USFS, DWR, CDFW, Local governments	1,4,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Inventory locations on the American River for creating shallow inundated floodplain habitat for multi-species benefits and implement where suitable opportunities are available (Water Forum 2001).	2	AMR-2.9	STE	NMFS, USFWS, USBR, Corps, CDFW, DWR, Water Forum	1	Long-term	$0	$0	$0	$0	$0	$0
Modify sport-fishing regulations to minimize "take" of wild steelhead and to minimize hatchery influence in the lower American River. This could include increased information in the regulations about not wading through redds and increasing the bag and possession limit for hatchery steelhead.	3	AMR-3.1	STE	NMFS, CDFW	2,5	short-term	$0	$0	$0	$0	$0	$0

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5.8.11 Mokelumne River Recovery Actions

Table 5-23. Mokelumne River Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Adaptively manage water releases in the Mokelumne River in consideration of the spatial and temporal distribution of steelhead life stages in the Mokelumne River.	1	MOR-1.1	STE	NMFS, USFWS, CDFW, DWR, Landowners, Irrigation districts	1	Long-term	$0	$0	$0	$0	$0	$0
Manage cold water pools in Camanche and Pardee reservoirs to provide suitable water temperatures in the Mokelumne River for all steelhead life stages.	1	MOR-1.2	STE	NMFS, USFWS, USBR, CDFW, EBMUD	1	Long-term	$278,030 for evaluation of alternative reservoir management practices; cost of any operational changes TBD based on the evaluation.	TBD	TBD	TBD	TBD	$278,030 for evaluation of alternative reservoir management practices; cost of any operational changes TBD based on the evaluation.
Implement the recommendations of the 2012 California Hatchery Scientific Review Group Report regarding the steelhead program at Mokelumne Hatchery.	1	MOR-1.3	STE	NMFS, USFWS, CDFW, DWR	4, 5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD; Specific actions to be taken and associated costs will be identified by the Mokelumne River Hatchery Coordination Team that will be formed according to the recommendation from the Hatchery Scientific Review Group.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Continue to develop and implement a spawning gravel augmentation plan for the Mokelumne River.	2	MOR-2.1	STE	NMFS, USFWS, USBR, CDFW, DWR	1,5	Long-term	$50,000 for plan development; gravel augmentation costs TBD	TBD	TBD	TBD	TBD	$50,000-TBD
Conduct feasibility studies for allowing steelhead access to habitat above Camanche and Pardee dams, including assessing habitat suitability and fish passage logistics.	2	MOR-2.2	STE	NMFS, USFWS, USBR, DWR, PG&E, FERC	1	Short-term	$720,000	$0	$0	$0	$0	$720,000
If the feasibility studies suggest that fish passage can be successful, then design and conduct an experimental fish passage program evaluating adult distribution, survival, spawning, and juvenile production in habitats above Camanche and Pardee dams.	2	MOR-2.3	STE	NMFS, USFWS, USBR, DWR	1	Short-term	$0	$9,000,000	$0	$0	$0	$9,000,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
If the experimental fish passage program demonstrates that passage above Camanche and Pardee dams can substantively contribute to the long-term viability of the DPS, then develop and implement long-term fish passage programs.	2	MOR-2.4	STE	NMFS, USFWS, USBR, DWR	1	Long-term	$0	$0	$3,500,000	$3,500,000	$3,500,000	10,500,000
Evaluate the adequacy of the existing flow regime through SWRCB processes, and dedicate flows as necessary.	2	MOR-2.5	STE	NMFS, USFWS, CDFW, SWRCB	1,5	Long-term	$0	$0	$0	$0	$0	$0
Negotiate agreements with landowners, water districts, and Federal and State agencies to provide additional instream flows or purchase water rights, and/or restore riparian habitat to promote shading in the Mokelumne River.	2	MOR-2.6	STE	USFWS, NMFS, Corps, USBR, Resource Conservation Districts, CDFW, DWR, Water Districts, Landowners, Local governments, NGOs	1, 5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on : (1) amount of water. Cost per unit is $43 - $88/af/year for upstream of Delta water purchases (Appendix D); and (2) amount of habitat restored. As identified in Appendix D, per unit costs for riparian restoration vary depending on whether fencing, planting, irrigation, or invasive weed control are needed. Evaluation of water available for acquisition and riparian habitat

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
												restoration opportunities could range up to $100,000.
Evaluate pulse flow benefits for steelhead attraction and passage in the Mokelumne River; if pulse flows are determined to be effective for attracting steelhead, implement the most beneficial pulse flow regime.	2	MOR-2.7	STE	NMFS, USFWFS, USBR, CDFW, DWR	1	Long-term	$0	$0	$0	$0	$0	$0
Monitor and evaluate sport-fishing regulations to ensure that angling impacts on steelhead in the Mokelumne River are consistent with recovery.	2	MOR-2.8	STE	NMFS, CDFW	1, 2	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Implement outreach projects in the Mokelumne River basin to educate the public regarding the steelhead life cycle and watershed stewardship.	2	MOR-2.9	STE	NMFS, USFWS, USBR, CDFW, DWR	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in the Mokelumne River.	2	MOR-2.10	STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Districts, CDFW, DWR, Landowners	1, 5	Long-term	$62,400	$0	$0	$0	$0	$62,400
Increase monitoring and enforcement in the Mokelumne River to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants.	2	MOR-2.11	STE	SWRCB, CVRWQCB, Local agriculture	1, 5	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Work with local land owners to restore riparian habitats in the Mokelumne River.	2	MOR-2.12	STE	NMFS, USFWS, Resource Conservation Districts, CDFW, DWR	1, 5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of habitat restored. As identified in Appendix D, per unit costs vary depending on whether fencing, planting, irrigation, or invasive weed control are needed.$5,000-$50,000 for initial scoping evaluation.
Permanently protect Mokelumne River riparian habitat through easements and/or land acquisition	2	MOR-2.13	STE	NMFS, USFWS, Resource Conservation Districts, CDFW, DWR	1, 5	Long-term	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Conduct research and monitoring to better understand the factors affecting the survival of steelhead downstream of Woodbridge Dam.	2	MOR-2.14	STE	EBMUD, CDFW, USFWS, NMFS	1,5	Short-term	$5,000 for initial study to develop goals, objectives, experimental design, and statistical analysis; cost of the research and monitoring is TBD based on the initial study.	TBD	$0	$0	$0	$5,000 for initial study to develop goals, objectives, experimental design, and statistical analysis; cost of the research and monitoring is TBD based on the initial study.
Implement projects to minimize predation in the Mokelumne River.	2	MOR-2.15	STE	EBMUD, CDFW, USFWS, NMFS	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
							for potential site-specific costs.					details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about $38,000 annually (BDCP 2013).
Implement projects to minimize entrainment in the Mokelumne River.	2	MOR-2.16	STE	EBMUD, CDFW, USFWS, NMFS	1	Short-term	TBD based on number of diversions and site specific factors affecting screening costs. $5,000-$50,000 for initial scoping evaluation.	$0	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is estimated at $20 million (San Francisco Estuary Partnership 2007).

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5.8.12 Cosumnes River Recovery Actions

Table 5-24. Cosumnes River Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop cooperative water use agreements (e.g., groundwater exchange agreements) with local water users to provide flows in the Cosumnes River.	3	COR-3.1	STE	CDFW, USFWS, NMFS, water districts	1	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of water. Cost per unit is $43 - $88/af/year for upstream of Delta water purchases (Appendix D)
Implement projects to minimize predation in the Cosumnes River	3	COR-3.2	STE	CDFW, USFWS, NMFS	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs.	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
												assumed that each site will cost about $38,000 annually (BDCP 2013).
Implement projects to minimize entrainment in the Cosumnes River.	3	COR-3.3	STE	CDFW, USFWS, NMFS, water districts	1,5	Short-term	TBD based on number of diversions and site specific factors affecting screening costs. $5,000-$50,000 for initial scoping evaluation.	TBD	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is estimated at $20 million (San Francisco Estuary Partnership 2007).

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5.9 Mainstem San Joaquin River Recovery Actions

Table 5-25. San Joaquin River Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Implement the Exhibit B hydrographs providing interim and restoration flows as outlined in the San Joaquin River Stipulation of Settlement (available at http://www.restoresjr.net/).	1	SJR-1.1	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	1,4	Long-term	$0	$0	$0	$0	$0	$0
Develop and implement a spring-run Chinook salmon reintroduction strategy as outlined in paragraph 14 of the San Joaquin River Stipulation of Settlement (available at http://www.restoresjr.net/).	1	SJR-1.2	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	1,4	Long-term	$0	$0	$0	$0	$0	$0
Implement channel modifications as outlined in the San Joaquin River Stipulation of Settlement, including increasing the channel capacity to accommodate restoration flows up to 4,500 cfs (available at http://restoresjr.net/).	1	SJR-1.3	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	1,4	Long-term	$0	$0	$0	$0	$0	$0
Minimize entrainment and fish losses to both adult and juvenile life stages to non-viable migration pathways as outlined in the San Joaquin River Stipulation of Settlement, including, placing temporary barriers at Mud and Salt Sloughs and other potential sources of adult entrainment, screening	1	SJR-1.4	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	1,4,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Arroyo Canal and other riparian diversions as they are identified, and modifying and screening the Chowchilla Bypass Bifurcation Structure (available at http://www.restoresjr.net/).												
Provide fish passage at existing structures as outlined in the San Joaquin River Stipulation of Settlement (available at http://restoresjr.net/) including: (1) modifications to the Sand Slough Control Structure; (2) modification of the Reach 4B head gate; (3) reconstruction of Sack Dam to ensure unimpeded fish passage; (4) construction of a Mendota Pool Bypass; (5) modifications to structures in the Eastside and Mariposa Bypasses channels; and (6) fixing other passage impediments including road crossings, drop structures, and others as identified in the DWR Passage Report (DWR 2012) for the San Joaquin River Restoration Area.	1	SJR-1.5	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	1,4,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Manage juvenile salmonid predation risk by filling and/or isolating high priority gravel pits as identified in paragraph 11(b) of the San Joaquin River Stipulation of Settlement (available at http://www.restoresjr.net/).	1	SJR-1.6	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	1,4	Long-term	$0	$0	$0	$0	$0	$0
Develop and implement an ecologically based San Joaquin River flow regime to help restore natural river processes and support all life stages of steelhead and spring-run Chinook salmon (Poff *et al.*1997).	1	SJR-1.7	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR, SWRCB	1,4	Long-term	$4,217,625	$4,217,625	$4,217,625	$4,217,625	$0	$16,870,500
Implement projects that improve wastewater and stormwater treatment in residential, commercial, and industrial areas throughout the San Joaquin River watershed to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants.	1	SJR-1.8	SRCS, STE	NMFS, USFWS, CDFW, DWR, SWRCB, Local governments	1,4,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD based on amount of water to be treated and whether existing treatment facilities need to be upgraded or new facilities are required.. Site-specific evaluations could range up to $100,000 each.
Develop a long-term strategy for monitoring and regulating discharges from agricultural lands in the San Joaquin River basin to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan)	1	SJR-1.9	SRCS, STE	SWRCB	1,5	5 Years	TBD	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
are met for all potential pollutants.												
Complete Total Maximum Daily Load projects for all Clean Water Act Section 303(d) listed pollutants entering the San Joaquin River.	1	SJR-1.10	SRCS, STE	SWRCB	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop and implement a spawning gravel augmentation plan in the San Joaquin River.	1	SJR-1.11	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	1	Long-term	$0	$0	$0	$0	$0	$0; covered under San Joaquin River Restoration Program
Develop and implement a program to reestablish steelhead upstream of Friant Dam. The program should include feasibility studies, habitat evaluations, fish passage design studies, and a pilot phase prior to implementation of the long-term program.	2	SJR-2.1	STE	NMFS, USFWS, USBR, CDFW, DWR	1,5	Long-term	$200,000	$4,000,000	$15,000,000	$17,000,000	$14,000,000	$50,200,000
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in the San Joaquin River.	2	SJR-2.2	SRCS, STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Districts, CDFW, DWR, SWRCB, Landowners	1,5	Long-term	$62,400	$0	$0	$0	$0	$62,400

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Develop education and outreach programs and coordinate with local governments, communities, and conservation districts to encourage river stewardship in the San Joaquin River basin.	2	SJR-2.3	SRCS, STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Districts, CDFW, DWR, SWRCB	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
Permanently protect San Joaquin River riparian and floodplain habitat through easements and/or land acquisition.	2	SJR-2.4	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	1,5	Long-term	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Implement projects to protect and restore riparian and floodplain habitats along the San Joaquin River, such as projects underway at the San Joaquin River National Wildlife Refuge to restore riparian habitat, expand the refuge, and breach deauthorized levees in order to increase floodplain habitat.	2	SJR-2.5	SRCS, STE		1,4	Long-term	TBD based on type and amount of habitat restored; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD based on type and amount of habitat restored; initial study is expected to cost at least $50,000.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Coordinate with county and other local planning processes to encourage protection of floodplain habitat along the San Joaquin River.	2	SJR-2.6	SRCS, STE	NMFS, USFWS, Corps, CDFW, DWR, Local governments	1,5	Long-term	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement of illegal stream bank alterations and monitor permitted alterations in the San Joaquin River.	2	SJR-2.7	SRCS, STE	Corps, SWRCB	1,4	Long-term						Cost is covered under action # COC-2.9
Compile available data and/or conduct new habitat analyses to determine if instream cover is lacking in the San Joaquin River, and add instream cover as necessary.	2	SJR-2.8	SRCS, STE	NMFS, USFWS, CDFW	1	5 years	$0	$0	$0	$0	$0	$0
Implement studies designed to quantify the impact of predation on steelhead in the San Joaquin River and identify specific locations where predation is a problem.	2	SJR-2.9	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	1,3,4	5 Years	$200,000-$400,000	$0	$0	$0	$0	$200,000-$400,000
Conduct studies to evaluate whether predator control actions (e.g., fishery management or directed removal programs) can be effective at minimizing predation on steelhead and spring-run Chinook salmon in the San Joaquin River; continue implementation if effective.	2	SJR-2.10	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR	1,3,4	5 Years						Cost covered by the cost of SFB-2.5 ($0-$75,000,000).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Implement habitat enhancement or augmentation actions designed to minimize predation on steelhead in the San Joaquin River.	2	SJR-2.11	SRCS, STE	NMFS, USFWS, USBR, CDFW, DWR, Various NGOs	1,3,4	Long-term	$0	$0	$0	$0	$0	$0
Develop and implement design criteria and projects to minimize predation at weirs, diversion dams, and related structures in the San Joaquin River.	2	SJR-2.12	SRCS, STE	NMFS, USFWS, USBR, Corps, CDFW, DWR	1,3,5	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs.	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
												$38,000 annually (BDCP 2013).
Monitor and evaluate the sport fishing regulations for the San Joaquin River to ensure they are consistent with the recovery of steelhead and spring-run Chinook salmon, and work with the Fish and Game Commission to modify the regulations as needed.	2	SJR-2.13	SRCS, STE	NMFS, CDFW	2	Long-term	$0	$0	$0	$0	$0	$0
Develop information to better understand the interaction between surface water and groundwater in the San Joaquin watershed in order to evaluate the potential impacts of water management options (e.g., groundwater sales; conjunctive use) in the watershed on San Joaquin River flows.	2	SJR-2.14	SRCS, STE	SWRCB, DWR, NMFS, USFWS, USBR, Corps, CDFW,	1.4	Short-term	$0	$0	$0	$0	$0	$0
Develop information to better understand the potential impact of inter basin water management (i.e., Sacramento River water being pumped into and then running off the San Joaquin basin) on the migratory cues and fish response (e.g., straying) for returning adult Chinook salmon and	2	SJR-2.15	SRCS, STE	NMFS, USFWS, USBR, Corps, CDFW, DWR	1,4	Short-term	$5,000 for initial study to develop goals, objectives, experimental design, and statistical analysis; cost of the research and monitoring is TBD based on the initial	TBD	$0	$0	$0	$5,000 for initial study to develop goals, objectives, experimental design, and statistical analysis; cost of the research and monitoring is TBD based on the initial study.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
steelhead.							study.					
Develop an incentive-based entrainment monitoring program in the San Joaquin River designed to work cooperatively with diverters to develop projects or actions in order to minimize pumping impacts.	2	SJR-2.16	SRCS, STE	NMFS, USFWS, USBR, Corps, CDFW, DWR	1,4	Short-term	TBD based on number of diversions and site specific factors affecting screening costs. Entrainment monitoring program estimated at up to $300,000 annually.	TBD	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is estimated at $20 million (San Francisco Estuary Partnership 2007).

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5.10 Southern Sierra Nevada Diversity Group Recovery Actions

5.10.1 Merced River Recovery Actions

Table 5-26. Merced River Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop and implement a program to reestablish steelhead in historic habitat upstream of Crocker-Huffman, Merced Falls, McSwain, and New Exchequer dams. The program should include feasibility studies, habitat evaluations, fish passage design studies, and a pilot reintroduction phase prior to implementation of the long-term program.	1	MER-1.1	STE	NMFS, USFWS, USBR, CDFW, DWR, MID, PG&E, FERC	1,5	Long-term	$200,000	$4,000,000	$15,000,000	$17,000,000	$14,000,000	$50,200,000
Manage releases from New Exchequer Reservoir in order to provide the	2	MER-1.2	STE	NMFS, USFWS, MID, FERC, CDFW, DWR	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD in the FERC licensing process

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
most beneficial flow and water temperatures for all steelhead life stages.												
Supplement flows provided pursuant to the Davis-Grunsky Contract and FERC License Number 2179 with water acquired from willing land owners and water districts to provide additional instream flow.	1	MER-1.3	STE	NMFS, USFWS, USBR, CDFW, DWR	1,4	Long-term	$0	$0	$0	$0	$0	$0
Develop a Merced River steelhead team to help guide collection and evaluation of baseline data to help address hypotheses for why resident O.mykiss are more abundant than anadromous O.mykiss in the Merced River. This information could be used to identify the flow and water	1	MER-1.4	STE	NMFS, USFWS, CDFW, DWR	1,2,3,4,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
temperature conditions that are most beneficial to anadromous O. mykiss.												
Evaluate whether pulse flows in the Merced River are beneficial to adult steelhead immigration and juvenile steelhead emigration; if pulse flows are determined to be effective, implement the most beneficial pulse flow regime.	1	MER-1.5	STE	NMFS, USFWS, MID, FERC, CDFW, DWR	1,4	Long-term	TBD	TBD	TBD	TBD	TBD	TBD in the FERC licensing process
Identify and implement floodplain and side channel projects to improve river function and increase habitat diversity in the Merced River.	1	MER-1.6	STE	NMFS, USFWS, MID, FERC, CDFW, DWR	1,4,5	Short-term	TBD, based on amount of floodplain and side channel habitat restored. Floodplain restoration unit cost ranges from is $5,000 - $80,000/acre (Appendix D Table HI-4); side channel reconnection unit cost ranges from $20,000 to	TBD	$0	$0	$0	TBD, based on amount of floodplain and side channel habitat restored. Floodplain restoration unit cost ranges from is $5,000 - $80,000/acre (Appendix D Table HI-4); side channel reconnection unit cost ranges from $20,000 to $300,000/acre.. $5,000-$50,000 for initial scoping evaluation.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
							$300,000/acre.. $5,000-$50,000 for initial scoping evaluation.					
Develop and implement a long-term gravel management plan to increase and maintain steelhead spawning habitat downstream of Crocker-Huffman, Merced Falls, and New Exchequer dams.	1	MER-1.7	STE	NMFS, USFWS, , MID, PG&E, FERC, CDFW, DWR	1,4	Long-term	$50,000 for plan development; gravel augmentation costs TBD	TBD	TBD	TBD	TBD	$50,000-TBD
Prioritize Merced River diversions based on their level of entrainment and screen those with the highest benefit to cost ratio.	2	MER-2.1	STE	NMFS, USFWS, USBR, CDFW, DWR, MID	1,3,5	5 years	$50,000 for prioritization; screening costs are TBD.	$0	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is estimated at $20 million (San Francisco Estuary Partnership 2007).
Work with water rights holders in the Merced River watershed to provide flows that are	2	MER-2.2	STE	NMFS, USFWS, USBR, Corps, CDFW, DWR, NRCS, Family Water Alliance, MID	1	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
protective of steelhead.												
Develop and implement ramping rate criteria for the Merced River that are protective of anadromous fishes.	2	MER-2.3	STE	NMFS, USFWS, Corps, MID, PG&E, FERC, CDFW, DWR	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD in the FERC licensing process
Continue to supply spawning-sized gravel to landowners for construction and maintenance of wing dam diversion structures in the Merced River; implement the Gravel Mining Reach Phase II projects.	2	MER-2.4	STE	NMFS, USFWS, CDFW, DWR	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD based on amount of gravel added; Per unit cost is $11 to $72/cubic yard (Appendix D).
Evaluate the potential benefits and feasibility of installing a water temperature control device on New Exchequer Dam in order to most efficiently	2	MER-2.5	STE	NMFS, USFWS, USBR, MID, FERC, CDFW, DWR	1	Short-term	<$50,000	$0	$0	$0	$0	<$50,000 for evaluation and feasibility study.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
utilize the volume of cold water in the reservoir.												
Federal, State, and local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring and creating riparian corridors within their jurisdiction in the Merced River watershed.	2	MER-2.6	STE	USFWS, Corps, CDFW, DWR, Local agencies, NGOs	1,4	Long-term	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$30,000 - $135,000	$150,000 -$675000
Permanently protect Merced River riparian habitat through easements and/or land acquisition	2	MER-2.7	STE	NMFS, USFWS, CDFW, DWR, landowners, Resource Conservation Districts	1,5	Long-term	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Increase monitoring and enforcement of illegal rip rap applications in the Merced	2	MER-2.8	STE	Corps, SWRCB	1,4,5	Long-term						Cost is covered under action # COC-2.9

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
River.												
Implement studies designed to quantify the impact of predation on steelhead in the Merced River. If the studies identify predator species and/or locations contributing to low steelhead survival, then evaluate whether predator control actions (e.g., fishery management or directed removal programs) can be effective at minimizing predation on steelhead in the Merced River; continue implementation if effective.	2	MER-2.9	STE	NMFS, USFWS, CDFW, DWR	1,2,3	Long-term						Cost covered by the cost of SFB-2.5 ($0-$75,000,000).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Implement programs and measures designed to control predation in the Merced River, including actions to isolate "ponded" sections of the river.	2	MER-2.10	STE	NMFS, USFWS, CDFW, DWR	1,3,5	Long-term	$0	$0	$0	$0	$0	$0

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5.10.2 Tuolumne River Recovery Actions

Table 5-27. Tuolumne River Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Evaluate and, if feasible, develop and implement a steelhead and spring-run Chinook salmon passage program for La Grange and Don Pedro dams. The program should include feasibility studies, habitat evaluations, fish passage design studies, and a pilot reintroduction phase prior to implementation of the long-term reintroduction program.	1	TUR-1.1	STE	NMFS, CDFW, Modesto Irrigation District, Turlock Irrigation District, FERC	1,5	Long-term	$720,150	$9,000,000	$3,468,000	$0	$0	$13,188,150

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Manage releases from La Grange and Don Pedro dams to provide suitable flows and water temperatures for all downstream life stages of steelhead.	1	TUR-1.2	STE	NMFS, CDFW, Modesto Irrigation District, Turlock Irrigation District, FERC	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD in the FERC licensing process
Develop a Tuolumne River steelhead team to help guide collection and evaluation of baseline data to help address hypotheses for why resident O.mykiss are more abundant than anadromous O.mykiss in the Tuolumne River. This information could be used to identify the flow and water temperature conditions that are most	1	TUR-1.3	STE	USFWS, CDFW, NMFS	1	Short-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
beneficial to anadromous O. mykiss.												
Evaluate whether pulse flows in the Tuolumne River are beneficial to adult steelhead immigration and juvenile steelhead emigration; if pulse flows are determined to be effective, implement the most beneficial pulse flow regime.	1	TUR-2.1	STE	NMFS, USFWS, USBR, CDFW, DWR, Modesto and Turlock Irrigation Districts, FERC	1	Long-term	TBD	TBD	TBD	TBD	TBD	TBD in the FERC licensing process
Continue to implement projects to increase the availability and quality of spawning and rearing habitat in the Tuolumne	2	TUR-2.2	STE	NMFS, USFWS, USBR, CDFW, DWR, Modesto and Turlock Irrigation Districts	1,4	Long-term	TBD	TBD	TBD	TBD	TBD	TBD based on the amount of spawning gravel to be added and the type and amount of rearing habitat restored. Per unit cost for gravel augmentation is $11 to $72/cubic yard (Appendix D). See Appendix D for per unit costs of restoring various

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
River.												types of rearing habitats (e.g., riparian, floodplain, instream cover. $5,000-$50,000 for initial scoping of rearing habitat restoration opportunities and gravel needs.)
Evaluate the feasibility of moving water diversions lower in the Tuolumne River in order to provide higher flows in the upstream reaches. If feasible and cost effective, move water diversions lower in the Tuolumne River.	2	TUR-2.3	STE	NMFS, USFWS, USBR, CDFW, DWR, Modesto and Turlock Irrigation Districts	1	Long-term	<$200,000 for evaluation; cost of moving diversions TBD based on information obtained during the evaluation.	TBD	TBD	TBD	TBD	<$200,000 for evaluation; cost of moving diversions TBD based on information obtained during the evaluation.
Develop and implement flow fluctuation criteria for the Tuolumne River that are protective of anadromous	2	TUR - 2.4	STE	NMFS, USFWS, Corps, CDFW, DWR, Modesto and Turlock Irrigation Districts, FERC	1	Long-term	TBD	TBD	TBD	TBD	TBD	TBD in the FERC licensing process

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
fishes.												
Work with State and Federal water acquisition programs to dedicate instream water in the Tuolumne River.	2	TUR - 2.5	STE	NMFS, USFWS, USBR, CDFW, DWR, Modesto and Turlock Irrigation Districts	1	Long-term	$0	$0	$0	$0	$0	$0
Evaluate modifying current operation plans (e.g., flood control curves) for Don Pedro with the Corps and irrigation districts to reallocate instream flows for salmonids.	2	TUR - 2.6	STE	Corps, Modesto and Turlock Irrigation Districts, NMFS, USFWS, CDFW	1	Short-term	$0	$0	$0	$0	$0	$0
Identify and implement floodplain and side channel projects to improve river function and	2	TUR - 2.7	STE	NMFS, USFWS, CDFW, Modesto and Turlock Irrigation Districts	1	Short-term	TBD	TBD	$0	$0	$0	TBD, based on amount of floodplain and side channel habitat restored. Floodplain restoration unit cost ranges from is $5,000 - $80,000/acre (Appendix D Table HI-

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
increase habitat diversity in the Tuolumne River.												4); side channel reconnection unit cost ranges from $20,000 to $300,000/acre. $5,000-$50,000 for initial scoping of restoration opportunities.
Update the 2006 Water Quality Control Plan for the Bay-Delta in order to improve flow conditions for steelhead in the Tuolumne River.	2	TUR - 2.8	STE	SWRCB, CDFW, USFWS, NMFS, Modesto and Turlock Irrigation Districts	1,4	Long-term	$0	$0	$0	$0	$0	$0
Restore riparian habitat to promote shading and habitat diversity in the Tuolumne River.	2	TUR - 2.9	STE	Corps, Modesto and Turlock Irrigation Districts, NMFS, USFWS, CDFW, CV Flood Protection Board	1		TBD	TBD	TBD	TBD	TBD	TBD, based on amount of habitat restored. As identified in Appendix D, per unit costs vary depending on whether fencing, planting, irrigation, or invasive weed control are needed. $5,000-$50,000 for initial scoping of restoration opportunities.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Implement projects to minimize predation at weirs, diversion dams, and related structures in the Tuolumne River.	2	TUR - 2.10	STE	NMFS, CDFW, DWR, USFWS, Modesto and Turlock Irrigation Districts	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs.	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about $38,000 annually (BDCP 2013).
Improve instream refuge cover for salmonids in the Tuolumne River to minimize predatory opportunities for striped bass and other non-native	2	TUR - 2.11	STE	NMFS, USFWS, CDFW, DWR	1,3	Long-term	TBD, based on the # of sites, # of miles, type of material, location of source material (onsite vs. imported), and placement method. Initial scoping to address those	TBD	TBD	TBD	TBD	TBD, based on the # of sites, amount of material needed, type of material, location of source material (onsite vs. imported), and placement method. Cost of initial study to address these issues is $5,000-$50,000. See Table H1-2 in Appendix D for cost per unit for various

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
predators.							issues would cost at least $50,000. See Table H1-2 in Appendix D for cost per unit for various projects.					projects
Develop a baseline monitoring program for the Tuolumne River to evaluate water quality throughout the watershed to identify pollutants to be included on the Clean Water Act section 303(d) list.	2	TUR - 2.12	STE	SWRCB, CDFW, USFWS, NMFS, Modesto and Turlock Irrigation Districts	1,5	Short-term	$0	$0	$0	$0	$0	$0
Complete Total Maximum Daily Load projects for all Clean Water Act Section 303(d) listed pollutants entering the Tuolumne	2	TUR - 2.13	STE	SWRCB	1	Short-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
River.												
Encourage voluntary landowner participation in the Tuolumne River watershed in educational opportunities such as water quality short courses, field demonstrations and distribution of water quality "Fact Sheets".	2	TUR - 2.14	STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Districts, CDFW, DWR, Landowners	2	Long-term	$76,140	$76,140	$76,140	$76,140	$0	$304,560
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in the Tuolumne River.	2	TUR - 2.15	STE	NMFS, USFWS, USEPA, Resource Conservation Districts, CDFW, DWR, SWRCB	1,5	Long-term	$62,400	$0	$0	$0	$0	$62,400

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Increase monitoring and enforcement in the Tuolumne River to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants excluding water temperature.	2	TUR - 2.16	STE	SWRCB, CVRWQCB, Local agriculture groups	1,4	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)
Evaluate Tuolumne River O.mykiss genetics to inform management in the anadromous reach as well as planning for potential reintroductions to the upper river.	3	TUR - 3.1	STE	CDFW, USFWS, NMFS	1,5	Short-term	$25,000 - $50,000	$0	$0	$0	$0	$25,000 - $50,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~Cost FY1-5	~Cost FY6-10	~Cost FY11-15	~Cost FY16-20	~Cost FY21-25	Total ~Cost
Prioritize lower Tuolumne River diversions based on their level of entrainment and screen those with the highest benefit to cost ratio	3	TUR - 3.2	STE	CDFW, USFWS, NMFS, USBR, DWR, Modesto and Turlock Irrigation Districts	1,5	5 years	$50,000 for prioritization; screening costs are TBD.	$0	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is estimated at $20 million (San Francisco Estuary Partnership 2007).

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5.10.3 Stanislaus River Recovery Actions

Table 5-28. Stanislaus River Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Evaluate and, if feasible, develop and implement a steelhead passage program for Tullock, Goodwin, and New Melones dams. The program should include feasibility studies, habitat evaluations, fish passage design studies, and a pilot reintroduction phase prior to implementation of the long-term reintroduction program.	1	STR-1.1	STE	NMFS, USFWS, USBR, CDFW, OID, South San Joaquin Irrigation District, TriDam, PG&E, FERC	1,5	Long-term	$720,150	$9,000,000	$3,468,000	$0	$0	$13,188,150

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Manage releases from Tulloch, Goodwin, and New Melones dams to provide suitable water temperatures and flows for all steelhead life stages. Suitable water temperatures for the Stanislaus River are specified on page 621 of the biological opinion for the long-term operations of the CVP/SWP (NMFS 2009b). Suitable minimum instream flow schedules for the Stanislaus River are described in Appendix 2-E of the biological opinion	1	STR-1.2	STE	NMFS, USFWS, USBR, Corps, CDFW, DWR, OID, South San Joaquin Irrigation District, Tridam	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
(NMFS 2009b).												
Develop a Stanislaus River steelhead team to help guide collection and evaluation of baseline data to help address hypotheses for why resident O.mykiss are more abundant than anadromous O.mykiss in the Stanislaus River. This information could be used to identify the flow and water temperature conditions that are most beneficial to anadromous O. mykiss.	1	STR-1.3	STE	NMFS, USFWS, USBR, CDFW	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Continue to implement projects to increase the availability and quality of spawning and rearing habitat in the Stanislaus River.	2	STR-2.1	STE	NMFS, USFWS, USBR, CDFW, DWR	1,4	Long-term	$0	$0	$0	$0	$0	$0
Evaluate whether pulse flows in the Stanislaus River are beneficial to adult steelhead immigration and juvenile steelhead emigration; if pulse flows are determined to be effective, implement the most beneficial pulse flow regime.	2	STR-2.2	STE	NMFS, USFWS, USBR, CDFW, DWR, Stanislaus River Fish Group, OID, South San Joaquin Irrigation District, TriDam, PG&E, FERC	1,5	Long-term	$0	$0	$0	$0	$0	$0. Pulse flows are required under the 2009 biological opinion for the long-term operations of the CVP/SWP.

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Work with State and Federal water acquisition programs to dedicate instream water in the Stanislaus River.	2	STR-2.3	STE	NMFS, USFWS, USBR, CDFW, DWR, Stanislaus River Fish Group	1	Long-term	$0	$0	$0	$0	$0	$0
Negotiate agreements with landowners, water districts, and Federal and State agencies to provide additional instream flows or purchase water rights in the Stanislaus River.	2	STR-2.4	STE	NMFS, USFWS, USBR, Corps, Resource Conservation Districts, CDFW, DWR, Water districts, Landowners, Local governments, NGOs	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of water. Cost per unit is $162 - $246/af/year for south of Delta water purchases (Appendix D)
Utilize the SWRCB regulatory process of updating the 2006 Water Quality Control Plan for the Bay-Delta to	2	STR-2.5	STE	NMFS, SWRCB	1,4	Short-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
improve flow conditions for steelhead in the Stanislaus River.												
Identify and implement floodplain and side channel projects to improve river function and increase habitat diversity in the Stanislaus River.	2	STR-2.6	STE	NMFS, USFWS, USBR, Corps, CDFW, DWR	1	Short-term	TBD, based on amount of floodplain and side channel habitat restored. Floodplain restoration unit cost ranges from is $5,000 - $80,000/acre (Appendix D Table HI-4); side channel reconnection unit cost ranges from $20,000 to $300,000/acre.. $5,000-$50,000 for initial scoping evaluation.	TBD	$0	$0	$0	TBD, based on amount of floodplain and side channel habitat restored. Floodplain restoration unit cost ranges from is $5,000 - $80,000/acre (Appendix D Table HI-4); side channel reconnection unit cost ranges from $20,000 to $300,000/acre.. $5,000-$50,000 for initial scoping evaluation.
Work with local land owners to restore riparian habitats along the Stanislaus River.	2	STR-2.7	STE	NMFS, USFWS, USBR, CDFW, DWR, Stanislaus River Fish Group	1,5	Long-term	TBD, based on amount of floodplain and side channel habitat restored. Floodplain restoration unit cost ranges from is $5,000 - $80,000/acre	TBD	$0	$0	$0	TBD, based on amount of floodplain and side channel habitat restored. Floodplain restoration unit cost ranges from is $5,000 - $80,000/acre (Appendix D Table

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
							(Appendix D Table HI-4); side channel reconnection unit cost ranges from $20,000 to $300,000/acre.. $5,000-$50,000 for initial scoping evaluation.					HI-4); side channel reconnection unit cost ranges from $20,000 to $300,000/acre.. $5,000-$50,000 for initial scoping evaluation.
Permanently protect riparian habitat along the Stanislaus River through easements and/or land acquisition.	2	STR-2.8	STE	NMFS, USFWS, USBR, Corps, Resource Conservation Districts, CDFW, DWR, Water districts, Landowners, Local governments, NGOs	1,5	Long-term	TBD, based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD, based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Monitor and evaluate the impact of the sport fishery on Stanislaus River steelhead to ensure the regulations are consistent with steelhead recovery, and work with the Fish and Game Commission to	2	STR-2.9	STE	NMFS, CDFW	2	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
modify the regulations as needed.												
Increase monitoring and enforcement in order to minimize steelhead poaching in the Stanislaus River.	2	STR-2.10	STE	NMFS, CDFW	2,4	Long-term						Cost is covered under action # COC-2.9
Implement outreach projects in the Stanislaus River to educate the public regarding the steelhead life cycle including how to identify steelhead redds. Encourage voluntary landowner participation in the Stanislaus River in educational opportunities such as water	2	STR-2.11	STE	NMFS, USFWS, USBR, CDFW, DWR, Stanislaus River Fish Group	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
quality short courses, field demonstrations and distribution of water quality "Fact Sheets".												
Evaluate programs and measures designed to minimize predation in the Stanislaus River.	2	STR-2.12	STE	NMFS, USFWS, CDFW, DWR, Stanislaus River Fish Group, OID	1,3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs.	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost about

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
												$38,000 annually (BDCP 2013).
Implement projects to minimize predation in the Stanislaus River at mine pits and at deep pools caused by bank stabilization projects.	2	STR-2.13	STE	NMFS, USFWS, CDFW, DWR, Stanislaus River Fish Group	1,3,4	Long-term	Costs covered in action STR-2.12	Costs covered in action STR-2.12	Costs covered in action STR-2.12	Costs covered in action STR-2.12	Costs covered in action STR-2.12	Costs covered in action STR-2.12
Implement projects to increase instream habitat complexity and predator refuge cover in the Stanislaus River, including the addition of large woody material.	2	STR-2.14	STE	NMFS, USFWS, CDFW, DWR, Stanislaus River Fish Group	1,3,4	Long-term	$750,000 - $2,000,000	$750,000 - $2,000,000	$750,000 - $2,000,000	$750,000 - $2,000,000	$750,000 - $2,000,000	$3,750,000 - $10,000,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop a baseline monitoring program for the Stanislaus River to evaluate water quality throughout the watershed to identify areas of concern.	2	STR-2.15	STE	NMFS, USWFS, USEPA, Resource Conservation Districts, CDFW, DWR, SWRCB, Stanislaus River Fish Group	1,5	3 Years	$0	$0	$0	$0	$0	$0
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water quality impacts in the Stanislaus River.	2	STR-2.16	STE	NMFS, USFWS, USFS, USEPA, Resource Conservation Districts, CDFW, DWR, Landowners	1,5	Long-term	$62,400	$0	$0	$0	$0	$62,400
Increase monitoring and enforcement in the Stanislaus River to ensure that the water quality criteria	2	STR-2.17	STE	SWRCB, CVRWQCB, Local agriculture groups	1,4,5	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
established in the Central Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants.												
Complete Total Maximum Daily Load projects for all Clean Water Act Section 303(d) listed pollutants entering the Stanislaus River.	2	STR-2.18	STE	EPA, SWRCB, CVRWQCB, Local agriculture groups	1,5	Long-term	$0	$0	$0	$0	$0	$0
Evaluate Stanislaus River *O.mykiss* genetics to inform management in the anadromous reach as well as planning for potential reintroductions to the upper river.	2	STR-2.19	STE	NMFS, CDFW, Reclamation, USFWS	1,5	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop an entrainment monitoring program in the Stanislaus River to determine the level of take at individual diversions. Prioritize diversions based on this monitoring program and screen those that are determined to have substantial impacts.	3	STR-3.1	STE	NMFS, USFWS, CDFW	1,3,5	5 years	$100,000 for monitoring program; screening costs are TBD.	$0	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is estimated at $20 million (San Francisco Estuary Partnership 2007).

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5.10.4 Calaveras River Recovery Actions

Table 5-29. Calaveras River Recovery Actions.

Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Develop and implement long-term year-round instream flow schedules and water temperature requirements that are protective of all steelhead life stages, including providing flows for upstream and downstream fish passage.	1	CAR - 1.1	STE	NMFS, USFWS, CDFW	1	Long-term	$594,090	$0	$0	$0	$0	$594,090
Establish a minimum carryover storage level at New Hogan Reservoir that meets the instream flow and water temperature requirements in the lower Calaveras River.	1	CAR - 1.2	STE	NMFS, USFWS, CDFW, Corps	1,5	Long-term	$1,144,240	$0	$0	$0	$0	$1,144,240
Remove or modify all fish passage impediments in the lower Calaveras River to meet NMFS and CDFW fish passage criteria.	1	CAR - 1.3	STE	NMFS, USFWS, CDFW, Corps	1	Long-term	$0	$15,000,000	$0	$0	$0	$15,000,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Monitor upstream and downstream fish passage through the existing Bellota weir fish ladder and operate the weir based on this monitoring information to provide timely and safe fish passage.	1	CAR-1.4	STE	NMFS, USFWS, USBR, CDFW, DWR, Fishery Foundation of California, Stockton East Water District	1,4	Long-term	$0	$0	$0	$0	$0	$0
Replace Bellota weir incorporating a permanent fish ladder and screened diversion as recommended in the Calaveras River Fish Screen Facilities Feasibility Study.	1	CAR-1.5	STE	NMFS, USFWS, USBR, CDFW, DWR, Fishery Foundation of California, Stockton East Water District	1	Short-term	$8-$10 million	$0	$0	$0	$0	$8-$10 million
Implement a Calaveras River monitoring program to identify the temporal and spatial distributions of migrating and holding steelhead. These data would help ensure that suitable flows, water temperatures, and passage conditions are	1	CAR-1.6	STE	NMFS, USFWS, USBR, CDFW, DWR, Fishery Foundation of California, Stockton East Water District	1	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
being provided when and where the fish are in the Calaveras River.												
Fully implement the Calaveras River fish passage improvement project in order to provide permanent upstream and downstream passage for salmonids between the mouth of the Calaveras River and Bellota weir.	2	CAR-2.1	STE	DWR, USFWS, USBR, Corps, CDFW, Fishery Foundation of California, Stockton East Water District	1	Long-term	TBD	TBD	TBD	TBD	TBD	TBD based on the number and type of fish passage impediments. NMFS is in the process of obtaining a cost estimate from DWR, the lead agency for the project.
Until year-round permanent fish passage improvements are made to preclude the need for flashboard weirs, operate Bellota and other weirs so that the flashboards are not in place from at least October through June.	2	CAR-2.2	STE	USFWS, USBR, Corps, CDFW, DWR, Fishery Foundation of California, Stockton East Water District	1	Long-term	$0	$0	$0	$0	$0	$0
Prioritize and screen unscreened diversions in the Calaveras River including Bellota weir.	2	CAR-2.3	STE	CDFW, NMFS, Stockton East Water District, Calaveras County Water District	1,3,5	5 years	$50,000 for prioritization; screening costs are TBD.	$0	$0	$0	$0	The cost of installing screens on all diversions in the Sacramento and San Joaquin river systems is

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
												estimated at $20 million (San Francisco Estuary Partnership 2007).
Negotiate agreements with landowners, Stockton East Water District (SEWD), Calaveras County Water District (CCWD) and federal and state agencies to provide additional instream flows.	2	CAR-2.4	STE	SEWD, CCWD, NMFS, USFWS, Corps, USBR, Resource Conservation Districts, CDFW, DWR, Water Districts, Landowners, Local Governments, NGOs	1,5	Long-term	TBD	TBD	TBD	TBD	TBD	TBD, based on amount of water. Cost per unit is $162 - $246/af/year for south of Delta water purchases (Appendix D)
Purchase water rights from Calaveras River water diverters in order to increase flows.	2	CAR-2.5	STE	NMFS, USFWS, Corps, USBR, Resource Conservation Districts, CDFW, DWR, Water Districts, Landowners, Local Governments, NGOs	1,5	Short-term	TBD	TBD	$0	$0	$0	TBD based on the amount of water accounted for in the water right. Cost per unit is $162 - $246/af/year for south of Delta water purchases (Appendix D)
Continue implementing the recommendations from the lower Calaveras River Salmonid Life History Limiting Factor Analysis to assess flow requirements for anadromous salmonids and also develop and implement further specific	2	CAR-2.6	STE	NMFS, USFWS, USBR, CDFW, DWR, Stockton East Water District	1	Long-term	$0	$0	$0	$0	$0	$0

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
recommendations.												
Evaluate pulse flow benefits for steelhead attraction and passage in the Calaveras River; if pulse flows are determined to be effective for attracting steelhead, implement the most beneficial pulse flow regime.	2	CAR-2.7	STE	NMFS, USFWS, USBR, Corps, DWR, CDFW	1,5	Long-term	$0	$0	$0	$0	$0	$0
Develop a baseline monitoring program for the Calaveras River to evaluate water quality throughout the watershed to identify areas of concern.	2	CAR-2.8	STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW	1	3 Years	$0	$0	$0	$0	$0	$0
Pursue grant funding or cost-share payments for landowners to inventory, prepare plans and implement best-management practices that reduce water	2	CAR-2.9	STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW	1	Long-term	$62,400	$0	$0	$0	$0	$62,400

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
quality impacts in the Calaveras River.												
Increase monitoring and enforcement in the Calaveras River to ensure that the water quality criteria established in the Central Valley Water Quality Control Plan (Basin Plan) are met for all potential pollutants.	2	CAR-2.10	STE	SWRCB, CVRWQCB, Local agriculture groups	1,4	Long-term						Cost is covered under the cost of action SAR-2.6 ($1,750,000)
Complete Total Maximum Daily Load projects for all Clean Water Act Section 303(d) listed pollutants entering the Calaveras River.	2	CAR-2.11	STE	NMFS, USFWS, USEPA, Resource Conservation Districts, SWRCB, DWR, CDFW	1	Long-term	$0	$0	$0	$0	$0	$0
Develop and implement a spawning gravel augmentation plan in the Calaveras River, including periodic evaluations of spawning gravel quality and quantity.	2	CAR-2.12	STE	NMFS, USFWS, Corps, DWR, CDFW	1	Long-term	$50,000 for plan development; gravel augmentation costs TBD	TBD	TBD	TBD	TBD	$50,000-TBD

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Curtail further development in active Calaveras River floodplains through zoning restrictions, county master plans, and other Federal, State, and county planning and regulatory processes.	2	CAR-2.13	STE	NMFS, USFWS, Corps, CDFW, DWR, Local governments	1,5	Long-term	$0	$0	$0	$0	$0	$0
Utilize bio-technical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip rap in the Calaveras River.	2	CAR-2.14	STE	NMFS, USFWS, USBR, Corps, CDFW, DWR, CBDA	1	Long-term	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement of illegal stream bank alterations and monitor permitted alterations in the Calaveras River.	2	CAR-2.15	STE	Corps, SWRCB	1,4	Long-term						Cost is covered under action # COC-2.9
Develop education and outreach programs to encourage river stewardship in the Calaveras River.	2	CAR-2.16	STE	NMFS, USFWS, USBR, CDFW, DWR, Various NGOs	2	Long-term	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
Monitor and evaluate the sport fishing regulations for the Calaveras River to ensure they are consistent with the recovery of steelhead, and work with the Fish and Game Commission to modify the regulations as needed.	2	CAR-2.17	STE	NMFS, CDFW	2	Long-term	$0	$0	$0	$0	$0	$0
Increase monitoring and enforcement in order to minimize anadromous fish poaching in the Calaveras River.	2	CAR-2.18	STE	CDFW	2	Long-term						Cost is covered under action # COC-2.9
Implement a study designed to quantify the amount of predation on steelhead by non-native species in the Calaveras River. If the study identifies predator species and/or locations contributing to low steelhead survival, then evaluate whether predator control actions (e.g., fishery management or	2	CAR-2.19	STE	NMFS, USFWS, CDFW, DWR	1,2	Long-term						Cost covered by the cost of SFB-2.5 ($0-$75,000,000).

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
directed removal programs) can be effective at minimizing predation on juvenile steelhead in the Calaveras River; continue implementation if effective.												
Develop and implement design criteria and projects to minimize predation at weirs, diversion dams, and related structures in the in the Calaveras River.	2	CAR-2.20	STE	NMFS, CDFW, DWR, USFWS, USBR, Corps	3	Long-term	$5,000-$50,000 for site identification and evaluation; project implementation costs TBD. See total cost for potential site-specific costs.	TBD	TBD	TBD	TBD	$5,000-$50,000 for site identification and evaluation. Total cost TBD. If structural modification is identified as a solution at a particular site, it is impracticable to provide a cost without knowing details of the specific structure and what type of modification is needed. If structural removal is identified as a solution, it is assumed that the average cost of removal will be roughly $8,300 per structure (BDCP 2013). If predator removal is identified as a solution, it is assumed that each site will cost

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
												about $38,000 annually (BDCP 2013).
Improve refuge cover for steelhead in the Calaveras River to minimize predatory opportunities for predators.	2	CAR-2.21	STE	NMFS, USFWS, CDFW, DWR	1,2	Short-term	TBD, based on the # of sites, # of miles, type of material, location of source material (onsite vs. imported), and placement method. See Table H1-2 in Appendix D for cost per unit for various projects.	$0	$0	$0	$0	TBD, based on the # of sites, amount of material needed, type of material, location of source material (onsite vs. imported), and placement method. Cost of initial study to address these issues is $5,000-$50,000. See Table H1-2 in Appendix D for cost per unit for various projects
Permanently protect riparian habitat through easements and/or land acquisition.	2	CAR-2.22	STE	NMFS, USFWS, CDFW, DWR	1,5	Long-term	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.	TBD	TBD	TBD	TBD	TBD based on specific easements and land acquisitions; initial study is expected to cost at least $50,000.
Examine the potential for re-establishing steelhead in historic habitats upstream of New Hogan Dam by conducting feasibility and habitat evaluations. If	3	CAR-3.1	STE	NMFS, USFWS, CDFW, DWR, Corps	1,5	Long-term	$200,000	$4,000,000	$15,000,000	$17,000,000	$14,000,000	$50,200,000

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Recovery Action	Action Priority	Action ID	Species	Potential Collaborators	Listing Factor(s) Addressed	Duration	~ Cost FY1-5	~ Cost FY6-10	~ Cost FY11-15	~ Cost FY16-20	~ Cost FY21-25	Total ~Cost
these evaluations suggest that re-establishment can be successful, then develop a phased program intended to re-establish steelhead upstream of New Hogan Dam.												

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6.0 Climate Change and Recovery of Salmon and Steelhead

"Climate variability plays a large role in driving fluctuations in salmon abundance by influencing their physical environment, the availability of food, the competitors for that food, and the predators that prey on small salmon. The complexity of influences on salmon, both climate and otherwise, combined with the scarcity of observations of factors important to salmon in estuaries and the ocean, make it challenging to identify the links between salmon and climate."

- Climate Impacts Group (2004)

6.1 Overview

The scientific basis for understanding the processes and sources of climate variability has grown significantly in recent years, and our ability to forecast human and natural contributions to climate change has improved dramatically. With consensus on the reality of climate change now established (Oreskes 2004; IPCC 2007), the scientific, political, and public priorities are evolving toward determining its ecosystem impacts, and developing strategies for adapting to those impacts. Climate forces directly influence regional temperature, wind, precipitation, snowpack and streamflow patterns, which may impact the habitat suitability for marine and anadromous species directly or indirectly (Schwing 2009).

Many salmon populations throughout the West Coast are at historically low levels due to stresses imposed by a variety of human activities including dam construction, logging, pollution, and over-fishing. Climate change affects salmon throughout their life cycle and poses an additional stress. Earlier peak flows flush young salmon from rivers to estuaries before they are physically mature enough for the transition, increasing a variety of stresses including the risk of being eaten by predators. Earlier snowmelt leaves rivers and streams warmer and shallower during the summer and fall (Thomas *et al.* 2009).

Increasing air temperatures, particularly during the summer, lead to rising water temperatures, which increase stress on coldwater fish such as salmon and steelhead. Projected temperatures for the 2020s and 2040s under a higher emissions scenario suggest that the habitat quality and quantity for these fish is likely to decrease dramatically (Mote *et al.* 2008; Salathé *et al.* 2005; Keleher *et al.* 1996; McCullough *et al.* 2001).

Warmer water temperatures and lower base flows will negatively affect salmonids in several ways. Fish metabolism increases with water temperature, reducing growth if more energy is devoted to searching for food. Warmer water causes salmonid eggs

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to hatch sooner. Resulting young may be smaller, and emerge at a time when their insect prey base is not available. (Thomas *et al.* 2009). In addition, diseases and parasites that infect salmon are more prevalent in warmer water.

Ocean conditions are also important to salmon populations, as they reside there for years. The oceans are also impacted by warmer temperatures. Warm coastal temperatures have been correlated with low salmon abundance; higher salmon abundance is associated with cooler ocean temperatures (Janetos *et al.* 2008; Crozier *et al.* 2008).

6.2 Climate Change and Environmental Variability

For ecosystem concerns (e.g., warming, wildfire, sea level rise, anthropogenic influences, El Niño) related to long-term climate changes, all regions under the management jurisdiction of NMFS are expected to experience environmental conditions that have not been experienced before. Warming over this century is projected to be considerably greater than over the last century (Thomas *et al.* 2009). Since 1900, the global average temperature has risen by about 1.5°F. By about 2100, it is projected to rise between 2°F and 10.5°F (**Figure 6-1**), but could increase up to 11.5°F (Thomas *et al.* 2009; California Climate Change Center 2006). In the United States, the average temperature has risen by a comparable amount and is very likely to rise more than the global average over this century, with some variation according to location. Several factors will determine future temperature increases. Increases at the lower end of this range are more likely if global heat-trapping gas emissions are substantially reduced.

If emissions continue to rise at or near current rates, temperature increases are more likely to be near the upper end of the range. Volcanic eruptions or other natural variations could temporarily counteract some of the human-induced warming, slowing the rise in global temperature, but these effects would only last a few years (Thomas *et al.* 2009).

Climate-related fire dynamics also will be affected by changes in the distribution of ecosystems across the landscape. Torn *et al.* (1998) project that there will be a doubling of catastrophic wildfires in some regions due to faster and more intense burning associated with warming, drying vegetation, and elevated wind speed. Increasing temperatures and shifting precipitation patterns also will drive declines in high elevation ecosystems such as alpine forests. As an example, under higher emissions scenarios (Figure 6-1), high-elevation forests in California are projected to decline by 60 to 90 percent before the end of the century. At the same time, grasslands are projected to expand, another factor likely to increase fire risk. Climate changes also could create subtle shifts in fire behavior, allowing more "runaway fires" – fires that are thought to have been brought under control, but then rekindle (Thomas *et al.* 2009).

Current climate trends predict a future of warmer oceans and melting glaciers and icecaps, all of which are expected to raise mean sea levels, leading to the inundation and displacement of many estuaries. A rise in sea level will most dramatically affect those estuaries that are confined by surrounding development, which prohibits their boundaries from naturally shifting in response to inundation. Projections for sea level rise by 2100 vary from 0.18 to 0.58

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meters (m), to 0.5 to. 1.4 m (IPCC 2007a; Rahmstorf 2007; Raper and Braithwaite 2006). Paleoclimatic data suggest that the rate of future melting of Greenland and Antarctic ice sheets and related sea-level rise could be faster than currently projected (NMFS 2009). A projected 1 m rise in sea level could potentially inundate 65 percent of the coastal marshlands and estuaries in the United States. In addition, there could be shifts in the quality of the habitats in affected coastal regions. Prior to being inundated, coastal watersheds would become saline due to saltwater intrusion into the surface and groundwater. Regarding California's water supply, the largest effect of sea level rise would likely be in the Delta (DWR 2005c). Increased intrusion of salt water from the ocean into the Delta could lead to increased releases of water from upstream reservoirs or reduced pumping from the Delta to maintain compliance with Delta water quality standards (Anderson *et al.* 2008).

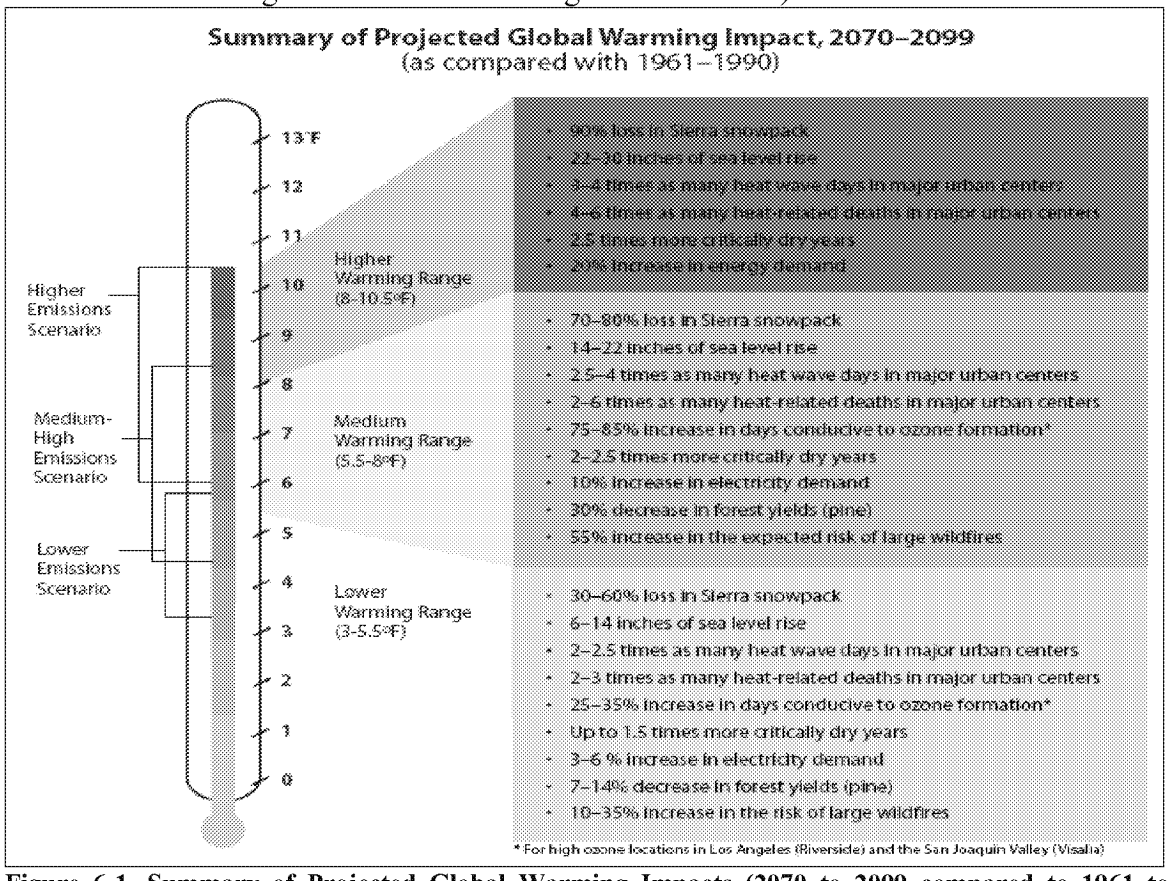


Figure 6-1. Summary of Projected Global Warming Impacts (2070 to 2099 compared to 1961 to 1990). ***(Source: California Climate Change Center 2006)***

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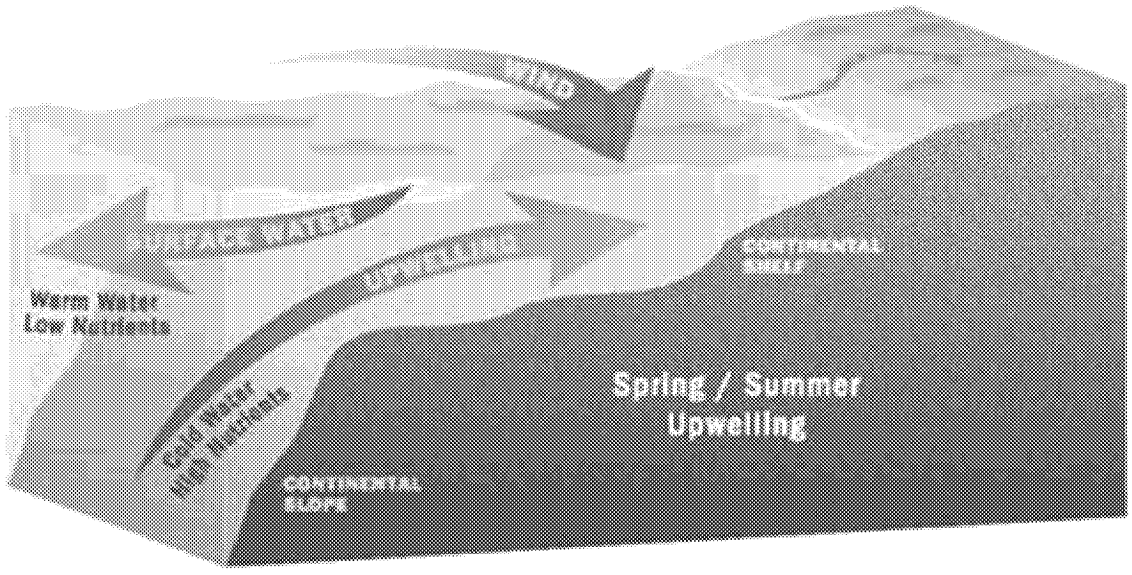


Figure 6-2. Schematic of Coastal Upwelling Near the California Coast. Winds from the northwest during spring and summer drive surface water offshore, and it is replaced by cool water high in nutrients that is "upwelled" onto the continental shelf. ***(Source: NMFS 2009 - image from NOAA Cordell Bank National Marine Sanctuary).***

Anthropogenic influences on salmon and steelhead habitat play a primary role in climate influences on extinctions (Francis and Mantua 2003). Over the past 150 years, human activities have degraded, and in some cases completely eliminated, much of the historic stream and estuarine habitats for anadromous salmonids. In many ways, human actions have forced semi-permanent changes to the salmonid landscape that parallel those typically associated with climate change (Karr 1994). For example, stream temperatures, flow regimes, sediment transports, and pool-to-riffle ratios are all subject to anthropogenic and climate changes. Karr (1994) indicates that one major difference between perturbations due to natural climate events versus one caused by human activities is the time scale of the resulting impacts. A warm phase of the El Niño-Southern Oscillation generally impacts precipitation and flow over a single year, while hydropower dam construction alters flow for decades to centuries (Francis and Mantua 2003).

Because it affects the distribution of heat in the atmosphere and the oceans, climate change will affect winds and currents that move along the nation's coasts, such as the California Current that bathes the West Coast from British Columbia to Baja California (Thomas *et al.* 2009). Wind-driven upwelling of deeper ocean water along the coast in this area is vital to moderation of temperatures and the high productivity of Pacific Coast ecosystems (**Figure 6-2**). Warmer temperatures are likely to increase ocean stratification, yet possible increases in winds may counter that in ways that mitigate or even increase the wind-driven upwelling of nutrients that fuel a productive food web (CIG 2004).

Coastal currents are subject to periodic variations caused by the El Niño-Southern Oscillation and the Pacific Decadal Oscillation, which have substantial effects on the success of salmon and other fishery resources. Climate change is expected to affect such coastal currents, and possibly the larger scale natural oscillations as well,

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although these effects are not yet well understood (Thomas *et al.* 2009).

In addition to carbon dioxide's heat-trapping effect, the increase in its concentration in the atmosphere is gradually acidifying the ocean (Thomas *et al.* 2009). About one-third of the carbon dioxide emitted by human activities has been absorbed by the ocean, resulting in a decrease in the ocean's pH. Since the beginning of the industrial era, ocean pH has declined demonstrably and is projected to decline much more by 2100 if current emissions trends continue (Thomas *et al.* 2009). Because less dissolved carbon is available as carbonate ions at a lower pH (Feely *et al.* 2008; Janetos *et al.* 2008), further declines in pH are very likely to continue to affect the ability of living organisms to create and maintain shells or skeletons of calcium carbonate. Ocean acidification also is anticipated to affect important plankton species in the open ocean, mollusks and other shellfish, and corals (Feely *et al.* 2008; Janetos *et al.* 2008; Royal Society 2005; Orr *et al.* 2005). Reductions in pH also affect photosynthesis, growth, and reproduction. The upwelling of deeper ocean water, deficient in carbonate and thus potentially detrimental to the food chains supporting juvenile salmon, has recently been observed along the West Coast (Feely *et al.* 2008).

It is unclear how coastal ocean conditions will respond to long-term climate change and, in turn, affect Chinook salmon and steelhead populations during their marine life stages. Results of studies by Pearcy (1992),Francis and Hare (1994), and Francis and Mantua (2003) indicate that many climate-related biophysical linkages to salmonid populations occur very early in the salmon's marine life history - likely just months after juvenile fish enter the ocean. This hypothesis that cohort survival can be greatly impacted by climate driven conditions (e.g. upwelling and resultant prey availability) when juvenile salmon enter the ocean was also found to apply to Central Valley Chinook salmon (Lindley *et al.* 2009), further indicating that coastal and estuarine environments are key areas of biophysical interaction. While there is uncertainty regarding how coastal ocean conditions will respond to long-term climate change, it is likely that near-shore marine areas will remain important for salmon survival.

6.3 Climate Change Effects on Ocean Conditions

Most climate factors affect the entire West Coast complex of salmonids. This is particularly true in their marine phase, because the California populations are believed to range fairly broadly along the coast and intermingle, and climate impacts in the ocean occur over large spatial scales (Schwing 2009). Because ocean warming will be widespread, populations at the southern extreme of their ranges will be most susceptible to future warming. Salmon and steelhead residing in coastal areas where upwelling is the dominant process are more sensitive to climate-driven changes in the strength and timing of upwelling. Coastal sea level is generally not a major issue along the West Coast, but future sea level rise will be important to juvenile fish in the San Francisco Bay and Delta, as well as in lagoons and estuaries where the annual cycle of bar development and breaching are important to salmonid life history strategies. Perhaps the greatest uncertainty is how ocean acidification will affect salmonids and their marine ecosystem (Schwing 2009). The following is a general discussion of anticipated future changes in ocean conditions, as they may affect off-shore areas used by winter- and spring-run Chinook salmon, and steelhead during their marine life stages.

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6.3.1 California Current Ecosystem

The California Current Ecosystem (CCE) is designated by NMFS as one of eight large marine ecosystems within the United States Exclusive Economic Zone. The California Current begins at the northern tip of Vancouver Island, Canada and ends somewhere between Punta Eugenia and the tip of Baja California Mexico (NMFS 2009). The northern end of the current is dominated by strong seasonal variability in winds, temperature, upwelling, plankton production and the spawning times of many fishes, whereas the southern end of the current has much less seasonal variability. For some groups of organisms, the northern end of the CCE is dominated by sub-arctic boreal fauna whereas the southern end is dominated by tropical and sub-tropical species. Faunal boundaries (i.e., regions where rapid changes in species composition are observed) are known for the waters between Cape Blanco Oregon/Cape Mendocino California, and in the vicinity of Point Conception California (**Figure 6-3**). Higher trophic level organisms often take advantage of the strong seasonal cycles of production in the north by migrating to the region during the summer to feed. Climate signals in this region are quite strong. During the past 10 years, the North Pacific has seen two El Niño events (1997/98, 2002/03), one La Niña event (1999), a four-year climate regime shift to a cold phase from 1999 until late 2002, followed by a four-year shift to warm phase from 2002 until 2006. The response of ocean conditions, plankton and fish to these events is well documented in the scientific literature. The biological responses are often so strong that the animals give early warning of events before such shifts are noticed in the physical oceanographic records (Osgood 2008). Numerous climate stressors (e.g., warming, sea level rise, freshwater flow) impact productivity and structure throughout the CCE. It is difficult to isolate the effect of individual stressors on most individual species, and most of these stressors impact many species at multiple trophic levels.

Five climate-related issues are of greatest concern in the CCE (Osgood 2008). The following provides a summary of these issues, based upon the analysis developed as part of NMFS' framework for a long-term plan to address climate impacts on living marine resources (Osgood 2008).

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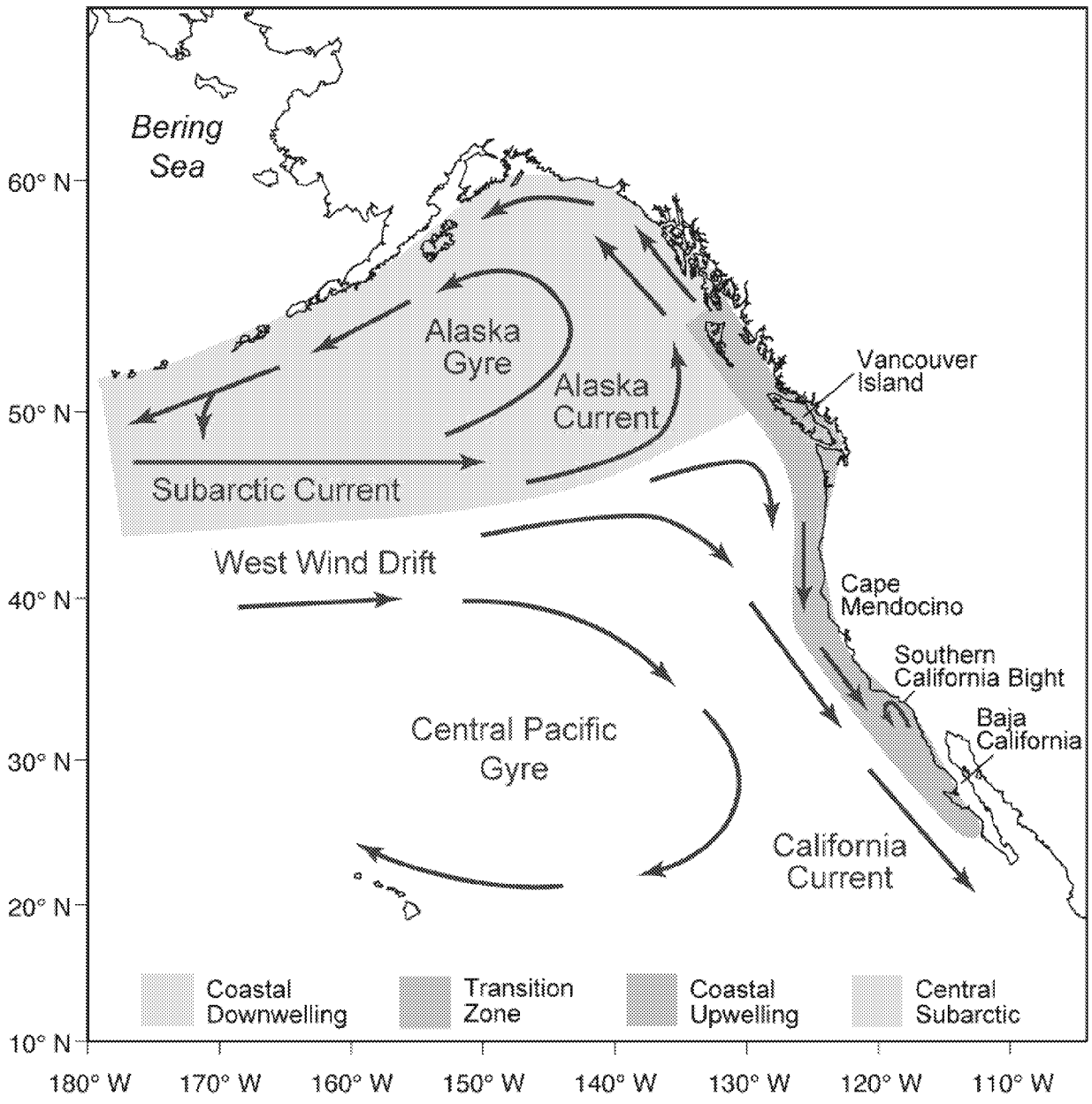


Figure 6- 3. The Principal Ocean Currents Affecting the Coastal Waters off of California. Eastward flow (West Wind Drift) bifurcates as it nears the west coast. The southward arm (the California Current) transports, cool, low salinity, nutrient-rich water along the U.S. west coast. (Source: Image from J.A. Barth, Oregon State University)

Increased Future Climate Variability

One of the likely consequences of global climate change will be a more volatile climate with greater extreme events on the intra-seasonal to inter-annual scales. For the CCE, more frequent and severe winter storms are expected to occur, with greater wind mixing, higher waves and coastal erosion, and more extreme precipitation events and years, which would impact coastal circulation and stratification. Some global climate models predict a higher frequency of El Niño events; others predict that the intensity of these events will be stronger. If true,

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primary and secondary production will be greatly reduced in the CCE, with negative effects transmitted up the food chain.

The Pacific Decadal Oscillation is a pattern of Pacific climate variability that shifts phases approximately every 20 to 30 years. During a "warm" or "positive" phase, the west Pacific becomes cool and part of the eastern ocean warms; during a "cool" or "negative" phase, the opposite pattern occurs. Most models project roughly the same timing and frequency of decadal variability in the North Pacific under the impacts of global warming. However, combined with the global warming trend, the CCE is expected to experience a greater frequency of years consistent with historical periods of lower productivity (e.g., positive Pacific Decadal Oscillation values). Based on ongoing observations, a positive Pacific Decadal Oscillation and a warmer ocean result in dominance of small warm-water zooplankton (which are lipid-depleted), which may result in food chains with lower bioenergetic content. By about 2030, it is expected that the minima in decadal regimes will be above the historical mean of the 20th Century (i.e., the greenhouse gas warming trend will be as large as natural variability).

The Extent and Timing of Freshwater Input

While variability in ocean conditions has substantial impacts on salmon survival and growth, future changes in freshwater and river conditions also will have a great effect on production of anadromous fish. Warmer air temperatures will result in more precipitation earlier in the year, and less snowpack. Changes in the seasonal and inter-annual timing and intensity of rainfall and snowpack, for example, are expected to increase winter and spring runoff and decrease summer runoff. These hydrologic changes may alter the way that water supplies from the Sacramento River are managed for hydropower generation and water storage, which may affect the manner in which Chinook salmon, steelhead and other estuarine-dependent species are managed.

Climate models project the 21st Century will feature greater annual precipitation in the Pacific Northwest, extreme winter precipitation events in California, and a more rapid spring snowmelt leading to a shorter, more intense spring period of river flow and freshwater discharge (Thomas *et al.* 2009). These changes are projected to considerably alter coastal stratification and mixing, riverine plume formation and evolution, and the timing of transport of anadromous fish populations to and from the ocean. A warmer and drier future also means that extra care will be needed in planning the allocation of water for the coming decades (Thomas *et al.* 2009). The current allocation of water resources between salmon and human requirements in the western United States has been a critical factor in the success of many salmon populations, and will be more so if future water availability is altered (Osgood 2008).

Changes in the Timing and Strength of the Spring Transition, and Their Resultant Effects on Marine Populations

The primary issue for the CCE is the onset and length of the upwelling season - when upwelling begins and ends (i.e., the "spring" and "fall" transitions). The biological transition date provides an estimate of when seasonal cycles of significant plankton and euphausiid production are initiated. At present, there is some evidence that coastal upwelling has become stronger over the past several decades due to greater contrasts between warming of the land (resulting in lower atmospheric pressure over the

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continent), relative to ocean warming. The greater cross-shelf pressure gradient will result in higher along-shore wind speeds and the potential for more upwelling (Bakun 1990). Regional climate models project that not only will upwelling-favorable winds will be stronger in summer, but that the peak in seasonal upwelling will occur later in the summer (Snyder *et al*. 2003).

Even though southward winds that cause coastal upwelling are likely to increase in magnitude, these winds may be less effective in driving vertical transport of nutrient-rich water because it is not known if these winds will be able to over-ride increased water column stratification (Osgood 2008; NMFS 2009). That is, the winds may not be able to mix this light buoyant water or transport it offshore resulting in the inability of the cold nutrient-rich water to be brought to the ocean surface. Thus, phytoplankton blooms may not be as intense, which may impact organisms up the food chain (Roemmich and McGowan 1995).

Given that the future climate will be warmer, the upper ocean at the watershed scale will almost certainly be, on average, more stratified (Osgood 2008). This will make it more difficult for winds and upwelling to mix the upper layers of the coastal ocean, and will make offshore Ekman pumping less effective at bringing nutrients into the photic zone. The result will be lower primary productivity throughout the salmon marine habitat (with the possible exception of the nearshore coastal upwelling zones) (Osgood 2008).

Should global warming result in shorter winters in the Pacific Northwest, areas where production is light limited (e.g., the northern California Current) may see higher productivity (Osgood 2008). During most years since 2002, phytoplankton blooms are initiated as early as February off northern California in years when storm intensity is low. These early blooms result in bursts in egg production by both copepods and euphausiids, initiating a cohort of animals that reach adulthood one to two months earlier than a cohort that is initiated with the onset of upwelling during March or April. The result would be a longer plankton production season. Alternatively, regional climate projections are for a later shift in the start time, peak times and end of the upwelling season, which could counter the idea of a longer upwelling season (Osgood 2008).

Ocean Warming and Increased Stratification, and Their Resultant Effects on Pelagic Habitat

This issue focuses on the central and southern California Current, and on the organisms that utilize the upper ocean habitat in this region. Generally warmer ocean conditions will cause a northward shift in the distribution of most species, and possibly the creation of reproductive populations in new regions. Existing faunal boundaries are likely to remain as strong boundaries, but their resiliency to shifts in ocean conditions due to global climate change is not known (Osgood 2008). Warmer water temperatures also will affect freshwater salmon and steelhead habitats by reducing habitat opportunity on both spatial and seasonal time scales. In coastal and oceanic regions, the southern boundaries of pelagic habitats used by many populations are expected to shift northward.

Warmer air temperatures may lead to increased stratification of the coastal CCE. The warmer temperatures will increase the heat flux into the ocean. Mixing and diffusion are not likely to redistribute this heat rapidly enough to prevent an increase in thermal stability and stratification of the upper ocean (Osgood 2008). The vertical gradient in ocean water temperature off of the California coast

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has intensified over the past several decades (Palacios *et al.* 2004). Areas with enhanced riverine input into the coastal ocean will also see greater vertical stratification. Moreover, increased melting of glaciers in the Gulf of Alaska coupled with warmer sea surface temperatures will result in increased stratification. Because some of the source waters that supply the northern California Current originate in the Gulf of Alaska, more stratified source waters will contribute to increased stratification of coastal waters of the northern California Current (Osgood 2008).

Changes to Ocean Circulation and Their Resultant Effects on Species Distribution and Community Structure

NMFS (2008) states that this is a climate-induced ecosystem concern primarily for the northern California Current, although changes in transport are known to have subtle effects on the entire Current. A particular biological concern is related to the variability in the transport of organisms, which impacts zooplankton species composition and regional recruitment patterns for demersal fish stocks.

As previously discussed, the California Current extends from the northern tip of Vancouver Island, Canada to southern Baja California, Mexico. As the current flows from north to south, the waters warm and mix with offshore waters such that both temperature and salinity increase gradually in a southward direction (Osgood 2008). Observations of the biota of the California Current show that there are pronounced latitudinal differences in the species composition of plankton, fish, and benthic communities, ranging from cold water boreal sub-arctic species in the north to warm water subtropical species in the south. Changes in abundance and species composition can be gradual in some cases, but it is widely accepted that faunal boundaries (zones of rapid change in species composition) are present in the waters in the vicinity of Capes Blanco and Mendocino, and at Point Conception. The strongest contrasts are observed during summer (Osgood 2008).

The strong contrast in species composition between shelf and offshore waters during summer is due to the upwelling process. A combination of upwelling itself, along with the sub-arctic water which feeds the inshore arm of the northern end of the CCE, create conditions favorable for development of a huge biomass of sub-arctic zooplankton. This pattern is slightly modified as a function of the phase of the Pacific Decadal Oscillation. During a cool phase, all of the northern CCE becomes more sub-Arctic in character (both shelf-slope-oceanic regions); during a warm phase of the Pacific Decadal Oscillation, the water masses and associated copepod community become far more similar to a sub-tropical community. Copepod biodiversity increases in coastal waters, due to shoreward movement of offshore waters onto the continental shelf, due to either weakening of southward wind stress in summer or strengthening of northward wind stress in winter. Thus, when Pacific Decadal Oscillation is in a positive phase, a greater proportion of the water entering the northern end of the current is sub-tropical in character rather than sub-Arctic.

Regardless of the season, the source waters that feed into the California Current from the north and from offshore can exert some control over the phytoplankton and zooplankton species that dominate the current (**Figure 6-4**).

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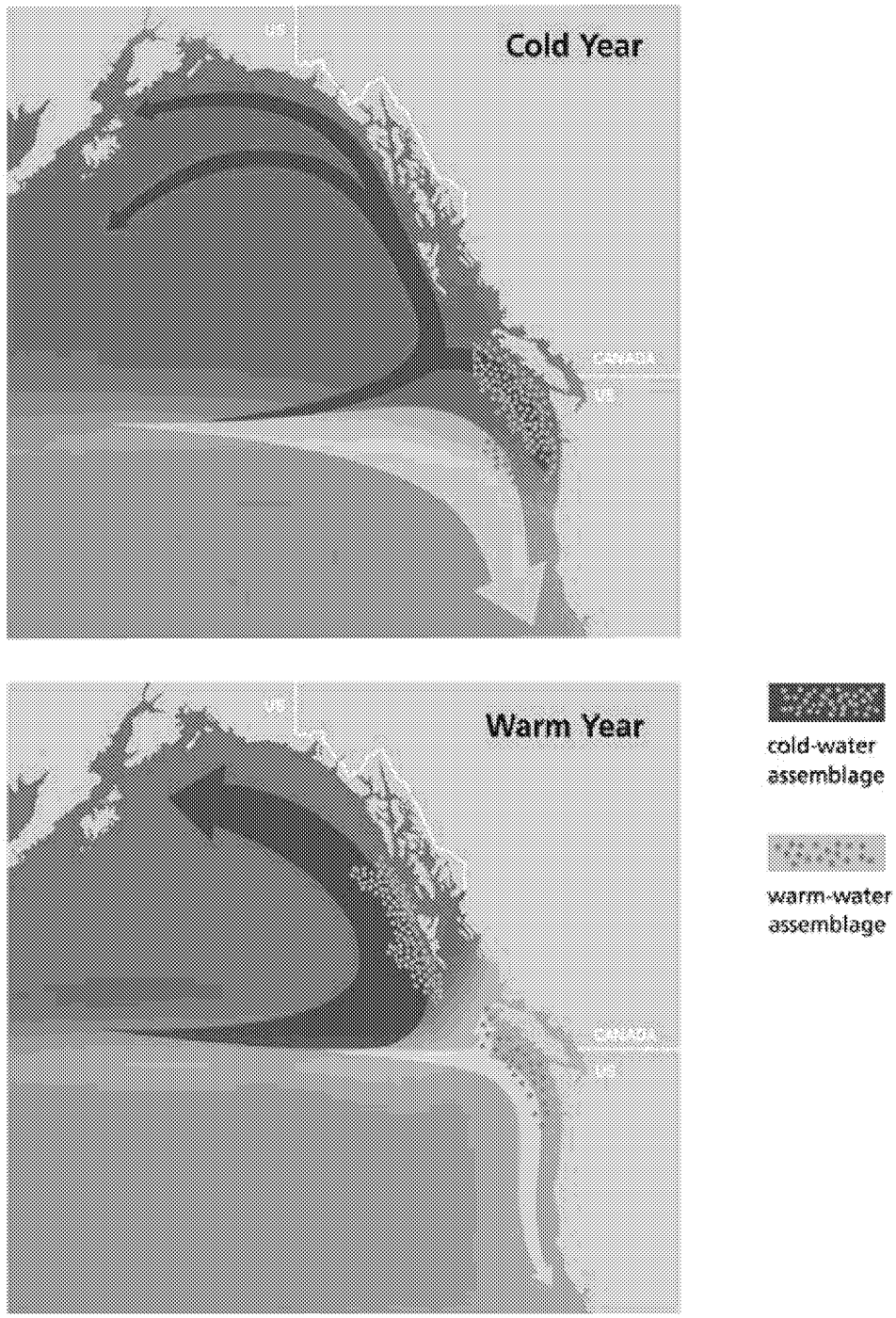


Figure 6-4. Schematic of the Flow of the North Pacific Current South into the California Current and North into the Gulf of Alaska. Cool years (such as La Niña and negative PDO years) are associated with greater flow into the California Current, which favors a southward displacement of coldwater and warmwater species. ***(Source: Osgood 2008)***

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Hooff and Peterson (2006) suggest that knowledge of source waters is critical to understanding ecosystem dynamics in the shelf waters of the Northern CCE because waters from the Gulf of Alaska carry large, lipid-rich copepods to the shelf waters, whereas waters coming from an offshore source carry small, oceanic lipid-poor copepods to the shelf waters. Thus, changes reflected by Pacific Decadal Oscillation shifts may result in local food chains that have considerably different bioenergetic content. Given, for example, that: (a) salmon returns are low when the Pacific Decadal Oscillation is in a positive, warm water phase, but high when the Pacific Decadal Oscillation is in a negative, cold-water phase; and (b) salmon returns to Pacific Northwest rivers are highly correlated with copepod community structure (Peterson and Schwing 2003), variations in the bioenergetic content of the food web may represent a mechanistic link between Pacific Decadal Oscillation sign change and salmon survival (Osgood 2008). This mechanistic link may also apply to Chinook salmon originating from the Central Valley because some of the source waters that supply the Gulf of the Farallones, where Central Valley salmon first enter the ocean, originate in the Gulf of Alaska and Central Valley Chinook salmon abundance was found to be correlated with prey availability in the Gulf of the Farallones (Wells *et al.* 2012).

Northward shifts in distribution also are possible. Generally warmer conditions could result in a northward shift in the distribution of some species, and possibly the creation of reproductive populations in new regions. Alternatively, if upwelling strengthens due to global climate change, regardless of the sign of the Pacific Decadal Oscillation, cold-water species should still be favored in the coastal upwelling zones (Osgood 2008). However, the onshore-offshore gradients in temperature and species abundance should strengthen if offshore waters become warmer and upwelling becomes stronger, creating stronger upwelling fronts, and perhaps a greater level of mesoscale activity. It is unclear how faunal boundaries might be affected (Osgood 2008).

6.4 Climate Change Effects on Salmon and Steelhead in the Central Valley

In California, there have been observed changes in air temperatures, annual precipitation, runoff, and sea levels over the past century (Anderson *et al.* 2008). Regional-scale climate models for California are in broad agreement that temperatures in the future will warm significantly, total precipitation may decline, and snowfall will decline significantly (Lindley *et al.* 2007). Literature suggests that by 2100, mean summer temperatures in the Central Valley may increase by 2 to 8°C, precipitation will likely shift to more rain and less snow, with significant declines in total precipitation possible, and hydrographs will likely change, especially in the southern Sierra Nevada mountains. Thus, climate change poses an additional risk to the survival of salmonids in the Central Valley. As with their ocean phase, Chinook salmon and steelhead will be more thermally stressed by stream warming at the southern ends of their ranges (e.g., Central Valley Domain). For example, warming at the lower end of the predicted range (about 2°C) may allow spring-run Chinook salmon to persist in some streams, while making some currently utilized habitat inhospitable (Lindley *et al.* 2007). At the upper end of the range of predicted warming, very little spring-run Chinook salmon habitat is expected to remain suitable (Lindley *et al.* 2007).

The complex life history of salmonids as well as the complexity of their multiple aquatic habitats makes it difficult to isolate what environmental factors, or drivers, are responsible for variability in these populations

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(Schwing 2009). Overall, the climate-species linkages for salmon are extremely complex. In a recent report to the Pacific Fishery Management Council, CDFW identified 46 possible reasons for the collapse of the 2004 and 2005 broods of Central Valley fall-run Chinook salmon. It is difficult to isolate the immediate effect of an individual stressor on a species, and most stressors impact many species at multiple trophic levels. Further, it is not likely that there is one single stressor, but a combination of several factors that drive ecosystem variability and change (Schwing 2009). Nevertheless, it is possible to focus on a relatively small number of factors that are sufficiently sensitive to climate change and impact the populations and freshwater and marine ecosystems of California anadromous salmonids.

This Recovery Plan addresses the California Central Valley steelhead DPS, and two Chinook salmon ESUs - Sacramento River winter-run Chinook salmon, and Central Valley spring-run Chinook salmon. Because of their extended use of the Sacramento and San Joaquin River systems, they are very dependent on runoff from the Sierra snowpack and the variability of precipitation affecting it (Osgood 2008), as previously discussed. The future climate of the freshwater habitats of the Central Valley Domain is expected to include:

- More frequent intense winter storms, high stream flow events, and floods
- Earlier snowmelt, with higher peak flows in winter, less spring runoff, and much lower summer flows
- Considerably warmer stream, river and ocean water temperatures during the summer
- Greater inter-annual precipitation variability, more frequent wet and drought years, and extended droughts
- Years with weaker fall storms, and delays in the onset of high stream flows
- More frequent wildfires and infestations, and increased erosion and sedimentation

The impacts of climate change on winter-run and spring-run Chinook salmon will differ due to differences in their life history. Winter-run Chinook salmon adults return and migrate upstream in winter through early spring, where they hold for several months before spawning in late spring and summer (Williams 2006). This spawning timing and subsequent fry emergence allows winter-run Chinook salmon juveniles to rear and move downstream during the cooler fall, winter, and spring months (Yoshiyama *et al.* 1998). That is, the juveniles can rear in freshwater for several months, without being exposed to stressful summer water temperatures. However, incubation, the most temperature-sensitive life stage, coincides with the time when river temperatures can exceed the lethal range for embryo incubation. Thus, winter-run Chinook salmon occur currently only in the Sacramento River, where summer water temperatures are cool enough to enable successful embryo incubation, but warm enough in winter to support juvenile rearing (Stillwater 2006 in Schwing 2009). They also spawn in deeper water than other populations (Moyle 2002). Juvenile winter-run Chinook salmon have historically exploited the floodplain habitat created by winter flooding in the Sacramento River Basin, which results in higher juvenile growth rates and presumably higher ocean survival (Sommer *et al.* 2001 in Schwing 2009).

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The life history of spring-run Chinook salmon is to migrate upstream in spring, hold through the summer in deep pools, and then spawn in early fall, with juveniles emigrating after either a few months or a year in freshwater. However, they have considerable flexibility in their life history strategies. Age at spawning for spring-run Chinook salmon varies from two to four years.

Central Valley watersheds are fed predominantly by runoff from Sierra snowmelt, which has been historically highest during the late spring and early summer. The resulting high flow allows Chinook salmon to reach their summer holding areas, while the lower flow extending from the summer into early fall is cool enough for spawning. In the San Joaquin River drainage, snowmelt at high elevations produced a long runoff period that benefited spring-run Chinook salmon, making them the dominant run in the region. However, the recent trend toward an earlier seasonal runoff and lower flow in spring and summer has reduced the potential for survival in these watersheds, and will make the transit of adults returning to their spawning streams more difficult (see watershed profile information for individual rivers located in the Southern Sierra Nevada Diversity Group).

Because eggs and juveniles are less tolerant of warm water temperatures, spawning occurs during the fall, after streams cool. On their migration to the ocean, juvenile fish access temporary habitats with warmer water temperatures and abundant food in floodplain, tidal marsh, and estuarine habitats. These habitats are very important in smolt growth and survival - smolt size at ocean entry strongly affects survival during the first year at sea (Williams 2006). After reaching the ocean in the late spring and summer, smolts forage near the coast on crustaceans, euphausids, and prey fishes (MacFarlane and Norton 2002) that are associated with upwelling. Smolt survival over their first winter is dependent on a threshold of prey and the resultant smolt condition after the first summer at sea (Williams 2006).

Because of their close proximity, a relatively small wildfire could simultaneously burn the headwaters of all three remaining spring-run Chinook populations. Such a fire has a 10 percent chance of occurring in any given year in California (Lindley *et al.* 2007), but this probability will increase due to climate change. Prolonged drought due to lower precipitation shifts in snowmelt runoff, and greater climate extremes could also easily render most existing spring-run Chinook salmon habitat unusable, either through temperature increases or lack of adequate flows.

Increased water temperature, low flow, drought and other climate-related events will compound the threats to Chinook salmon due to human manipulation of their freshwater habitats. Because of these watersheds' great dependence on Sierra snowpack melt, the projected shift toward earlier runoff (Dettinger and Cayan 1995; Cayan *et al.* 2001) will exacerbate sensitivity to low flow and warm stream conditions at critical life stages. Winter-run Chinook salmon are especially vulnerable to climate warming, prolonged drought, and other catastrophic climate events, because they have only one remaining population that spawns in the hottest time of the year (also see the conceptual recovery scenario for winter-run Chinook salmon). Additionally, future ocean productivity will decline due to altered upwelling cycles, thus reducing prey availability and salmon ocean survival (NMFS 1997 in Schwing 2009).

Central Valley steelhead also exhibit a flexible life history, allowing them to compensate for the variable conditions and extremes of their habitat (McEwan 2001). Most juveniles

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remain in streams for one or two years before becoming smolts and emigrating out to the Delta and ocean (Hallock 1961 in Schwing 2009). Others may remain in the rivers their entire lives. Temperature and water quality are critical factors for fry and juvenile survival (Moyle 2002). Fry move into cooler, deeper, faster-flowing channels in the late summer and fall (Hartman 1965, Everest and Chapman 1972, and Fontaine 1988 in Schwing 2009). Juvenile steelhead prefer deep pools with heavy cover, as well as higher-velocity rapids (Bisson *et al.* 1982, 1988 and Dambacher 1991 in Schwing 2009).

The distribution of steelhead today is greatly reduced from the historical distribution. Dams and water diversions limit steelhead access to less than 20 percent of their historical spawning and rearing areas in the Central Valley (Yoshiyama *et al.* 2001; Lindley *et al.* 2006). Climate warming will further restrict access to cool water streams. Most of the same climate factors that affect other California steelhead populations are critical to Chinook salmon. The diversity and variability of their life history complicates their management. Yet this same attribute reduces their vulnerability to climate change.

Additionally, low flows during juvenile rearing and outmigration are associated with poor survival through the Delta (Kjelson and Brandes 1989; Baker and Morhardt 2001; and Newman and Rice 2002) and poor returns in subsequent years (Speed 1993). Climate change also may impact Central Valley salmonids through community effects. For example, warming may increase the activity and metabolic demand of predators, reducing the survival of juvenile salmonids (Vigg and Burley 1991).

6.5 Concepts for Buffering Climate Change Effects and Application in this Recovery Plan

The general concepts of resiliency and refugia discussed below have been used in the strategy (Chapter 3) of this recovery plan to identify a distribution of habitat in the Central Valley and habitat types that are most likely to allow winter-run Chinook salmon, spring-run Chinook salmon, and steelhead to withstand the effects of climate change. This distribution of habitat is reflected in the ESU/DPS level recovery criteria relating to population spatial structure. The types of habitats that these species will need in the face of climate change have been factored into the watershed prioritizations identified in the recovery strategy.

6.5.1 Resiliency

In ecology, resiliency carries the additional meaning of how much disturbance a system can "absorb" without crossing a threshold and entering an entirely different state of equilibrium (e.g., distinctly different physical habitat structure or conditions) (Bakke 2009). In regard to recovery, habitat restoration, and conservation of at-risk aquatic species, resiliency also requires that certain key habitat characteristics or processes will change little, or not at all, in response to climate change. When it comes to stream aquatic habitat, the most important elements to remain steady are temperature and disturbance regime (Bakke 2009). Resiliency is temporally dependent and given enough time, large disturbances are virtually certain to occur on the landscape and to the climate. Resiliency can only function on a landscape scale; there must be enough individual rivers available with the appropriate habitat and connectivity so that a disturbance to one portion of the system has a minimal impact on at-risk aquatic species because

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other parts of the system are able to support sensitive populations through the recovery and recolonization period (Bakke 2009).

In the long-term, there is no substitute for a landscape that offers redundancy of habitat opportunities. This recovery plan incorporates the resiliency concept by using the Central Valley diversity groups as recovery units (see Section 3.2.1) and generally calling for multiple viable populations within each of the units. Having an ESU or DPS spatial structure with each diversity group represented and population redundancy within each diversity group follows the historic population structure, which allowed the species to withstand extreme climactic events and persist for thousands of years. Because the biological recovery criteria for each of the three species covered in this plan (Section 4.3.4) are based on the species' historic spatial structure, it is assumed that an ESU/DPS that meets those criteria should be resilient to disturbances caused by climate change.

6.5.2 Refugia

Refugia are places in the landscape where organisms can go to escape extreme conditions (Bakke 2009). Typically, this refers to short-term conditions such as floods or high water temperatures. But in the context of climate change, refugia can also be places where a population may persist through decades and centuries of unfavorable climate conditions and instability. For coldwater obligate fish species, refugia will continue to be areas where groundwater emergence influences water temperature and volume. These refugia will exist on multiple scales: (1) local areas of cold water emergence within a reach otherwise insufficiently cold; (2) lower sections of rivers downstream of reservoirs with large amounts of coldwater storage; and (3) entire stream systems where groundwater hydrology is dominant or snowmelt hydrology is preserved due to high elevations. Thus, the same set of circumstances producing cold water conditions in the current landscape may, to varying degrees, produce thermal refugia against global warming.

The coldwater refugia concept has been applied in this recovery plan as a factor in the prioritization of watersheds. For example, Battle Creek, Mill Creek, and Deer Creek each were identified as core 1 watersheds for spring-run Chinook salmon, in part, because fish in those watersheds should be able to withstand warming air temperatures either by coldwater spring inputs (Battle Creek) or having access to holding and spawning habitat at relatively high elevation (Mill Creek and Deer Creek). As another example of how the refugia concept was applied in this recovery plan, the Sacramento River downstream of Shasta Dam was identified as a core 1 area for winter-run Chinook salmon, in part, because, in wetter year types, suitable water temperatures for spawning and incubation are provided during the summer via coldwater releases from the dam. Even with the projected effects of climate change, it is likely that suitable temperatures for winter-run Chinook salmon will be available downstream of Shasta Dam during wetter years. However, considering the expected increase in the frequency of dry years, which often result in mortality during egg incubation, it will be increasingly difficult to maintain the species without access to coldwater in the summer on a more consistent annual basis. As such, the McCloud River watershed, which receives coldwater from high elevation snowmelt and from springs, has been identified as a primary area for reintroduction. Reintroducing salmon and steelhead to historic high elevation habitats is a key part of the recovery strategy (see Section 3.3.2) because coldwater refugia will be needed to allow the species to withstand climate change.

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7.0 Implementation

"Although recovery actions can, and should, start immediately upon listing a species as endangered or threatened under the ESA, prompt development and implementation of a recovery plan will ensure that recovery efforts target limited resources effectively and efficiently into the future."

NMFS 2010b. Interim Endangered and Threatened Species Guidance

7.1 Costs and Benefits of Salmon and Steelhead Recovery

Implementing the recovery actions in this recovery plan will be expensive, with a rough estimate ranging from $17 to $37 billion[29]. This investment in recovery of salmon and steelhead will result in economic, societal and ecosystem benefits. Monetary investments in watershed restoration projects can promote the economy in a myriad of ways. These include stimulating the economy directly through the employment of workers, contractors and consultants, and the expenditure of wages and restoration dollars for the purchase of goods and services. Habitat restoration projects have been found to stimulate job creation at a level comparable to traditional infrastructure investments such as mass transit, roads, or water projects (Oregon Watershed Enhancement Board 2010). In addition, viable salmonid populations provide ongoing direct and indirect economic benefits as a resource for fish, recreation, and tourist related activities. Dollars spent on salmon and steelhead recovery will promote local, State, Federal and tribal economies, and should be viewed as an investment with both societal (clean rivers, healthy ecosystems) and economic returns.

[29] Estimate derived by summing the costs of all recovery actions presented in Chapter 5.

The largest direct economic returns resulting from recovered salmon and steelhead are associated with sport and commercial fishing. On average 1.6 million anglers fish the Pacific region annually (Oregon, Washington and California) and 6 million fishing trips were taken annually between 2004 and 2006 (NMFS 2010a). Most of these trips were taken in California and most of the anglers lived in California. The California salmon fishery is estimated to generate $118 to $279 million in income annually, and provide roughly two to three thousand jobs (Michael 2010). With a revived sport and commercial fishery, an increase in economic gains and the creation of jobs would be realized across California, but most notably for river communities and rural coastal counties.

Many of the actions identified in this Recovery Plan are designed to improve watershed-wide processes which will benefit many native species of plants and animals (including other state and federally listed species) by restoring natural ecosystem functions. In addition, restoration of habitat in watersheds will provide substantial benefits for human communities. Some of these benefits are: improving and protecting the quality of important surface and ground water supplies; reducing damage from flooding resulting from floodplain development; and controlling invasive exotic animal and plant species which can threaten water supplies and

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increase flooding risk. Restoring and maintaining healthy watersheds also enhances important human uses of aquatic habitats, including outdoor recreation, ecological education, field based research, aesthetic benefits, and the preservation of tribal and cultural heritage.

The final category of benefits accruing to recovered salmon and steelhead populations are even more difficult to quantify and are related to the ongoing costs associated with maintaining populations that are at risk of extinction. Significant funding is spent annually by entities (Federal, State, local, private) in order to comply with the regulatory obligations that accompany populations that are listed under the ESA.

Important activities, such as water management for agriculture and urban use, are now constrained to protect ESA listed populations of salmon and steelhead. Recovering the salmonid populations so the protections of the ESA are no longer necessary will also result in elimination of the regulatory requirements imposed by the ESA, and allow greater flexibility for land and water managers to optimize their activities and reduce costs related to ESA protections. Salmon recovery is best viewed as an opportunity to diversify and strengthen the economy while enhancing the quality of life for present and future generations.

7.2 Integrating Recovery Implementation into NMFS Actions

It is a challenging undertaking to facilitate a change in practice and policy that reverses the path towards extinction of a species to one of recovery. This change can only be accomplished with effective outreach and education, strong partnerships, focused recovery strategies and solution-oriented thinking that can shift agency and societal attitudes, practices and understanding.

Implementation of the recovery plan by NMFS will take many forms and is generally and specifically described in the NMFS Protected Resources Division Strategic Plan 2006 (NMFS 2006). The Recovery Planning Guidance (NMFS 2010b) also outlines how NMFS will cooperate with other agencies regarding plan implementation. These documents, in addition to the ESA, will be used by NMFS to set the framework and environment for plan implementation. The PRD Strategic Plan asserts that species conservation (in implementing recovery plans) by NMFS will be more strategic and proactive, rather than reactive. To maximize existing resources with workload issues and limited budgets, the PRD Strategic Plan champions organizational changes and shifts in workload priorities to focus efforts towards "…*those activities or areas that have biologically significant beneficial or adverse impacts on species and ecosystem recovery*" (NMFS 2006).

NMFS actions to promote and implement recovery planning include:

- Formalizing recovery planning goals on a program-wide basis to prioritize work load allocation and decision-making (to include developing the mechanisms to make implementation (*e.g.*, restoration) possible).
- Conducting outreach and education.
- Facilitating a consistent framework for research, monitoring, and adaptive management that can directly inform recovery objectives and goals.
- Establishing an implementation tracking system that is adaptive and pertinent to support the annual reporting for the Government Performance and Results Act, Bi-Annual Recovery Reports to

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Congress and the 5-Year Status Reviews.

To achieve recovery, NMFS will need to promote the recovery plan and provide needed technical information and assistance to other entities that implement actions that may impact the species' recovery. For example, NMFS intends to work with key partners on high priorities such as facilitating fish passage assessments and ensuring protective measures consistent with recovery objectives are included in County General Plans.

While recovery plans are guidance documents not regulatory documents, the intent is that they are used to prioritize and target necessary actions for the survival and recovery of the species. The Recovery Planning Guidance (NMFS 2010b) specifically outlines NMFS' obligations:

> "...the ESA clearly envisions recovery plans as the central organizing tool for guiding each species' recovery process. They should also guide Federal agencies in fulfilling their obligations under section 7(a)(1) of the ESA… and provide context and a framework for implementing other provisions of the ESA with respect to a particular species, such as section 7(a)(2) consultations on Federal agency activities, development of Habitat Conservation Plans or Safe Harbor agreements under section 10, special rules for threatened species under section 4(d), or the creation of experimental populations in accordance with section 10(j)."

As further discussed below, this recovery plan is intended to inform decisions made pursuant to or concerning critical habitat designation under section 4, land acquisition under section 5, take prohibitions through sections 4(d) and 9, cooperation with state(s) under section 6, needed research under section 10, and fishery management actions taken and Essential Fish Habitat (EFH) consultations conducted under the provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

The approaches NMFS intends to use when implementing various sections of the ESA are discussed in detail and are summarized in **Table 7-1**. These approaches are intended to formalize the recovery plans in the daily efforts and decision-making at NMFS in the Southwest Region. Of necessity, some of these methods address the urgent issues of staffing and workload that NMFS faces. As a result, our commitment to implementing recovery plans extends to the ways in which we prioritize the many requests for consultations and permits we receive.

7.2.1 Working with Constituents and Stakeholders

NMFS commits to using recovery plans as a guiding mechanism for its daily endeavors. Successful implementation of this recovery plan will require the support, efforts and resources of many entities, from Federal and State agencies to individual members of the public. NMFS commits to working cooperatively with other individuals and agencies to implement recovery actions and to encourage other Federal agencies to implement actions where they have responsibility or authority.

7.2.2 ESA Section 4

Section 4 provides the mechanisms to list new species as threatened or endangered, designate critical habitat, develop protective regulations for threatened species, and develop recovery plans. Critical habitat designations may be revised as needed to reflect recovery strategies.

Sacramento River winter-run Chinook salmon critical habitat was designated on June 16, 1993, and includes the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta;

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all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Estuary to the Golden Gate Bridge north of the San Francisco/Oakland Bay Bridge (58 FR 33212). CV spring-run Chinook salmon and CV steelhead critical habitat was designated 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).

NMFS will reevaluate the designations in light of the data and criteria developed for this plan, and may propose the designation of additional habitat. The key recovery areas, special management considerations and recovery priorities identified in this recovery plan will inform future critical habitat designations. Certain unoccupied historic habitats that may be essential for recovery, and that are recommended for future critical habitat consideration include:

Sacramento River winter-run Chinook salmon

- Little Sacramento River
- McCloud River
- Battle Creek
- Non-natal rearing tributaries to the Sacramento River

Although these areas may provide sites and habitat components that are consistent with the physical and biological features that are essential for the conservation of Sacramento River winter-run Chinook salmon described in the final rule designating critical habitat for that ESU (58 FR 332112, 33216-17; June 16, 1993), a more detailed evaluation of habitat conditions will need to be undertaken when re-considering whether a system should be proposed for critical habitat. In the Little Sacramento and McCloud rivers and Battle Creek, these sites and habitat components include freshwater rearing, migration and spawning habitats. Although these habitats are currently blocked by dams, the many miles of relatively unimpaired cold water habitats and the fact that they historically supported winter-run Chinook salmon may make these areas highly valuable to the recovery of the species. Non-natal rearing tributaries to the Sacramento River include freshwater rearing habitat. Some non-natal rearing areas potentially have a high value because they provide critical and improved growing conditions, particularly during high winter flow events on the Sacramento River.

CV spring-run Chinook salmon and CV steelhead

- Little Sacramento River
- McCloud River
- North Fork Feather River
- North, Middle and South Yuba River
- Upper American River
- Mokelumne River
- North Fork Stanislaus River
- Tuolumne River
- Merced River
- San Joaquin River (CV spring-run Chinook salmon only)

This list represents the unoccupied historic habitat identified in the Conceptual Recovery Footprint maps presented in Chapter 3 (Figures 3-5 and 3-6). Although these areas may provide sites and habitat components consistent with the primary constituent elements (PCEs) essential for the conservation of CV spring-run Chinook salmon and CV steelhead that are included in the critical habitat designated for this ESU and DPS (50 C.F.R. § 226.211(c)), a more detailed evaluation of habitat conditions will need to

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be undertaken when re-considering whether a system should be proposed for critical habitat.[30]

Section 4(d) of the ESA directs the Secretary of Commerce (who has delegated such authority to NMFS) to issue regulations as deemed necessary and advisable to conserve species listed as threatened. ESA section 9 prohibits any take of species listed as endangered. Pursuant to regulations issued under section 4(d) of the ESA (commonly referred to as 4(d) rules), NMFS may also prohibit the take of threatened species. Section 4(d) of the ESA gives NMFS the discretion to customize prohibitions and regulate activities to provide for the conservation of threatened species when applying the take prohibitions that apply to endangered species under ESA section 9. A 4(d) rule is currently in place for Central Valley spring-run Chinook salmon and CV steelhead at 50 C.F.R. § 223.203. That 4(d) rule applies the endangered species prohibitions of section 9(a)(1) to threatened Central Valley spring-run Chinook salmon and CV steelhead, subject to certain limitations. Those limitations include limits on take prohibitions found in 50 C.F.R. § 223.203 (b).

Based on our review of the special management considerations necessary to implement recovery actions for spring-run Chinook salmon and steelhead, development of additional 4(d) limits on the take prohibitions for the following activities are recommended for consideration:

- Fish passage facilities that are consistent with NMFS fish passage criteria
- Levee construction or maintenance activities that meet the following requirements, provided they are applicable to the levee activity being considered:
  - Part of a comprehensive flood management program that has been approved by NMFS and includes a detailed conservation strategy for implementing recovery actions for floodplain and riparian habitat restoration
  - Levee relocations that create frequently activated floodplain areas (Williams *et al.* 2009), and minimize the potential for the stranding of juvenile fish
  - Slurry wall construction within urban river corridors
  - In-river repair and maintenance actions within urban flood corridors that meet NMFS design and maintenance criteria for urban levees
- Spawning gravel augmentation projects below dams
- Adult and juvenile fish collection and relocation actions that are part of a NMFS-approved fish reintroduction program

The above recommendations are made because the activities could provide for the conservation of threatened species, potentially without involving the additional time and cost involved with methods of ESA compliance that are currently available for these activities.

[30] As described in the Recovery Strategy (Chapter 3), it is important to note that it is not necessary to re-establish populations in all of these watersheds to meet the recovery criteria for CV spring-run Chinook salmon or CV steelhead. In fact, successful reintroductions into just a few areas will allow the recovery criteria to be met.

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7.2.3 ESA Section 5

Section 5 of the ESA provides that the Secretary of the Interior and the Secretary of Agriculture, with respect to the National Forest System, shall establish and implement a program to conserve fish, wildlife, and plants, including listed endangered and threatened species. To carry out this program, the appropriate Secretary shall use certain land acquisition and other authority, and is given additional authority related to land and water acquisition. Multiple National Forests lands are present within the Central Valley domain.

7.2.4 ESA Section 6

Section 6 of the ESA describes protocols for consultation and agreements between NMFS and the states for the purpose of conserving threatened or endangered species. The current agreement under section 6 of the ESA between NMFS and California covers abalone and green sturgeon. NMFS will explore options with CDFW for including winter-run Chinook salmon, spring-run Chinook salmon, and steelhead in the existing or a new agreement under section 6 of the ESA.

Table 7-1. Summary of approaches NMFS intends to use when implementing various sections of the ESA and MSFCMA.

Authority	Description	Implementation Actions
ESA Section 7	Section 7(a)(1) Interagency Cooperation (Use of authorities)	Use threats assessments and recovery actions to guide Federal partners to further the conservation of listed Central Valley salmon and steelhead.
ESA Section 7	Section 7(a)(2) Interagency Cooperation (Consultation)	Continue to use the viable salmonid population concept described in this Recovery Plan to help determine effects of proposed actions on the likelihood of species' survival and recovery.
	Note: Permits issued section 10(a)(1) of the ESA also undergo section 7 consultation prior to issuance.	Use threats assessments and recovery strategy as a guide to prioritizing consultations when making workload decisions.
		Place high priority on consultations for actions that implement recovery strategy or specific actions.
		Streamline consultations for those actions with little or no effect on recovery areas or priorities.
ESA Section 9	Section 9 Enforcement	Prioritize those actions and areas deemed of greatest threat or importance for focused efforts to halt illegal take of listed species.
ESA Section 10	Section 10(a)(1)(B) Incidental Take Permits	Prioritize permit applications that address identified research and monitoring needs in the recovery plan.
		Prioritize cooperation and assistance to landowners proposing activities or programs designed to achieve recovery objectives.
Magnuson-Stevens Fishery Conservation and Management Act	Fishery Management	Implement fishery regulations to maintain salmon harvest levels at or below those necessary to allow for the recovery of listed salmon and steelhead.
		Implement fishery regulations to reduce bycatch of salmon in federally-managed fisheries.

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7.2.5 ESA Section 7

Section 7(a)(1) provides that all Federal agencies shall "…in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species…." "Conservation" is defined in the ESA as "the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to [the ESA] are no longer necessary." 16 U.S.C. § 1532(3). . Therefore, a key theme is *recovery*. To encourage Federal agencies to fulfill their section 7(a)(1) requirement to carry out conservation programs for listed Central Valley salmon and steelhead, NMFS will:

1. Encourage development of a West Coast Region California Central Valley Area Office or Regional Memorandum of Understanding (MOU) similar to a 1994 MOU [Daily Env't Rep. (BNA) No. 188, at E-1] between Agencies (which expired in 1999), establishing a framework for cooperation and participation to further the purposes of the ESA that specifically outlines a process for coordinating and implementing appropriate recovery actions identified in recovery plans.

2. Prepare, and send after recovery plan approval, a letter to all other appropriate Federal agencies outlining section 7(a)(1) obligations and meet with these agencies to discuss listed salmonid conservation and recovery priorities.

3. Encourage use of conservation bank credits when appropriate to contribute toward recovery of listed anadromous salmonids in the Central Valley.

4. In addition to minimization of incidental take or effects to habitat, encourage meaningful and focused mitigation, in alignment with recovery goals for restoration and threat abatement, for actions that incidentally take listed Central Valley salmon and steelhead or affect their habitat.

5. Encourage Federal partners to include recovery actions in project proposals.

6. Conduct outreach to Federal partners, and provide an outline of 7(a)(1) obligations.

Under section 7(a)(2), Federal agencies must consult with NMFS (and/or USFWS) when they determine an action may affect a listed species or its critical habitat. NMFS then conducts an analysis of potential effects of the action. In the process of consultation, NMFS currently expends considerable effort to assist agencies in avoiding and minimizing the potential effects of proposed actions to ensure agency actions do not jeopardize a species or destroy or degrade habitat. Consultations have helped prevent and minimize take.

To improve the section 7(a)(2) consultation process, NMFS will utilize its authorities to:

- ❑ Continue to use the viable salmonid population concept described in this Recovery Plan to help determine effects of proposed actions on the likelihood of species' survival and recovery.

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- Place high priority on consultations for actions that implement recovery strategy or specific actions.
- Develop and maintain databases to track the amount of incidental take authorized and effectiveness of conservation and mitigation measures.
- Provide recommended actions in the recovery plan as section 7(a)(1) conservation recommendations as applicable.
- While still fulfilling all relevant statutory and regulatory requirements, focus staff priorities, to the extent possible, away from section 7 compliance in watersheds not designated as a priority for recovery and direct efforts to recovery implementation
- Streamline consultations for those actions with little or no effect on recovery areas or priorities.
- Prioritize staff efforts to carefully and consistently consider short-term and long-term impacts to watershed processes when conducting jeopardy analysis for Federal actions in key listed Central Valley salmon and steelhead watersheds.
- Apply the VSP framework and recovery priorities to evaluate population and area importance in jeopardy and adverse modification analysis.
- Encourage action agencies to purchase credits from a NMFS approved conservation bank whenever appropriate.

Within this framework NMFS will utilize its authorities to:

- Encourage the Federal Emergency Management Agency (FEMA) to fund upgrades for flood-damaged facilities to meet the requirements of the ESA and facilitate recovery.
- Encourage the U.S. Environmental Protection Agency (USEPA) to prioritize action on pesticides known to be toxic to fish and/or are likely to be found in fish habitat; and to take protective actions, such as restrictions on pesticide use near water.
- Encourage the Federal Highway Administration and Caltrans to develop pile driving guidelines, approved by NMFS, for all bridge construction projects in key Dependent, Independent, and other watersheds with extant listed Central Valley salmon and/or steelhead populations.
- Encourage the development of section 7 Conservation Recommendations to help prioritize Federal funding towards recovery actions (NMFS, USFWS, NRCS, USEPA, etc) during formal consultations.
- Encourage all Federal agencies, or their designated representatives, to field review projects and actions upon project completion to determine whether or not the projects were implemented as planned and approved. Encourage all Federal agencies, or their designated representatives to report the initial findings of such field reviews to NMFS.
- Encourage Federal agencies to coordinate and develop programmatic consultations for activities that contribute to the recovery of listed Central Valley salmon and steelhead, to streamline their permitting processes.
- Encourage all consulting agencies to provide biological assessments that comport to 50 CFR 402.14(c) for all

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projects in all watersheds where listed Central Valley salmon and/or steelhead are present and/or with designated critical habitat.

7.2.6 ESA Section 9

Section 9 prohibits the taking of endangered species; these prohibitions may be extended through 4(d) rules to threatened species, as discussed above. The recovery plan will assist NMFS' Enforcement personnel by targeting key watersheds essential for species recovery. Core watersheds identified in this plan should be considered the highest priority areas. NMFS biologists will work closely with NMFS Enforcement regarding the identification of threats and other activities believed to place Chinook salmon and steelhead at high risk of take and/or extirpation. Actions will include the following:

- NMFS will conduct outreach and provide enforcement with a summary of the recovery priorities and threats.
- NMFS will prioritize those actions and areas deemed of greatest threat or importance for focused efforts to halt illegal take of listed species.
- NMFS will develop a plan to outline responsibilities and priorities to ensure activities by NMFS staff, when supporting enforcement, are focused on the highest recovery priorities.
- When a take has occurred, NMFS biologists will work with NMFS enforcement, to the extent feasible, with the development of a take case.
- NMFS enforcement will work with CDFW, in conjunction with the Joint Enforcement Agreement to increase patrols and landowner outreach in critical watersheds, particularly during droughts, when listed Central Valley salmon and steelhead are potentially at greater threat of unauthorized taking.
- Regular meetings between recovery staff and Enforcement will occur. NMFS Enforcement will place a high priority on identification and curtailment of threats in key watersheds identified for recovery.

7.2.7 ESA Section 10

Section 10(a)(1)(A) provides NMFS authority to issue permits to authorize take of listed species for scientific purposes, or to enhance the propagation or survival of listed species.

Section 10(a)(1)(B) provides NMFS authority to issue permits to authorize take of listed species that is incidental to otherwise lawful activities for non-federal entities. Requests for such a permit must be accompanied by a conservation plan that, among other things, describes the effects of the incidental taking and how the entity will minimize and mitigate those effects.

To improve the section 10 authorization process, NMFS will utilize its authorities to:

Section 10(a)(1)(a) Research Permits

- Prioritize permit applications that address identified research and monitoring needs in the recovery plan.
- Evaluate all proposed activities against the identified threats, recovery strategy, and recovery actions identified in the plan.
- Develop and maintain databases to track the amount of take authorized and the effectiveness of conservation and mitigation measures.

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Section 10(a)(1)(B) Habitat Conservation Plans (HCPs)

The USFWS/NMFS Habitat Conservation Planning Handbook (USFWS and NMFS 1996) stresses the need for consistency of mitigation measures for a species and for specific standards. Although, not a preferred option (according to the USFWS/NMFS HCP Handbook), if offsite mitigation is necessary this recovery plan can be used to target watersheds for recovery actions. In some circumstances off-site mitigation may provide greater opportunity for recovery than onsite mitigation (*i.e.*, if an HCP's covered activities occur in a non-focus watershed).

Within the HCP framework NMFS will utilize its authorities to cooperate and assist landowners in proposing activities or programs designed to contribute to recovery objectives.

Section 10(j) Experimental Populations

Section 10(j) of the ESA provides for the designation of specific populations of species as "experimental populations" under certain circumstances and procedures. The potential use of section 10(j) of the ESA could facilitate reintroductions by helping to minimize regulatory requirements on land and water users. This regulatory approach has been taken in order to help facilitate the reintroduction of spring-run Chinook salmon into the San Joaquin River downstream of Friant Dam. However, the regulatory context for future fish reintroductions in the Central Valley will be determined on a case by case basis.

7.2.8 Fisheries Management and EFH

Much of listed Central Valley salmon and steelhead habitat is located in areas identified as Essential Fish Habitat (EFH) for the Pacific Coast Salmon Fishery Management Plan (FMP) under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). NMFS anticipates the objectives and recovery strategies will serve as a guide when providing conservation recommendations for actions that may adversely affect EFH. In addition, NMFS will implement fishery regulations, through coordination with PFMC, to maintain salmon harvest levels at or below those necessary to allow for the recovery of listed salmon; and NMFS will work to implement fishery regulations to reduce bycatch of listed salmon in federally-managed fisheries.

7.2.9 Coordination with other NMFS Divisions and the PFMC

Other divisions within NOAA can contribute significantly to recovery. NMFS staff will coordinate closely with the SWFSC and the NOAA Restoration Center, to assist in the development, review and funding of restoration projects.

In addition NMFS staff will need to coordinate closely with the PFMC for establishing an ecosystem-based fishery management plan to prevent overfishing of listed Chinook salmon.

7.2.10 Technical Assistance

In conjunction with NMFS' statutory authorities and obligations we are engaged in a significant amount of outreach to various constituencies where we provide technical assistance regarding listed salmon and steelhead, their habitat needs, and various life history requirements. Due to the large proportion of private lands and the limited contributions of ESA section 7, developing partnerships through providing technical assistance will be critical for

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recovery. Through this role NMFS will focus efforts in key areas critical for recovery through the following actions:

- Work with individual cities and counties throughout the Central Valley so they have sufficient information to develop city planning and land use policies protective of listed Central Valley salmon and steelhead.
- Continue working with the Natural Resource Conservation Service, Resource Conservation Districts, and Reclamation Districts, to encourage improved agricultural practices as well as land use practices of rural residential landowners.
- Prioritize cooperation and assistance to landowners proposing activities or programs designed to achieve recovery objectives.
- Work with the SWRCB to restore and maintain natural flow patterns of clean, cold water across the ESUs/DPS.

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Sites Reservoir Project - South and West of Delta Participants

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SITES PROJECT AUTHORITY

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Sites Project Authority
Maxwell, CA

Subject: **Sites South and West of Delta Participants ("Participants")**
- 2019 Informational Needs

Dear Jim:

Based on discussion among some of the subject Participants, which discussions have not constituted a quorum of the Reservoir Project Committee, the following matters have been identified as information needed prior to the end of 2019 to enable individual participation decisions by Participants for the 2020 Phase 2 Participation in the Sites Reservoir Project. These matters are not in any particular order of importance.

1. Provide a plan, including a communication schedule and targeted milestones, to work with wildlife/fishery agencies and the State Water Resources Control Board to define likely boundaries for permitting requirements in 2019.

2. Narrow and update the range of Sites' operating scenarios and yields considering:
   a. best information available from the 2019 permitting discussions with the wildlife/fishery agencies and the State Water Resources Control Board on Sites operating criteria;
   b. SWRCB estimated decisions regarding Phases 1 and 2 of the Delta Water Quality Control Plan and the Voluntary Settlement Agreement(s);
   c. Participants' Sites deliveries as (1) SWP water and as (2) non-project water;
   d. use of delivery demand patterns provided by the South and West of Delta Participants;
   e. benefits of Sites Reservoir to the Bureau of Reclamation and its contractors in the modeling of Sites yields;
   f. integration with WaterFix and other downstream facilities (e.g. Fremont Weir); and
   g. continuing the use of 2030 ELT climate change information used to date, and providing modeling outputs by water year type and Participant.

3. After said narrowing and refinement, and in cooperation with interested Participants, develop Sites operating scenarios for the 2070 level of climate change.

4. Cooperate with the Participants to complete the following agreements with the California Department of Water Resources:
   a. Funding agreement to bill interested Participants for Sites costs; and
   b. Memorandum of Understanding or agreement to identify the delivery priority for Sites water to the South and West of Delta Participants.

Draft_0001102

5. Work with the Participants to understand, refine and improve the yield modeling as it may be affected by Delta carriage losses under different water year types.

6. Update the expected level of state and federal funding for Sites Reservoir, define associated benefits to federal participants, and determine the impact of such funding on the cost and yield shares of Reservoir benefits among the state, federal and Participant parties.

7. Adopt a formal Use of Storage policy that describes:
   a. how storage will be allocated to participants;
   b. how operational fills and releases will be allocated to participants;
   c. the role of participant decision-making in said fills and releases; and
   d. how participants may utilize their share of storage for their own benefit and the benefit of others (e.g. borrowing/leasing/transferring water stored to and from others).

   We are inclined, subject to further study, to favor an "ownership" model of storage whereby funding participants make individual decisions regarding the fill, release, and use of their share of storage and yield resulting therefrom.

8. Identify the extent to which collection of geotechnical information for the Project, including 2019 collection, is known (e.g. % completed by site) and may be used to further refine the range of Project cost estimates.

We request:

9. A meeting with you and your staff to discuss these matters, and
10. Your staff to identify the extent to which these matters are or are not included in the 2019 Budget, and options for addressing those matters not included therein.

The extensive cooperation and effort to date among the Sites Authority, staff and Reservoir Project Committee participants is acknowledged, and we look forward to developing the necessary information and permits to drive the Sites Project to its successful completion.

Sincerely,

Dwayne Chisam
Antelope Valley-East Kern Water Agency

Robert Cheng
Coachella Valley Water District

Mark Krause
Desert Water Agency

Randall Neudeck (CHANDRA CHILMAKURI for RANDALL NEUDECK)
Metropolitan Water District of Southern California

Douglas Headrick
San Bernardino Valley Municipal Water District

Cindy Kao
Santa Clara Valley Water District

Robert H. Kunde
for Dirk Marks
Santa Clarita Valley Water Agency

Jeff Davis
San Gorgonio Pass Water Agency

Robert H. Kunde
Robert Kunde
Wheeler Ridge-Maricopa Water Storage District

Valerie Pryor
Zone 7 Water Agency

Sites Reservoir
Coordination Meeting
Meeting Agenda

Date: **9 January 2020**
Time: **9:00 AM to 11:00 AM (PST)**
Location: **2485 Natomas Park Drive (Jacobs Office)**

Call in: (866) 203-7023

PC: 2150376387

- Introductions
- Program updates (Reclamation and Authority)
- Project Overview
- Overview of Ongoing Activities
- Status on merged model for Federal Feasibility Report
- Status the data viewer
- Daily model status
- Update on CDFW process
- New action items

Outstanding Action Items

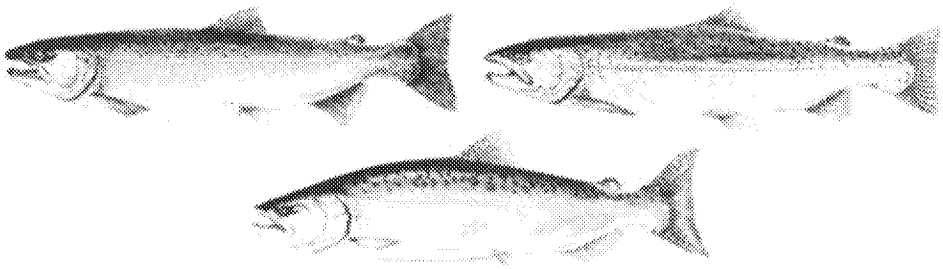
No.	Action Item	Lead	Status/Comments
1	Viewer: Provide comments to Tim Hill.	All	
2	Develop Water Rights schedule	Spranza	
3	Need brief summary on Sites with Shasta raise – prior work	Leaf	Narrative on history is still needed.
4	Develop a description of the model for Operational Flexibility that documents the assumptions	Leaf	**Still needed?**

No.	Action Item	Lead	Status/Comments
6	Develop summary of 2019 BiOps effects on Sites operations	Leaf	**Still needed?**
6	Evaluation of near-field and far-field effects on fish	Lecky, Briard, and Fish Team	Ongoing
7	Need a schedule for LTGen modeling. Also please review the previous scope of work to confirm it is still appropriate and provide to Derya for Reclamation review.	Tull, Leaf	**Still needed?**
8	Need to account for habitat in the "tax table" for diversions. Will require HEC-RAS and GIS tools to map.	Tull, Leaf	Project description and operation criteria need to be defined

From: Tom Stokely [tgstoked@gmail.com]
Sent: 1/9/2020 12:34:32 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Draft letter for CACSST today
Attachments: CAC to Bonham on Sites Reservoir DRAFT.docx; Sites_Environmental minimums_8.6.18-2.pdf; GRK_Sites-Res-EIS-comments_vFINAL_v2.pdf; Coalition Letter to Sites Project Authority Requesting Recirculated DEISEIR 3.17.19 (reduced0.pdf

I thought you ought to see this before we talk about it.

TS



California Advisory Committee On Salmon and Steelhead Trout

January 9,2020 DRAFT

Charlton H. Bonham, Director
California Department of Fish and Wildlife
1416 Ninth St., 12th Floor
Sacramento, CA 95814

Subject: Concerns with Sites Reservoir Salmon Impacts and Accelerated Approvals/Permitting Called for In Draft Water Resilience Portfolio

Dear Chuck;

The California Advisory Committee on Salmon and Steelhead is tasked with advising you, the director of the California Department of Fish and Wildlife, in preparing and maintaining "a comprehensive program for the protection and increase of salmon, steelhead trout, and anadromous fisheries" in California.[1]

In our capacity as your advisor, we are expressing to your our great concern about the proposed Sites Reservoir's potential impacts to salmon and steelhead in the Sacramento River and Delta. We recommend that you request preparation of a Supplemental/Recirculated Draft EIS/EIR for the project. We strongly recommend that the you oppose accelerated approvals and permitting for Sites Reservoir that have been identified in the Draft Water Resilience Portfolio.

Furthermore, we recommend that you oppose any efforts to reduce minimum instream flow requirements in the Sacramento River below what has been recommended by your agency in 2016-15,000 cfs. The Sites Project Authority is requesting minimum instream flows of 5,000 cfs at Wilkins Slough, much less than your agency's recommendations and much less than environmental coalition recommendations that no diversions be allowed until there are flows as high as 35,000 cfs at Freeport (see Attachment 1).

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[1] California Fish and Game Code § 6920 (2008)
§ 6920. Preparation and maintenance of program; Consultation with public agencies
(a) The department shall, with the advice of the Advisory Committee on Salmon and Steelhead Trout and the Commercial Salmon Trollers Advisory Committee, prepare and maintain a detailed and comprehensive program for the protection and increase of salmon, steelhead trout, and anadromous fisheries.

The Sites Reservoir, while billed as using "surplus" water from wet years to be used in drier years, was modeled in the Draft EIS/EIR to take minimum instream flows in the Sacramento River well below safe levels for downstream aquatic resources (3,250 cfs at Red Bluff, 4,000 cfs at Hamilton City and 5,000 cfs at Wilkins Slough). An analysis by Kamman Hydrology found that the Sites DEIS/EIR modeling includes significant changes in the timing of diversions from the Trinity River that would increase Trinity River temperatures during critical spawning periods in the fall, while also not accounting for a water contract with Humboldt County and a federal record of Decision to release Trinity River water for Lower Klamath River fisheries (see Attachment 2). Furthermore, the attached March 17, 2019 coalition letter (Attachment 3) identifies 38 issues that are inadequately addressed in the Sites Draft EIS/EIR, necessitating a recirculated/supplemental DEIS/EIR.[2] These are issues that cannot be remedied in a final EIS/EIR- a recirculated draft is required.

The need for a recirculated DEIS/EIR for Sites is in stark contrast to the Draft Water Resilience Portfolio that contains statements on pages 19 and 35:

"Accelerate state permitting and approvals of projects selected under the Water Storage Investment Program (Proposition 1) so that they are ready to go; for example, advance the largest off-stream reservoir in the suite of projects – Sites Reservoir – in a manner that protects and enhances fish and wildlife and water reliability."

We fail to see how accelerated permitting and approvals of Sites will provide for protection and enhancement of fish and wildlife and water quality. To the contrary, a recirculated/supplemental DEIS/EIR is necessary to protect public trust resources such as salmon and steelhead.

The Sites Project Authority has already misrepresented benefits to the Sacramento River salmon that were debunked by your staff at CDFW, and as a result the California Water Commission (CWC) removed salmon benefits from public funding under Proposition 1. The Sites Project Authority is in the process of downsizing the project and has yet failed to provide a viable operations plan.

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[2] The 38 issues in the March 17, 2019 Environmental/Fisheries Coalition letter include: Foreseeable Impacts to Trinity River Water Temperature Objectives Associated with Sites Project Operations Need to be Evaluated with an Accurate Temperature Model, Foreseeable Impacts to Trinity River Associated with Trinity Lake Carryover Storage, Inaccurate Existing (Baseline) TRD Water Operations, Incomplete Cumulative Impact Assessment Pertaining to TRD Operations, Mitigation for Trinity/Lower Klamath Impacts, Narrow Scope of Alternatives, No Action Alternative and Existing Conditions, Sites Project Water Rights and Potential Unforeseen/Undisclosed Impacts, Cumulative Impacts, Sites Reservoir Operating Procedures/Priorities Absent, Tribal Consultation and Mitigation Absent, Compliance with California Endangered Species Act (CESA), Hydropower Licensing, Environmental Baseline/Modeling, Bypass Flows and Diversion Rates, Reduced Delta Outflows and impacts on Delta Smelt and Other Important Bay-Delta Species, Delta and Longfin Smelt Impacts due to Old and Middle River Reverse Flows, Sacramento River Flow and Temperature Modeling, Sacramento River Temperature Effects, Impacts to Floodplain Habitat, Evaluation of Fishery Impacts Lacking, Water Quality – Toxic Metals, Methylmercury, Noxious Algal Blooms, Water Quality – Salinity, Geomorphology, Entrainment Losses of Native Fish, Fish Screens, Impacts on Funks and Stone Corral creeks, Reservoir Fishery Impacts from Pumping Plant Operation, Recreation, Wildlife Mitigation Actions, Need for a Natural Community Conservation Plan (NCCP), Nesting Birds, Giant Garter Snake, Botanical Surveys and Botanical Resources Mitigation.

Nonetheless, Sites has received approval for over $816 million in public funding from the CWC for benefits to wildlife refuges and Delta smelt, with nearly $41 million being provided up front.

It is this committee's belief that the public funding benefits are based on providing a volume of water that will destroy salmon and steelhead in the Sacramento River. Our committee does not believe that it is a wise use of public funds to destroy a public trust asset (salmon), regardless of the other benefits (refuges and Delta smelt) claimed by the proponents.

It is your agency's mission to ensure that this does not happen as a result of a truncated permitting process and bowing to political pressure to reduce minimum instream flow requirements.

In conclusion, we urge you to do the following:

- Recommend that the Sites Project Authority and the Bureau of Reclamation prepare a supplemental/recirculated DEIS/EIR for Sites
- Oppose language in the draft Water Resiliency Portfolio to accelerate permitting and approvals for Sites
- Stand firm with your agency staff recommendation to oppose Sacramento River minimum instream bypass flows of less than 15,000 cfs per CDFW's 2016 recommendation.

We request that you respond in writing to this letter.

Sincerely,

Darren Mierau, Chairman

Attachments: 1. Sites Reservoir Criteria For An Environmentally Responsible Project
2. Kamman Hydrology Report on Sites Reservoir
3. March 17, 2019 Coalition Letter Requesting Supplemental/Recirculated Sites DEIS/EIR

cc: Governor Newsom
Resources Secretary Wade Crowfoot
CalEPA Secretary Jared Blumenfeld
Senator Mike McGuire
Senator Toni B. Atkins
Senator Jerry Hill
Senator Jim Nielsen
Assembly Member Mark Stone
Assembly Member Megan Dahle
Assembly Member Monique Limón
Assembly Member Philip Y. Ting
Joe Yun, Executive Officer California Water Commission
Fritz Durst, Chairman Sites Project Authority

SITES RESERVOIR:
CRITERIA FOR AN ENVIRONMENTALLY RESPONSIBLE PROJECT

- Upper Sacramento River bypass flows: Flows of at least 15,000 cfs past all Sacramento River points of diversion for Sites Reservoir are required prior to the diversion of water into the reservoir during the months of October to June to protect out-migrating juvenile salmonids. (*See* Table A)

- Lower Sacramento River flows: Diversions of water into the reservoir should not occur from October to June unless flows at Freeport are greater than 35,000 cfs. Lower Sacramento River bypass flows in October and June shall be based on real time monitoring for salmonids. (*See* Table A)

- Flows for the San Francisco Bay-Delta Estuary: Per Table B, diversions of water into the reservoir should occur only when sufficient Delta inflows and outflows are available to meet the needs of Delta smelt, longfin smelt, migrating Chinook salmon, and other flow-dependent species.

- Floodplain inundation: Diversions must not reduce the frequency or duration of inundation of the Yolo Bypass and the Sutter Bypass, as floodplain inundation is beneficial for rearing salmon, migratory birds, and other wildlife.

- Overhead powerlines: Any new overhead powerlines associated with the project should be sited along exiting transmission corridors and not run along the Delevan National Wildlife Refuge. The power lines should also conform to current Avian Power Line Interaction Committee guidelines.

- Refuge water supplies: Water supply availability for federal, state, and private wildlife refuges must not be negatively affected, and a detailed description of conveyance methods should be provided for any publicly funded Level 4 refuges water supplies.

- Mitigation for construction impacts: Detailed plans must be developed showing how all temporary and permanent impacts of the project on golden eagles, giant garter snakes, vernal pools, and other species and habitats will be mitigated according to law, including appropriate assurances and performance standards.

- Releases of water from Sites Reservoir to the Sacramento River: Additional analysis of the water quality impacts of reservoir releases is necessary, given concerns regarding water temperature, algal blooms, and other water quality parameters.

Table A: Sites Reservoir bypass flows triggered by Sacramento River fish and wildlife protections

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Notes
Sacramento River at Freeport	real time	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	35,000 cfs	real time				Based on NGO proposed WaterFix minimum bypass flow of 35,000 cfs at Freeport Nov-May. The 35,000 cfs bypass flow is also in effect in Oct and Jun if real time observations show salmon are present.
Sacramento River at all Points of Diversion for	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs	15000 cfs				Minimum bypass flow. Based on CDFW 2016 recommendation.
Max diversion rate	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%	2% / 5%				When Net Delta Outflow Index (NDOI) is above minimum flows identified in Table A and Table B but below 60,000 cfs, diversions to Sites limited to a maximum of 2% of the river flow. When NDOI exceeds 60,000 cfs, diversions to Sites limited to 5% of Sacramento River flow.

Table B: Sites Reservoir bypass flows triggered by downstream water quality protections

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Notes
Delta Outflow				42,800 cfs		44,500 cfs			42,800 cfs				Bypass flow, based on longfin smelt flow need but will benefit salmon and other species as well (SWRCB 2017)
	11,400 cfs in W and AN years, 7,400 cfs all other yr types	11,400 cfs in W and AN years, 7,400 cfs all other yr types								7,100 cfs	7,100 cfs	11,400 cfs in W and AN years, 7,400 cfs all other yr types	Bypass flow, consistent with proposed NGO terms and conditions for California Water Fix regarding Delta Smelt
X2	74 km (W) or 81 km (AN)	No diversions in AN or W years	No diversions of X2-related releases in AN or W years									74 km (W) or 81 km (AN)	No diversions when diversions would result in noncompliance with current Delta smelt RPA requirements to maintain Fall X2 position in Sept-Dec period following a W or AN year
OMR, E:I, etc.	Water supply releases, water transfers, and refuge releases for SOD delivery are subject to all water quality and endangered species protections in the Delta.												

Kamman Hydrology & Engineering, Inc.
11 Valencia Avenue, San Rafael, CA 94901
Telephone: (415) 491-9600
Facsimile: (415) 680-1538
Email: greg@KHE-Inc.com

January 21, 2019

Mr. Noah Oppenheim, Pacific Coast Federation of Fishermen's Association (PCFFA)
Mr. Thomas Stokely, Save California Salmon

Subject: Review of Draft Environmental Impact Report/Statement
Sites Reservoir Project

Dear Mr. Oppenheim and Mr. Stokely:

I have reviewed the Draft Environmental Impact Report/Draft Environmental Impact Statement (DEIR/S) for the Sites Reservoir (Sites) Project located in Glenn and Colusa Counties, California. The focus of my review was to evaluate if the Sites Project and associated Trinity River Division (TRD) of the Central Valley Project (CVP) operations would potentially impact the hydrology and water quality of the Trinity River. I am familiar with how TRD operations affect water temperatures as I have completed numerous water temperature modeling studies related to alternative operations of Trinity and Lewiston reservoirs with a focus on effects on downstream temperatures in the Trinity River. These studies were completed from 1997 through 2004. A copy of my resume is attached.

The DEIR/S indicates that the project poses less than significant impacts on the water quality to the Trinity River downstream of Trinity and Lewiston reservoirs. However, based on my review and analysis of the DEIR/S and other available information, I have identified a number of notable deficiencies in the water quality assessment that fail to identify and correctly analyze revised water operation impacts on Trinity River water quality (temperature) and, in turn, biological resources. Therefore, it is my opinion that the information presented in the DEIR/S is inadequate in evaluating potential adverse impacts to the water quality of the Trinity River. Nor does it propose mitigation measures for reasonably foreseeable adverse impacts to water quality and aquatic resources of the Trinity River. A discussion of the identified deficiencies is provided below.

1. Foreseeable Impacts to Trinity River Associated with Sites Project Operations

Based on my knowledge and experience in analyzing water temperature conditions of the TRD of the CVP, it is my opinion that the revised TRD water operations associated with the Sites Project will lead to increased water temperatures in Lewiston Reservoir and releases to the Trinity River. Any increase in the temperature of water released to the Trinity River would degrade water quality conditions and increase the potential for violations of North Coast Basin Plan[1] water quality (temperature) objectives as well at the water temperature objectives

[1] "Water Quality Control Plan for the North Coast Region" Footnote 5, Table 3-1, page 3-8.00: Accessed at http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/083105-bp/04_water_quality_objectives.pdf

established under the Trinity River Record of Decision (USDOI 2000) to protect outmigrating juvenile salmonids[2].

I reached this conclusion through analysis of water resources system modeling results provided in Appendix 6B of the DEIR/S. Tables 1 through 3 are taken from Appendix 6B and present Trinity Reservoir storage, Trinity River flow and Clear Creek Tunnel diversion modeling results for both the Sites Project No Action Alternative and Alternative D under a variety of water year types. Table 1 presents a comparison of end of month (EOM) storage in Trinity Reservoir. The DEIR/S suggests incorrectly that the small differences between the No Action Alternative and Alternative D are not significant per the following statement (page 6-36).

> *The CALSIM II model monthly simulation of real-time daily (or even hourly) operation of the CVP and SWP results in several limitations in use of the CALSIM II model results. The model results must be used in a comparative manner to reduce the effects of use of monthly assumptions and other assumptions that are indicative of real-time operations, but do not specifically match real-time observations. Given the CALSIM II model uses a monthly time step, incremental flow and storage changes of 5 percent or less are generally considered within the standard range of uncertainty associated with model processing, and as such flow changes of 5 percent or less were considered to be similar to Existing Conditions/No Project/No Action flow levels in the comparative analyses using CALSIM II conducted in this EIR/EIS.*

Table 2 presents the monthly average releases to the Trinity River from Lewiston Reservoir. Apart from the 8.9% decline during December of Wet years, 8.6% to 31.2% decline in flows during February and March of Above Average water year-types, and the 24.2% drop during February of the Below Average water year-type, there are no reductions in flow under Alternative D that are considered significant in the DEIR/S.

Table 3 presents the changes in flow through the Clear Creek Tunnel, which represent diversions from Lewiston Reservoir (via the Carr power plant) to the Sacramento River and potentially Sites Reservoir. A general pattern seen in the these data is a shift in operations under the Project Alternative that increase the rate of diversions through the winter months (December-March) and reduce diversion rates through the summer/fall months (July-November) during dry and critically dry year types. I assume this change in operations is intended to provide more water to the Sacramento River during the winter to enhance

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Daily Average Not to Exceed	Period	River Reach
60°F	July 1- Sept 15	Lewiston to Douglas City Bridge
56°F	Sept 15-Oct 1	Lewiston to Douglas City Bridge
56°F	Oct 1- Dec 31	Lewiston to North Fork Confluence

[2] Trinity River Outmigrant Juvenile Salmonid objectives at Weitchpec (Trinity River Flow Evaluation (USFWS and HVT 1999) accessed at http://www.trrp.net/library/document/?id=226

Normal, Wet and Extremely Wet	April 1-May 22	<13.0 C (<55.4 F)
	May 23-June 4	<15.0 C (<59.0 F)
	June 5-July 9	<17.0 C (<62.6 F)
Dry and Critically Dry	April 1-May 22	<15.0 C (<59.0 F)
	May 23-June 4	<17.0 C (<62.6 F)
	June 5-July 9	<20.0 C (<68.0 F)

the opportunity for diversion to Sites Reservoir. However, this change in operations would have a significant negative effect on the water temperatures in Lewiston Reservoir as well as the temperature of releases to the Trinity River.

Table 4 was developed in order to compare the total average flow through Lewiston Reservoir under the Sites Project No Action Alternative and Alternative D operations. The total flow through Lewiston Reservoir was computed by summing the average monthly flow values of releases to the Trinity River (Table 1) and flow through Clear Creek Tunnel (Table 3).

Due to its geometry and operations of the TRD, water temperatures in Lewiston Reservoir are highly variable. During the summer when there are relatively low and constant releases to the Trinity River and Carr power plant diversions are at capacity, the rate of flow through Lewiston Reservoir is sufficient to displace its entire volume in about 2.5 days and water temperatures remain relatively cool (Brown et al., 1992)[3]. On the other hand, when the Carr power plant is not operating, flow through Lewiston Reservoir stagnates and thermal stratification develops within days, typically leading to the warming of summer surface waters to between 60 and 70 F (15.6 and 21.1 C) (Ibid).

Modeling that I have completed suggests that total flow rates through Lewiston Reservoir (i.e. the sum of Carr power plant diversions and river releases) should be between approximately 800 cubic feet per second (cfs) during the late summer/early fall months of normal year-types and up to 1900 cfs during the summer/fall months of critically dry year-types in order to comply with downstream temperature objectives (Kamman, 1999a)[4]. The maximum late summer/early fall daily releases for releases to the Trinity River under the Trinity ROD range from 300 to 450 cfs. Thus, Carr power plan diversions (i.e., flow through Clear Creek Tunnel) would need to be maintained between 1450 and 1600 cfs to meet summer/early fall temperature needs during normal and critically dry years, respectively.

Based on this this information, it can be inferred that any decrease on total flow through Lewiston Reservoir during the summer/fall period would lead to increased temperatures in water released to the Trinity River as well as that diverted via the Carr power plant and Clear Creek Tunnel. Comparison of total flow rates through Lewiston Reservoir for Alternative D (Table 4) indicates significant reductions during most summer/fall months of the representative dry and critically dry year-types. Most notable are the reductions in flow and likely reservoir heating during the month of October, where flow through Lewiston Reservoir is reduced by 165% and 56% during dry and critically dry year-types, respectively, a time when meeting downstream temperature objectives is already compromised (Kamman, 1999b)[5].

Evaluation of average monthly temperature results for releases to the Trinity River presented in Appendix 7E (River Temperature Modeling) of the DEIR/S do not corroborate the anticipated increase in Lewiston Reservoir temperatures. Table 5 presents the DEIR/S temperature modeling results and

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[3] Brown, R., Yates, G., and Field, J. (1992) "Temperature Modeling of Lewiston Lake with the BETTER two-dimensional reservoir flow mixing and heat exchange model." *Rep.*, Department of Transportation and Planning, Trinity County, Weaverville, CA.

[4] Kamman, G.R., 1999a, Temperature Analysis of Proposed Trinity River Fish and Wildlife Restoration Flow Alternatives using the BETTER Model: Prepared for: Trinity County Planning Department, June, 80p.

[5] Kamman, G.R., 1999b, Addendum to Temperature Analysis of Proposed Trinity River Fish and Wildlife Restoration Flow Alternatives using the BETTER Model: Cumulative Effects. Prepared for: Trinity County Planning Department, September, 7p.

suggests (contrary to the discussion above) that water temperatures in Lewiston Reservoir (i.e., temperature of releases to Trinity River) would decrease as total flow through the reservoir decreases. In fact, the temperature decreases are most pronounced during some dry and critically dry months of greatest reduction in flow rates through Lewiston Reservoir, when water temperatures would be increasing. This leads me to call into question the validity of the temperature model analysis of TRD operations presented in the DEIR/S.

More important is that the proposed change in TRD operations by the Sites Project directly conflicts with and reverses intended operations stipulated in the Secretary of Interior's 2000 Record of Decision (ROD) for the Trinity River Mainstem Fishery Restoration project. As you are aware, the modeling and temperature analysis work I completed for Trinity County back in the late 1990's contributed significantly to development of the instream flow and Carr power plant and Clear Creek Tunnel diversion schedules for the Trinity Preferred Alternative in order to better meet downstream temperature objectives. This work was accomplished through lengthy and focused analyses and meetings with project stakeholders and resulted in final preferred alternative operations with increased late summer CVP diversions to the Sacramento River. Acknowledging that even the river releases and temperatures from Lewiston Reservoir associated with the Preferred Alternative may not satisfy downstream temperature objectives, the Trinity Project ROD stipulates the following (page 20): "*Under the Preferred Alternative, the TRD would be operated to release additional water to the Trinity River, and the timing of exports to the Central Valley would be shifted to later in the summer to help meet Trinity River instream temperature requirements*". By proposing to reduce late summer CVP diversions to the Sacramento River, the Sites Project creates a foreseeable potential impact on Trinity River water quality by reversing the very operations associated with the Trinity River ROD that are intended to satisfy downstream water temperatures objectives and protect instream beneficial uses, particularly for salmon and steelhead.

This potential shift in TRD operations is concerning due to the fact that there are frequent exceedances of water temperature objectives under the current TRD ROD operations and flows. Recent studies completed by the U.S. Fish and Wildlife Service[6] provide data on how the TRD operations and ROD flows comply with downstream Basin Plan and Restoration Project temperature objectives. Appendix A from David and Goodman (2017), presented below, summarizes the exceedances to the Basin Plan (DGC and NFH locations) and Trinity River Restoration Project (TRWEI location) temperature objectives for the period 2001 through 2016.

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[6] David, A.T. and Goodman, D.H., 2017, Performance of water temperature management on the Klamath and Trinity Rivers, 2016. U.S. Fish and Wildlife Service, Arcata Fisheries Technical Report TR 2017-29, November, 72p; and
Polos, J. 2016. Adult salmon water temperature targets. Trinity River Restoration Program Performance Measure. Trinity River Restoration Program.

Appendix A. Number of days exceeding numeric water temperature objectives for the three specified locations on the Trinity River, 2001-2016. DGC = Trinity at Douglas City; NFH = Trinity above the North Fork Trinity; TRWE1 = Trinity above the Klamath.

	Objective locations			Forecast water year	Actual water year
Year	DGC	NFH	TRWE1	type	type
2001	--	--	33[a]	Dry	Dry
2002	0	--	54	Normal	Normal
2003	11	--	34	Wet	Wet
2004	0	--	43	Wet	Wet
2005	--	1	21[b]	Normal	Wet
2006	6	0	18	Ex. Wet	Ex. Wet
2007	3	0	19	Dry	Dry
2008	1	4	0	Normal	Dry
2009	31	2	21	Dry	Dry
2010	6	7	10	Normal	Wet
2011	0	0	7	Wet	Wet
2012	0	1	25	Normal	Normal
2013	0	0	26	Dry	Dry
2014	18	15	53	Crit. Dry	Crit. Dry
2015	--	18	65	Dry	Dry
2016	14	3	52	Wet	Wet

[a] Data unavailable prior to 5/3 for TRWE1 in 2001. We assumed mean daily temperatures did not reach or exceed 15.0 C before this date.
[b] Data unavailable prior to 4/4 for TRWE1 in 2005. We assumed mean daily temperatures did not reach or exceed 13.0 C before this date.

These exceedances occur during all water year types, but with highest frequency during dry and critically dry year types. Of note in this Appendix are the high number of exceedances during the wet water year 2016. As reported by David and Goodman, the exceedances during 2016 are, in part, due to depletion of the cool water pool (carry-over storage) during the preceding 3-year drought period (2013-2015).

2. Foreseeable Impacts to Trinity River Associated with Trinity Lake Carryover Storage

Ordinarily in late summer, water temperatures in Trinity Reservoir are well stratified, displaying a layer of warm water above a deeper pool of much colder water. During this time, releases from Trinity Reservoir to Lewiston Reservoir occur through a submerged powerhouse outlet. If the reservoir is drawn down to a relatively low level, the upper warm layer may intersect the powerhouse outlet, releasing warm water to Lewiston Reservoir. In turn, these warm temperatures are propagated through Lewiston Reservoir to the Trinity River. As presented below, a number of studies have been completed to quantify the minimum October 1st carryover storage volume that is needed to protect against the introduction of warm summer water releases during various water year types and droughts.

In 1998, Trinity County retained KHE to evaluate how an intense multi-year drought would affect carryover storage in Trinity Reservoir (Kamman, 1998)[7]. The study approach included an

[7] Kamman, G.R., 1998, Carryover Storage Analysis – Simulated (1928-1934) period. Prepared for: Trinity County Planning Department, May 22, 3p

interannual accounting of Trinity Reservoir storage during a series of representative water year-types similar to those experienced during the 1928-1934 drought.[8] Water releases from Trinity Lake were based on the water year type for Trinity Division operations[9] under the ROD Flows. A series of interannual Trinity Reservoir water budgets were developed with initial carryover storage volumes ranging from 750- to 2000-TAF.

Study results (Kamman, 1998) indicate that under CVP operations to meet ROD Flows, there is a net annual increase in Trinity Reservoir storage during normal (1928) year-types, but decrease during dry (-17.5 TAF) and critically dry (-341 TAF) year-types. Thus, when starting with 750 TAF of storage, Trinity Reservoir storage would have dropped below 200 TAF after the third year of the drought, primarily driven by storage reductions experienced during critically dry years. Study results also indicate that a starting storage volume of 1250 TAF is required to maintain a minimum carryover storage of 600 TAF through the drought. However, modeling results (Kamman, 1999a and 1999b) indicate that even 600 TAF of carryover storage does not fully achieve compliance with temperature objectives during dry and critically dry year types. This study suggests that a minimum carryover storage volume of between 1250- and 1500-TAF during the first year of drought is likely required in order to provide the necessary water release temperatures to the Trinity River to meet downstream temperature objectives during subsequent years.

In addition to the work cited above, I am aware of other studies focused on identifying the minimum Trinity Reservoir carryover storage to provide the necessary cold water releases to satisfy river temperature objectives. In their 1992 testimony to the State Water Board, Finnerty and Hecht (1992)[10] concluded that Trinity Reservoir carryover storage of 900 TAF or slightly more may be needed to meet downstream temperature objectives during 90% of all years. Their conclusion was based on analysis of hydrology, reservoir operations and temperatures for 1991, a single critically dry year-type. The second study, completed by Deas in 1998[11] on behalf of Trinity County, included water temperature simulations of Trinity Reservoir using the Water Temperature Simulation Model (WTSM). Deas evaluated temperature compliance under 1990 dry year-type conditions assuming initial reservoir storage volumes of 750-, 1250- and 1500-TAF. Model simulation results indicated elevated water temperatures at the powerhouse intake elevation for the 750 TAF carryover storage scenario and minimal to no temperature concerns at initial carryover storage volumes of 1250- and 1500-TAF, respectively. Deas' findings of elevated temperatures associated with 750 TAF of carryover storage are corroborated in the 2012 report by Reclamation[12], which found that a September 30 carryover storage requirement of less than 750 TAF is "problematic" in meeting state and federal Trinity River temperature objectives

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[8] The interannual water budget accounting started in 1928, a normal water year type.

[9] It is likely that CVP operations would change during drought periods. However, we did not have the knowledge or expertise to define such changes. Thus, the analysis used operations consistent with the earlier PROSIM simulations.

[10] Hecht, B. and Finnerty, A.A., 1992, Testimony to the State Water Resources Control Board regarding Carryover Storage in Trinity and Lewiston Reservoirs to Protect Public-interest Resources. State Water Resources Control Board Water Right Phase of the Bay-Delta Estuary Proceedings, June 26, 7p.

[11] Deas, M.L., 1998, Trinity Reservoir Carryover Analysis. Prepared for: Trinity County Planning Department, Natural Resources Division, August, 26p.

[12] U.S. Department of Interior, Bureau of Reclamation, 2012, Trinity Reservoir Carryover Storage Cold Water Pool Sensitivity Analysis – Technical Service Center (TSC) Technical Memorandum No. 86-68220-12-06. August 20, 7p.

protective of the fishery.

The Sites Project water operation and temperature analyses assume a minimum Trinity Reservoir carryover storage volume of 600TAF. The study findings presented above indicate that initial October 1 carryover storage volumes of 600- and 750-TAF are not sufficient to satisfy Trinity River temperature objectives for a single dry/critically dry water year-type, let alone multi-year droughts. Thus, it is reasonable to foresee that current implementation of the ROD Flows without sufficient carryover storage will not achieve Trinity River temperature objectives during critically dry year-types. Modeling results indicate that critically dry water year-types deplete reservoir carryover storage volumes at much higher rates than occurs during dry years. Whether dealing with dry or critically dry year-types, reservoir storage has no chance of being replenished during multi-year droughts under the current and proposed Sites Project CVP operations.

As determined by Finnerty and Hecht, a minimum baseline carryover storage volume of 900 TAF is required to meet Basin Plan temperature objectives on the Trinity River during a single dry year. Studies by Deas and Kamman suggest this baseline carryover storage volume is likely higher for critically dry year-types. Significantly higher carryover storage volumes over the baseline value are required to preserve the necessary reservoir cool water pool during multi-year drought periods, in order to achieve temperature objectives. Modeling studies suggest first year drought carryover storage volumes of around 1750 TAF are sufficient to maintain adequate carryover storage to meet temperature objectives during multi-year droughts. Thus, a single minimum carryover storage volume cannot be developed without revising CVP operations that focus on preserving Trinity Reservoir carryover storage, most likely by reducing water that is diverted out of the Trinity River basin.

The Sites Project DEIR/S presents the results of their modeling analyses as monthly average values of flow, storage and water temperature for multiple years within designated water-year type classifications. This presentation masks the impacts from a single extreme dry year as well as repeated impacts associated with a continuous multi-year drought. These are the periods of greatest concern and potential damage to aquatic resources, but they are not identified or described in the DEIR/S. Prior to 2016, the USGS[13] developed a water temperature model that accurately simulates daily mean water temperature along the course of the Trinity River, from Lewiston Dam to the Klamath River confluence. This model would be a more appropriate tool to evaluate how changes in TRD water operations associated with the Sites Project would satisfy water temperature objectives in the Trinity River.

3. Inaccurate Existing (Baseline) TRD Water Operations

The water operations analysis for Sites Project EIR/S did not include an analysis considering use of Humboldt County's 50 thousand acre feet (TAF) water contract included as a provision of the Trinity River Division Act. The following is an excerpt from the Statutory Authority Appendix contained in the DEIS for the Long-Term Plan to Protect Adult Salmon in the Lower Klamath River (Lower Klamath LTP)[14] describing Humboldt County's 50 TAF water contract.

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[13] Jones, E.C., Perry, R.W., Risley, J.C., Som, N.A. and Hetrick, N.J., 2016, Construction, calibration and validcation of the RBM10 water temperature model for the Trinity River, Northern California. U.S. Department of Interior, U.S. Geological Survey, Open-File Report 2016-1056, prepared in cooperation with the U.S. Fish and Wildlife Service and the Bureau of Reclamation, 56p.

[14] U.S. Department of Interior, Bureau of Reclamation, 2016, Long-Term Plan to Protect Adult Salmon in the Lower Klamath River, Humboldt County, California Draft Environmental Impact Statement, October.

Construction of the Trinity River Division (TRD) of the Central Valley Project (CVP) was authorized by the Act of August 12, 1955 (Public Law 84-386) (TRD Act). In section 2 of the 1955 TRD Act, Congress directed that the operation of the TRD should be integrated and coordinated with the operation of the CVP, subject to two conditions set forth as distinct Provisos in section 2 of that Act. The first of these two Provisos states that the Secretary of the Interior is authorized and directed to "adopt appropriate measures to insure the preservation and propagation of fish and wildlife" including certain minimum flows in the Trinity River deemed at the time as necessary to maintain the fishery. The second Proviso directs that not less than 50,000 acre-feet of water shall be released and made available to Humboldt County and other downstream users[15].

The recently released Solicitor's Opinion, M-37030, concludes that each of the two Provisos in section 2 of the TRD Act are "separate and independent limitations on the TRD's integration with, and thus diversion of water to, the CVP" and that the two Provisos may "require separate releases of water as requested by Humboldt County and potentially other downstream users pursuant to Proviso 2 and a 1959 Contract between the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and Humboldt County."[16] *M- Opinion 37030 at 2. Formal 18 opinions of the Solicitor are binding on the Department of the Interior and its bureaus.*

Chapter 6 and Appendix 6A of the Sites Project DEIR/S state that the project water operations modeling analyses adhered to 2000 Trinity River ROD releases to the Trinity River downstream of Lewiston Reservoir to meet instream flow requirements. The DEIR/S states, "The total volume of water released to the Trinity River ranges from approximately 368,600 AF in critically dry years to 815,000 AF in extremely wet years, depending on the annual water-year type (hydrology) determined as of April 1st (DOI, 2000). Table 6-2 shows the annual volumes, peak flows, and peak flow duration by water type." Table 6-2 from the DEIR/S is presented below. However, there is no mention of Humboldt County's 50 TAF annual water contract being integrated into the DEIR/S water resources system modeling and analysis. It is not possible to compare total annual modeled Trinity River releases from the DEIR/S (Table 2, attached) to the annual Trinity River ROD flow volumes (Table 6.2 below) as they represent different water year type classification schemes[17]. The USFWS report by David and Goodman (2017) indicates how the Humboldt County 50 TAF water contract has been especially important for flow augmentation during dry years to meet flow and temperature targets in the lower Klamath River to reduce the probability of an adult fish kill. The omission of the Humboldt County 50 TAF contract in the DEIR/S analyses could have significant effects on the water quality conditions and potential impacts

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[15] Reclamation's water permits from the State of California includes the following condition:
"Permittee shall release sufficient water from Trinity and/or Lewiston Reservoirs into the Trinity River so that not less than an annual quantity of 50,000 acre-feet will be available for the beneficial use of Humboldt County and other downstream users." Condition 9

[16] The 1959 water delivery contract between Reclamation and Humboldt County includes the following:
"The United States agrees to release sufficient water from Trinity and/or Lewiston Reservoirs into the Trinity River so that not less than an annual quantity of 50,000 acre-feet will be available for the beneficial use of Humboldt County and other downstream users."
Contract, Article 8.

[17] The water year types included in the Trinity ROD are probability-based and classified by ranges of annual upper Trinity River Basin water year runoff. This classification is different from the water year types presented in all other tables in Appendix 6B of the DEIR/S, which are based on the historical record of WY1922 through WY2003 and defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 2000).

to both the Trinity and Sacramento Rivers. Therefore, the DEIR/S should be considered incomplete in the analysis of the effects of the Site Project operations on the Trinity River.

Table 6-2
Trinity River Record of Decision
Annual Flow Volumes and Peak Flows

Water Year Type	Volume (AF)	Peak Flow (cfs)	Peak Flow Duration (days)
Extremely Wet	815,000	11,000	5
Wet	701,000	8,500	5
Normal	647,000	6,000	5
Dry	453,000	4,500	5
Critically Dry	369,000	1,500	36

Notes:
cfs = cubic feet per second
Source: DOI, 2000.

4. Incomplete Cumulative Impact Assessment

In addition to the omission of the Humboldt County 50 TAF water delivery contract on the Trinity River, the Sites Project DEIR/S fails to consider and incorporate the Lower Klamath LTP operations into the water resources system modeling analyses. Under CEQA, a cumulative impact assessment must consider development projects within the cumulative study area, which includes past projects, projects under construction and approved, and pending projects that are anticipated to be either under construction or operational by the time of the completion of the proposed project. The Sites DEIR/S states the following (pg. 6A-2, Appendix 6A).

> *The Existing Conditions/No Project/No Action Condition simulation was developed assuming Year 2030 level of development and regulatory conditions. The Existing Conditions/No Project/No Action Condition assumptions include existing facilities and ongoing programs that existed as of March 2017 (publication of the Notice of Preparation) that could affect or could be affected by implementation of the alternatives. The Existing Conditions/No Project/No Action Condition assumptions and the models do not include any restoration actions or additional conveyance over the current conditions.*

Although the ROD for the Lower Klamath LTP[18] wasn't signed until April 2017, it was certainly a well-known and defined pending project and should have been incorporated into the baseline condition of the water resource system modeling analysis. Tables 6 through 8 provide average monthly storage and flow values for the TRD under the Lower Klamath LTP. Comparison of the Lower Klamath LTP Alternative 1 conditions presented in Table 6 through 8 to the Sites Project No Action Alternative conditions presented in Tables 1 through 3 indicate significant differences in project operations and hydrologic conditions when including the Lower Klamath LTP in the water resource impact assessment. For example, under the Lower Klamath LTP, diversions to

[18] U.S. Department of the Interior, Bureau of Reclamation, 2017, Record of Decision for the Long Term Plan to Protect Adult Salmon in the Lower Klamath River, April, Accessed at https://www.usbr.gov/mp/nepa/includes/documentShow.php?Doc_ID=28314

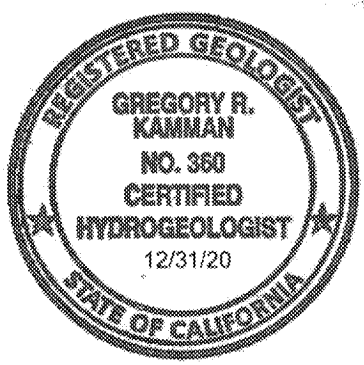
the Sacramento River are reduced by an average of 13 TAF per year, while Sites DEIR has diversions increasing, on average, by 4 TAF per year. The main reason for this difference is the August and September Trinity River release rates: as a result of flow augmentations, the Lower Klamath LTP increases average releases to Trinity River by 20% and 42% (presumably using the Humboldt County 50TAF water) above No Action flows, respectively (see Table 7). Alternative D of the Sites Project maintains a constant 450 cfs baseline ROD flow during these months for all water year types. The Lower Klamath LTP introduces significant project operations, not included in the Sites Project DEIR/S analyses, which could have significant effects on the anticipated water supply available to the project as well as impacts to temperature on the Sacramento River. Because of this omission in the impact analysis, the Sites Project DEIR/S should be considered incomplete.

Another cumulative impact that is not evaluated in the Sites Project DEIR/S is the influence of climate change on the meteorology and hydrology of northern California rivers. The water temperature modeling of Alternatives completed as part of DEIR/S analyses uses historic meteorologic and hydrologic data and do not consider the predicted warmer future temperatures in the Trinity and Klamath River basins under climate change (USBR, 2011)[19]. Warmer air temperatures under climate change will result in warmer reservoir and river water temperatures. Anticipated changes to the timing and magnitude of spring snowmelt hydrograph and associated tributary accretion (flow and water temperature) are likely to increase river water temperatures, which will reduce the attainment of water temperature objectives on the Trinity River, especially those established for outmigrant juvenile salmonids. Thus, the DEIR/S fails to evaluate the cumulative impact of climate change conditions.

Please feel free to contact me with any questions regarding the material and conclusions contained in this letter.

Sincerely,

Greg Kamman, PG, CHG
Principal Hydrologist



[19] U.S. Department of the Interior, Policy and Administration, Bureau of Reclamation, 2011, SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water. April, 226p.

TABLE 1: Trinity Lake end of month storage. Source: Table SW-01-9a, Appendix 6B of Sites Project DEIR/S.

Table SW-02-9a
Trinity Lake, End of Month Elevation
Long-term Average and Average by Water Year Type

Analysis Period	End of Month Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Long-term												
Full Simulation Period[1]												
No Action Alternative	2,278	2,280	2,285	2,292	2,302	2,313	2,325	2,324	2,321	2,310	2,297	2,286
Alternative D	2,281	2,283	2,288	2,294	2,304	2,314	2,325	2,325	2,322	2,310	2,298	2,287
Difference	2	3	3	2	2	1	1	1	1	1	1	1
Percent Difference[3]	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Water Year Types[2]												
Wet (32%)												
No Action Alternative	2,322	2,323	2,325	2,324	2,337	2,347	2,357	2,359	2,358	2,350	2,342	2,332
Alternative D	2,322	2,323	2,324	2,325	2,338	2,348	2,358	2,360	2,358	2,350	2,341	2,331
Difference	-1	0	0	1	1	1	0	0	0	0	-1	-1
Percent Difference	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Above Normal (15%)												
No Action Alternative	2,305	2,305	2,307	2,298	2,313	2,329	2,341	2,342	2,340	2,331	2,321	2,309
Alternative D	2,307	2,307	2,309	2,305	2,319	2,334	2,345	2,346	2,344	2,335	2,323	2,311
Difference	2	2	2	7	6	5	4	4	4	4	2	2
Percent Difference	0.1%	0.1%	0.1%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%
Below Normal (17%)												
No Action Alternative	2,275	2,278	2,285	2,281	2,289	2,298	2,313	2,313	2,310	2,298	2,287	2,277
Alternative D	2,275	2,278	2,286	2,281	2,289	2,298	2,314	2,313	2,310	2,298	2,286	2,277
Difference	0	1	0	0	0	0	0	0	0	0	0	0
Percent Difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dry (22%)												
No Action Alternative	2,260	2,261	2,270	2,283	2,291	2,304	2,316	2,312	2,307	2,293	2,277	2,266
Alternative D	2,261	2,263	2,273	2,284	2,292	2,304	2,316	2,312	2,306	2,291	2,277	2,266
Difference	2	2	2	1	1	0	0	-1	-1	-1	0	0
Percent Difference	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%
Critical (15%)												
No Action Alternative	2,189	2,190	2,198	2,240	2,246	2,255	2,263	2,260	2,258	2,239	2,218	2,203
Alternative D	2,203	2,206	2,211	2,242	2,248	2,257	2,265	2,262	2,260	2,242	2,224	2,208
Difference	14	16	13	2	2	2	2	2	2	2	6	5
Percent Difference	0.6%	0.7%	0.6%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.3%	0.2%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

TABLE 2: Monthly flow on Trinity River below Lewiston Reservoir. Source: Table SW-04-9a, Appendix 6B of Sites Project DEIR/S.

Table SW-04-9a
Trinity River below Lewiston Reservoir, Monthly Flow
Long-term Average and Average by Water Year Type

Analysis Period	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Long-term												
Full Simulation Period[1]												
No Action Alternative	368	368	522	655	645	575	554	3,779	2,091	923	450	450
Alternative D	373	368	498	638	621	570	561	3,779	2,091	923	450	450
Difference	5	-1	-24	-17	-24	-5	6	0	0	0	0	0
Percent Difference[3]	1.2%	-0.2%	-4.6%	-2.6%	-3.7%	-0.9%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%
Water Year Types[2]												
Wet (32%)												
No Action Alternative	373	368	852	1,412	1,026	1,096	627	4,636	3,318	1,289	450	450
Alternative D	373	368	775	1,351	1,052	1,143	647	4,636	3,318	1,289	450	450
Difference	0	0	-76	-61	26	47	20	0	0	0	0	0
Percent Difference	0.0%	0.0%	-8.9%	-4.3%	2.5%	4.3%	3.2%	0.0%	0.0%	0.0%	0.0%	0.0%
Above Normal (15%)												
No Action Alternative	373	713	621	316	831	436	469	4,462	2,488	1,048	450	450
Alternative D	373	709	621	332	760	300	469	4,462	2,488	1,048	450	450
Difference	0	-5	0	16	-72	-136	0	0	0	0	0	0
Percent Difference	0.0%	-0.7%	0.0%	5.1%	-8.6%	-31.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Below Normal (17%)												
No Action Alternative	373	368	300	380	517	319	507	3,774	1,672	869	450	450
Alternative D	373	368	300	380	392	319	507	3,774	1,672	869	450	450
Difference	0	0	0	0	-125	0	0	0	0	0	0	0
Percent Difference	0.0%	0.0%	0.0%	0.0%	-24.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dry (22%)												
No Action Alternative	373	368	300	380	300	300	529	3,216	1,251	667	450	450
Alternative D	373	368	300	380	300	300	529	3,216	1,251	667	450	450
Difference	0	0	0	0	0	0	0	0	0	0	0	0
Percent Difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Critical (15%)												
No Action Alternative	342	368	300	380	300	300	575	2,092	783	450	450	450
Alternative D	373	368	300	380	300	300	575	2,092	783	450	450	450
Difference	31	0	0	0	0	0	0	0	0	0	0	0
Percent Difference	9.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

TABLE 3: Monthly flow through Clear Creek Tunnel. Source: Table SW-05-9a, Appendix 6B of Sites Project DEIR/S.

Table SW-05-9a
Clear Creek Tunnel, Monthly Flow
Long-term Average and Average by Water Year Type

Analysis Period	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Long-term												
Full Simulation Period[1]												
No Action Alternative	1,033	344	257	420	95	269	369	168	551	1,812	1,926	1,866
Alternative D	900	261	269	460	155	341	373	163	576	1,862	1,957	1,875
Difference	-133	-83	12	40	61	71	-16	-5	25	50	30	9
Percent Difference[3]	-12.9%	-24.2%	4.7%	9.4%	64.2%	26.4%	-4.2%	-3.2%	4.6%	2.8%	1.6%	0.5%
Water Year Types[2]												
Wet (32%)												
No Action Alternative	1,593	461	536	430	81	344	463	278	421	1,742	1,678	2,135
Alternative D	1,571	448	585	437	118	355	493	268	439	1,765	1,882	2,142
Difference	-22	-32	49	7	36	12	10	-10	18	23	204	6
Percent Difference	-1.4%	-6.7%	9.1%	1.6%		3.4%	2.0%	-3.5%	4.3%	1.3%	12.1%	0.3%
Above Normal (15%)												
No Action Alternative	964	437	304	289	58	302	588	0	167	1,417	1,875	1,958
Alternative D	1,088	340	237	289	71	468	564	21	166	1,500	2,313	1,875
Difference	124	-98	-67	0	12	166	-24	21	-1	83	438	-83
Percent Difference	12.9%	-22.4%	-22.1%	0.0%		54.9%	-4.1%		-0.5%	5.9%	23.3%	-4.3%
Below Normal (17%)												
No Action Alternative	429	186	65	295	80	364	265	61	660	1,538	1,796	1,361
Alternative D	433	68	96	334	212	406	171	61	660	1,698	1,714	1,342
Difference	4	-118	32	39	132	22	-94	0	0	161	-82	-18
Percent Difference	1.0%	-63.5%	48.6%	13.4%		5.6%	-35.3%	0.0%	0.0%	10.5%	-4.6%	-1.4%
Dry (22%)												
No Action Alternative	684	333	100	406	166	141	222	221	965	2,100	2,322	1,468
Alternative D	676	205	81	551	265	285	252	200	978	2,147	2,119	1,420
Difference	-209	-128	-20	143	99	154	29	-22	73	47	-203	-48
Percent Difference	-23.6%	-38.4%	-19.7%	35.2%	59.9%	109.4%	13.1%	-9.8%	8.1%	2.2%	-8.7%	-3.3%
Critical (15%)												
No Action Alternative	818	156	62	715	70	135	385	147	561	2,245	2,075	1,812
Alternative D	142	84	99	710	90	174	342	143	585	2,200	1,802	1,235
Difference	-676	-72	37	-5	21	39	-43	-4	25	-45	-272	222
Percent Difference	-82.6%	-46.2%		-0.8%		28.5%	-11.2%	-2.5%	4.4%	-2.0%	-13.1%	22.0%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

TABLE 4: Estimated Monthly flow through Lewiston Reservoir.

Flow through Lewiston Lake (cfs)												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Full Simulation Period1												
No Action Alternative	1401	704	779	1075	740	844	943	3947	2642	2735	2376	2116
Alternative D	1273	621	767	1098	776	911	934	3942	2667	2785	2407	2125
Difference	(128)	(83)	(12)	23	36	67	(9)	(5)	25	50	31	9
Percent Difference	-9.1%	-11.8%	-1.5%	2.1%	4.9%	7.9%	-1.0%	-0.1%	0.9%	1.8%	1.3%	0.4%
Wet (32%)												
No Action Alternative	1966	781	1388	1842	1107	1440	1110	4914	3739	3031	2128	2585
Alternative D	1944	748	1360	1788	1170	1498	1140	4904	3757	3054	2332	2592
Difference	(22)	(33)	(28)	(54)	63	58	30	(10)	18	23	204	7
Percent Difference	-1.1%	-4.2%	-2.0%	-2.9%	5.7%	4.0%	2.7%	-0.2%	0.5%	0.8%	9.6%	0.3%
Above Normal (15%)												
No Action Alternative	1337	1150	925	585	889	738	1057	4462	2655	2465	2325	2408
Alternative D	1461	1049	858	601	831	768	1033	4483	2654	2548	2763	2325
Difference	124	(101)	(67)	16	(58)	30	(24)	21	(1)	83	438	(83)
Percent Difference	9.3%	-8.8%	-7.2%	2.7%	-6.5%	4.1%	-2.3%	0.5%	0.0%	3.4%	18.8%	-3.4%
Below Normal (17%)												
No Action Alternative	802	486	365	595	597	703	772	3835	2332	2407	2246	1811
Alternative D	806	368	396	634	604	725	678	3835	2332	2567	2164	1792
Difference	4	(118)	31	39	7	22	(94)	0	0	160	(82)	(19)
Percent Difference	0.5%	-24.3%	8.5%	6.6%	1.2%	3.1%	-12.2%	0.0%	0.0%	6.6%	-3.7%	-1.0%
Dry (22%)												
No Action Alternative	1257	633	400	708	466	441	751	3437	2156	2767	2772	1918
Alternative D	1049	505	381	851	565	595	781	3416	2229	2814	2569	1870
Difference	(208)	(128)	(19)	143	99	154	30	(21)	73	47	(203)	(48)
Percent Difference	-16.5%	-20.2%	-4.8%	20.2%	21.2%	34.9%	4.0%	-0.6%	3.4%	1.7%	-7.3%	-2.5%
Critical (15%)												
No Action Alternative	1160	456	362	1015	370	435	960	2239	1344	2695	2525	1462
Alternative D	515	384	399	1010	390	474	917	2235	1368	2650	2252	1685
Difference	(645)	(72)	37	(5)	20	39	(43)	(4)	24	(45)	(273)	223
Percent Difference	-55.6%	-15.8%	10.2%	-0.5%	5.4%	9.0%	-4.5%	-0.2%	1.8%	-1.7%	-10.8%	15.3%

TABLE 5: Monthly temperatures of Trinity River below Lewiston Dam. Source: Table SQ-33-9a, Appendix 7E of Sites Project DEIR/S.

Table SQ-33-9a
Trinity River below Lewiston Dam, Monthly Temperature
Long-term Average and Average by Water Year Type

	Monthly Temperature (DEG-F)											
Analysis Period	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Long-term												
Full Simulation Period[1]												
No Action Alternative	49.4	44.7	40.0	39.4	42.7	47.0	50.2	46.6	50.9	51.3	51.7	50.7
Alternative D	49.3	44.6	39.9	39.5	42.7	46.9	50.3	46.6	50.8	51.1	51.3	50.7
Difference	-0.1	-0.1	-0.1	0.2	0.0	-0.2	0.1	0.0	-0.1	-0.2	-0.4	0.1
Percent Difference[2]	-0.2%	-0.2%	-0.2%	0.4%	0.0%	-0.4%	0.2%	-0.1%	-0.2%	-0.4%	-0.7%	0.1%
Water Year Types[3]												
Wet (32%)												
No Action Alternative	47.0	44.6	41.5	40.6	43.0	45.9	49.1	46.8	48.3	50.8	51.6	48.6
Alternative D	47.0	44.6	41.3	40.5	43.0	45.8	49.1	45.8	48.3	50.7	50.9	48.8
Difference	0.1	0.0	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	-0.2	-0.7	0.2
Percent Difference	0.1%	0.1%	-0.2%	-0.2%	-0.1%	-0.3%	-0.1%	0.0%	0.0%	-0.3%	-1.4%	0.4%
Above Normal (15%)												
No Action Alternative	48.2	43.3	40.2	38.6	42.8	47.3	49.9	45.9	50.6	51.6	50.9	48.8
Alternative D	47.7	43.2	39.8	38.8	42.8	47.2	50.0	45.9	50.5	51.2	49.6	49.4
Difference	-0.5	-0.1	-0.4	0.1	0.0	-0.1	0.1	-0.1	-0.1	-0.4	-1.3	0.6
Percent Difference	-1.1%	-0.2%	-1.1%	0.3%	0.0%	-0.2%	0.2%	-0.2%	-0.2%	-0.6%	-2.5%	1.3%
Below Normal (17%)												
No Action Alternative	50.2	44.7	39.0	38.7	41.9	46.8	51.1	46.4	51.3	52.0	52.0	51.3
Alternative D	50.2	44.7	39.1	38.8	41.9	46.7	51.8	46.5	51.3	51.8	52.2	51.5
Difference	0.0	0.0	0.2	0.1	0.0	-0.2	0.6	0.0	0.0	-0.3	0.1	0.2
Percent Difference	0.1%	0.1%	0.4%	0.3%	0.0%	-0.4%	1.0%	0.1%	0.0%	-0.6%	0.3%	0.4%
Dry (23%)												
No Action Alternative	49.5	45.0	39.6	38.4	42.4	47.9	51.4	46.7	51.9	50.7	50.1	50.3
Alternative D	49.7	44.7	39.4	39.0	42.4	47.6	51.1	46.6	51.7	50.5	50.5	50.4
Difference	0.2	-0.2	-0.2	0.6	0.0	-0.4	-0.2	-0.1	-0.2	-0.3	0.4	0.1
Percent Difference	0.4%	-0.5%	-0.4%	1.5%	0.1%	-0.8%	-0.4%	-0.2%	-0.5%	-0.5%	0.8%	0.2%
Critical (10%)												
No Action Alternative	54.5	45.7	38.2	39.4	43.1	48.0	50.2	49.3	55.5	52.5	54.4	56.6
Alternative D	53.8	45.5	38.4	39.7	43.2	47.8	50.4	49.2	55.3	52.6	53.9	55.6
Difference	-0.7	-0.2	0.1	0.2	0.1	-0.2	0.2	-0.1	-0.2	0.1	-0.5	-1.0
Percent Difference	-1.3%	-0.5%	0.3%	0.6%	0.2%	-0.3%	0.4%	-0.2%	-0.3%	0.2%	-0.9%	-1.8%

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the monthly average

TABLE 6: Monthly Trinity Lake Storage. Source: Table 4-1, Lower Klamath LTP DEIS.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action (TAF)												
Extremely Wet	1,197	1,258	1,399	1,618	1,839	1,998	2,208	2,300	2,236	2,105	1,993	1,850
Wet	1,373	1,393	1,507	1,621	1,806	1,952	2,114	2,090	2,018	1,898	1,752	1,606
Normal	1,322	1,324	1,346	1,415	1,529	1,669	1,843	1,773	1,689	1,534	1,386	1,276
Dry	1,096	1,089	1,113	1,127	1,189	1,292	1,403	1,381	1,302	1,159	1,005	901
Critically Dry	1,051	1,016	1,014	988	1,012	1,088	1,087	1,048	985	838	676	598
Average All Years	1,233	1,242	1,306	1,385	1,511	1,637	1,779	1,755	1,686	1,548	1,403	1,283
Alternative 1 (TAF)												
Extremely Wet	1,170	1,236	1,377	1,597	1,821	1,981	2,191	2,285	2,221	2,090	1,979	1,839
Wet	1,362	1,382	1,497	1,613	1,798	1,946	2,107	2,083	2,011	1,890	1,743	1,595
Normal	1,319	1,321	1,343	1,415	1,528	1,669	1,842	1,772	1,689	1,536	1,387	1,266
Dry	1,092	1,085	1,109	1,123	1,184	1,288	1,399	1,357	1,298	1,149	992	881
Critically Dry	1,044	1,007	1,005	979	1,004	1,058	1,078	1,039	976	848	677	576
Average All Years	1,224	1,233	1,298	1,377	1,504	1,631	1,772	1,749	1,680	1,544	1,396	1,269
No Action compared to Alternative 1 (TAF)												
Extremely Wet	-27	-22	-22	-21	-17	-17	-17	-15	-15	-15	-15	-11
Wet	-11	-11	-10	-9	-8	-7	-7	-7	-6	-8	-8	-11
Normal	-3	-2	-3	0	0	0	0	0	0	3	1	-10
Dry	-4	-4	-4	-4	-4	-4	-4	-4	-4	-11	-13	-20
Critically Dry	-7	-9	-9	-9	-8	-9	-9	-9	-9	11	1	-22
Average All Years	-9	-9	-9	-8	-7	-6	-6	-6	-6	-5	-8	-14
No Action compared to Alternative 1 (%)												
Extremely Wet	-2%	-2%	-2%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
Wet	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%	0%	0%	-1%
Normal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%
Dry	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	-2%
Critically Dry	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	1%	0%	-4%
Average All Years	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%	0%	-1%	-1%

Key:
TAF = thousand acre-feet

TABLE 7: Monthly flow on Trinity River below Lewiston Reservoir. Source: Table 4-3, Lower Klamath LTP DEIS.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action (cfs)												
Extremely Wet	373	796	930	1,264	1,525	2,468	1,042	4,570	4,626	1,241	450	450
Wet	373	300	1,023	1,175	915	510	481	4,687	2,862	1,102	450	450
Normal	373	300	300	300	385	302	477	4,189	2,120	1,102	450	450
Dry	337	286	300	300	300	300	543	2,848	847	481	450	450
Critically Dry	368	267	300	300	300	300	600	1,498	783	450	450	400
Average All Years	363	359	605	696	668	654	584	3,753	2,210	890	450	445
Alternative 1 (cfs)												
Extremely Wet	373	719	930	1,248	1,455	2,468	1,042	4,570	4,626	1,241	460	477
Wet	373	300	1,024	1,151	910	505	481	4,687	2,862	1,102	503	533
Normal	373	300	300	300	358	302	477	4,189	2,120	1,102	508	632
Dry	337	286	300	300	300	300	543	2,848	847	481	574	725
Critically Dry	332	267	300	300	300	300	600	1,498	783	450	699	861
Average All Years	359	349	605	687	652	652	584	3,753	2,210	890	538	630
No Action compared to Alternative 1 (cfs)												
Extremely Wet	0	-77	0	-16	-69	0	0	0	0	0	10	27
Wet	0	0	1	-24	-5	-5	0	0	0	0	53	83
Normal	0	0	0	0	-27	0	0	0	0	0	58	182
Dry	0	0	0	0	0	0	0	0	0	0	124	275
Critically Dry	-37	0	0	0	0	0	0	0	0	0	249	461
Average All Years	-4	-10	0	-9	-16	-2	0	0	0	0	88	185
No Action compared to Alternative 1 (%)												
Extremely Wet	0%	-10%	0%	-1%	-5%	0%	0%	0%	0%	0%	2%	6%
Wet	0%	0%	0%	-2%	-1%	-1%	0%	0%	0%	0%	12%	18%
Normal	0%	0%	0%	0%	-7%	0%	0%	0%	0%	0%	13%	40%
Dry	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	28%	61%
Critically Dry	-10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	55%	115%
Average All Years	-1%	-3%	0%	-1%	-2%	0%	0%	0%	0%	0%	20%	42%

Key:
% = percent
cfs = cubic feet per second

TABLE 8: Monthly flow on Trinity River Diversion to Sacramento River at Lewiston Reservoir. Source: Table 4-3, Lower Klamath LTP DEIS.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No Action (cfs)												
Extremely Wet	827	233	235	410	7	329	278	498	407	1,836	1,526	2,079
Wet	945	541	376	482	97	322	591	0	290	1,180	1,952	2,065
Normal	792	355	193	418	243	396	228	0	472	1,563	1,991	1,471
Dry	712	418	166	385	134	153	229	247	1,011	1,973	2,098	1,358
Critically Dry	598	609	132	748	168	157	426	378	736	2,028	2,178	949
Average All Years	802	439	241	464	131	276	387	172	575	1,640	1,965	1,648
Alternative 1 (cfs)												
Extremely Wet	766	234	233	410	7	329	278	465	407	1,836	1,513	1,984
Wet	904	551	355	482	100	303	586	0	290	1,181	1,937	2,025
Normal	767	344	196	378	270	396	228	0	469	1,510	1,957	1,471
Dry	636	415	162	387	134	152	229	247	1,008	2,092	2,009	1,196
Critically Dry	521	642	132	753	143	177	426	373	736	1,701	2,092	880
Average All Years	748	443	234	457	134	272	386	167	573	1,623	1,920	1,573
No Action compared to Alternative 1 (cfs)												
Extremely Wet	-61	1	-2	0	0	0	0	-33	0	0	-13	-95
Wet	-42	10	-21	0	3	-20	-5	0	0	-9	-14	-41
Normal	-25	-10	4	-40	27	0	0	0	-3	-43	-34	0
Dry	-75	-3	-4	2	0	-1	0	0	-3	119	-89	-163
Critically Dry	-77	32	0	5	-25	20	0	-4	0	-327	-86	-69
Average All Years	-53	4	-7	-7	3	-4	-2	-5	-2	-18	-45	-74
No Action compared to Alternative 1 (%)												
Extremely Wet	-7%	0%	-1%	0%	0%	0%	0%	-7%	0%	0%	-1%	-5%
Wet	-4%	2%	-6%	0%	3%	-6%	-1%	0%	0%	-1%	-1%	-2%
Normal	-3%	-3%	2%	-10%	11%	0%	0%	0%	-1%	-3%	-2%	0%
Dry	-11%	-1%	-3%	1%	0%	0%	0%	0%	0%	6%	-4%	-12%
Critically Dry	-13%	5%	0%	1%	-15%	13%	0%	-1%	0%	-16%	-4%	-7%
Average All Years	-7%	1%	-3%	-1%	3%	-1%	0%	-3%	0%	-1%	-2%	-5%

Key:
% = percent
cfs = cubic feet per second

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	1991 - 1994	Project Geologist/Hydrogeologist Geomatrix Consultants, Inc., San Francisco, CA
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SKILLS AND EXPERIENCE

As a Principal Hydrologist with over 25 of technical and consulting experience in the fields of geology, hydrology, and hydrogeology, Mr. Kamman routinely manages projects in the areas of surface- and ground-water hydrology, stream and wetland habitat restoration, water supply, water quality assessments, water resources management, and geomorphology. Areas of expertise include: stream and wetland habitat restoration; characterizing and modeling basin-scale hydrologic and geologic processes; assessing hydraulic and geomorphic responses to land-use changes in watersheds and causes of stream channel instability; evaluating surface- and ground-water resources and their interaction; and designing and implementing field investigations characterizing surface and subsurface conditions; and stream and wetland habitat restoration feasibility assessments and design. In addition, Mr. Kamman commonly works on projects that revolve around sensitive fishery, wetland, wildlife and/or riparian habitat enhancement. Thus, Mr. Kamman is accustomed to working within a multi-disciplined team and maintains close collaborative relationships with biologists, engineers, planners, architects, lawyers, and resource and regulatory agency staff. Mr. Kamman is a prime or contributing author to over 80 technical publications and reports in the discipline of hydrology – the majority pertaining to ecological restoration. Mr. Kamman routinely teaches courses on stream and wetland restoration through U.C. Berkeley Extension and San Francisco State University's Romberg Tiburon Center.

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2.0 DECLARATIONS, DEPOSITIONS & CEQA REVIEW COMMENTS

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4.0 ENGINEERING DESIGNS AND SPECIFICATIONS

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Miller Pacific Engineering Group and Kamman, G.R., 2013, Landslide stabilization retaining wall and rip-rap cascade, Green Gulch Zen Center, Muir Beach, CA. Prepared for: Green Gulch Zen Center, July, 8 sheets.

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Kamman, G.R. and Lapine, S., 2010. Former Reservoir Fill Site, Restoration at Muir Beach, Golden Gate National Recreation Area (100% Construction drawings). Prepared for Golden Gate National Parks Conservancy, May 12, 2 sheets.

Kamman, G.R. and Lapine, S., 2010. Alluvial Fan Fill Site, Restoration at Muir Beach, Golden Gate National Recreation Area (100% Construction drawings). Prepared for Golden Gate National Parks Conservancy, May 12, 2 sheets.

Kamman, G.R., Kamman, R.Z. and Lapine, S., 2010. Technical Specifications, Point Reyes National Seashore, Restore Critical Dune Habitat to Protect Threatened and Endangered Species, 100% plan set. Prepared for: Point Reyes National Seashore Association and National Park Service, June 1, 132p.

Kamman G.K. and Lapine, S., 2010, Dragonfly Creek Restoration Design, in: State of California, Department of Transportation, Project plans for construction on adjacent to State Highway in the City and County of San Francisco 0.3 mile south of Route 1/101 separation, March 25, 30 sheets.

Kamman G.R. and Lapine, S.L., 2009, Project Plans for Construction on Eastern Tributary of Tennessee Hollow Creek, The Presidio of San Francisco, CA. Prepared for: The Presidio Trust, on behalf of State of California, Department of Transportation., September 23,10 sheets.

Kamman, R.Z., Kamman G.K., and Beahan, C., 2008, 100% Design Drawings, Plans for construction of Vineyard Creek Channel Enhancement Project, from end of Arbor Circle to McClay Road, Project No. 2008-006. Prepared for Marin County Department of Public Works, Flood Control and Water Conservation District Zone 1 and City of Novato, CA, June, 28 sheets.

Kamman G.K., Kamman, R.Z., and Beahan, C., 2008, Contract documents including: notice to contractors, proposals, special provisions and contract documents for Vineyard Creek Channel Enhancement Project, from end of Arbor Circle to McClay Road, Novato California. Prepared for Marin County Department of Public Works, Flood Control and Water Conservation District Zone 1, June, 144p.

Kamman G.K. and Kamman, R.Z., 2008, Giacomini Wetland Restoration Project, Phase 2 (2008) Construction Drawings. Prepared for Golden Gate National Recreation Area and Point Reyes National Seashore, May, 33 sheets.

Kamman G.K., Kamman, R.Z., and Beahan, C., 2007, Giacomini Wetland Restoration Project, Phase I (2007) Construction Drawings. Prepared for Golden Gate National Recreation Area and Point Reyes National Seashore, August, 23 sheets.

Kamman G.K., Kamman, R.Z., and Beahan, C., 2007, Technical Specifications for Giacomini Wetland Restoration Project, Phase I (2007) Construction. Prepared for Golden Gate National Recreation Area and Point Reyes National Seashore, with contributions from Winzler & Kelly, August, 185p.

Kamman G.K. and Kamman, R.Z., 2008, Technical Specifications for Giacomini Wetland Restoration Project, Phase 2 (2008) Construction. Prepared for Golden Gate National Recreation Area and Point Reyes National Seashore, May, 243p.

Kamman, G.R., Kamman R.Z., and Beahan, C., 2007, 100% Specifications, Lower Redwood Creek floodplain and salmonid habitat restoration at the Banducci site, Golden Gate National Recreation

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Area, Marin County, CA. Prepared for Golden Gate Parks Conservancy and National Park Service, June 8, 46p.

Kamman, R.Z., Kamman G.K., and Beahan, C., 2007, 100% Design Drawings, Lower Redwood Creek Restoration, The Banducci Site, Golden Gate National Recreation Area, Marin County, CA. Prepared for Golden Gate Parks Conservancy and National Park Service, February 28, 7 sheets.

Kamman G.K. and Kamman, R.Z., 2006, Feasibility Study and Construction Drawings for Freshwater Marsh and High Water Wildlife Refugia on the West Pasture of the Giacomini Dairy. Prepared for Golden Gate National Recreation Area and Point Reyes National Seashore, September.

Kamman, G.R., 2002, Haypress Pond Restoration Grading Plan, Tennessee Valley, Sausalito, CA. Prepared for Golden Gate National Recreation Area, National Park Service, January 10, 15p.

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5.0 ACADEMIC APPOINTMENTS

San Francisco State University, 2012 through 2014, Wetland hydrology. SFSU College of Extended Learning, Romberg Tiburon Center, CA, 2-day course, 1.6 CEU.

San Francisco State University, 2011, Introduction to wetland hydrology. Basic Wetland Delineation Training, SFSU College of Extended Learning, Romberg Tiburon Center, CA, March 28-April 1.

University of California, Berkeley Extension, 2001 through 2008, Hydrologic and geomorphic processes in stream restoration. Civil and Environmental Engineering, Certificate Program in California Water Management and Ecosystem Restoration, Berkeley, CA, 2-day course, 1.0 CEU.

San Francisco State University, 2007, Introduction to tidal wetland hydrology. SFSU College of Extended Learning, Romberg Tiburon Center, CA, May 11-12, 1.6 CEU.

City of San Jose, 2005, Hydrologic and geomorphic processes in stream restoration. City of San Jose's Environmental Services Department, Watershed Protection Division, San Jose, CA, January 26.

Miami University Geology Field Station, Dubois, WY, 1989, Instructor, Summer Session, May-July.

Miami University, Oxford, Ohio, 1985-89, Instructor and Research/Teaching Assistant (MS candidate).

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From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 1/9/2020 1:29:51 PM
To: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]; Herrin, Jeff [jeff.herrin@aecom.com]; Frederiksen, Lee E. [Lee.Frederiksen@hdrinc.com]; Alicia Forsythe [aforsythe@sitesproject.org]
CC: Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]
Subject: RE: Near Term Actions

Excellent, thanks.

John Spranza

D 916.679.8858 M 816.640.2487

From: Laurie Warner Herson [mailto:laurie.warner.herson@phenixenv.com]
Sent: Thursday, January 9, 2020 1:16 PM
To: Spranza, John <John.Spranza@hdrinc.com>; Herrin, Jeff <jeff.herrin@aecom.com>; Frederiksen, Lee E. <Lee.Frederiksen@hdrinc.com>; Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Arsenijevic, Jelica <Jelica.Arsenijevic@hdrinc.com>
Subject: RE: Near Term Actions

I just had a quick call with Randy Olsen at USACE. He was happy to hear that we had found a copy of the BO – he would have had to have us make a FOIA request. Although he was in a hurry to get to a meeting, Randy did confirm that Reclamation controls the conservation pool (bottom 30,000 af) at Black Butte for CVP; USACE controls flood releases, storage contracts and recreation.

From: Spranza, John [mailto:John.Spranza@hdrinc.com]
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To: Herrin, Jeff <jeff.herrin@aecom.com>; Frederiksen, Lee E. <Lee.Frederiksen@hdrinc.com>; Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Arsenijevic, Jelica <Jelica.Arsenijevic@hdrinc.com>
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a. The delta is in excess conditions and the SC diversion would not effect that.
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Thanks.
Lee

Lee Frederiksen, PE
D 916.817.4883 M 916.213.0569

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From: Herrin, Jeff [mailto:jeff.herrin@aecom.com]
Sent: Wednesday, January 8, 2020 11:05 AM
To: Frederiksen, Lee E. <Lee.Frederiksen@hdrinc.com>
Subject: Near Term Actions

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CC: Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]; Herrin, Jeff [jeff.herrin@aecom.com]
Subject: RE: Near Term Actions
Attachments: NODOS - Stoney Gorge Ops.pdf

All - Have we already looked at this for prior consideration of water supply?

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CC: Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]
Subject: RE: Near Term Actions

This is before my time. I will forward to Rob Tull to Jacobs can see if the information here is still applicable. I'm not sure this takes into account keeping the Delta in excess conditions.

From: Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
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To: Spranza, John <John.Spranza@hdrinc.com>; Frederiksen, Lee E. <Lee.Frederiksen@hdrinc.com>; Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Arsenijevic, Jelica <Jelica.Arsenijevic@hdrinc.com>; Herrin, Jeff <jeff.herrin@aecom.com>
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[Meeting Name]
Meeting Minutes

Sites
Program Management Team

Meeting Information:

Date:	October 10, 2019	**Location:**	Conference call
Start Time:	4:00 p.m.	**Finish Time:**	5:30 p.m.
Notes By:	Erin Heydinger	**Reviewed By:**	Lee Frederiksen

Purpose: Review three items: 1. Sites Authority Principles and Requirements for Feasibility; 2.

Meeting Participants (indicate absent invitees):

Lee Frederiksen	Thad Bettner	Mike Azevedo
Jim Watson	Dan Ruiz	Name
Jeff Herrin	Felix Hernandez	Name
Bill Vanderwaal	Kevin Spesert	
Jeff Sutton	Erin Heydinger	

Action Items:

	Action Item	Owner	Deadline	Notes
1	**Review the Sites Authority Principles and Requirements for Feasibility**	**All**	**End of day 10/11/2019**	**Document has been approved by WG contingent on comments.** **Send comments to Erin Heydinger at erin.heydinger@hdrinc.com**
2	**Compare AACE contingency to what is used in the Affordability Analysis engineering document.**	**Jeff Herrin**	**10/16/2019**	
3	**Clarify what units are used in the various tables in the Affordability Analysis documents.**	**Jeff Herrin**	**10/16/2019**	
4	**Notify USBR that Sites does not want to fund the downhole geophysics associated with the Fletcher borings**	**Jim Watson/Lee Frederiksen**	**10/14/2019**	
5	**Set up follow-up meeting for the week of October 21 to discuss assumptions related to Affordability Analysis engineering memo.**	**Erin Heydinger/ Marcia Kivett**	**10/14/2019**	

Meeting Minutes:

1. Lee provided a summary of the agenda and gave WG members a chance to add to the agenda.
2. Sites Authority Principles for Feasibility and Requirements:
    a. Lee provided a summary of the purpose of the document. This outlines what the Authority would need to conduct a Feasibility Study and what the principles would be for determining feasibility. This document will provide a basis for formulating, evaluating, and recommending a project.
    b. Jim added that this document will be used for the California Water Commission to assist with the determination of feasibility. The framework will lead to the statement that the feasibility document meets the requirements of a locally led project.
    c. Thad: how does this document differ from what was provided in the WSIP application?
        i. Jim: The document in the WSIP application was a draft Feasibility and followed USBR's process. This document is specific to a locally led project and will be more fully developed. Jeff H. added that the WSIP application did not fully develop what would be required for Feasibility. The framework provided fills in some of the missing pieces.
    d. Lee went through the document and summarized each section.
    e. Question: what is the timing for finishing the Authority Feasibility?
        i. Jim provided an overview of the process, including approving this document and stating CEQA compliance.
    f. Note: the state requires a less detailed cost estimate than the federal government (Class 4 vs. Class 3).
    g. Bill asked the group if they would like to move forward now or if they'd like a couple more days. The recommendation is that the Work Group approves it contingent on further comments or questions received by the end of the day October 11th.
    h. For the Reservoir Committee meeting, staff will provide any redlines or changes that were provided versus what was provided to the Work Group. The WG also requested that staff provide an overview of why this document is needed and why we're moving forward with it now.
3. Facility Affordability Analysis – Engineering Component
    a. Lee provided an overview of the Affordability Analysis and the Engineering TM. The goal of this document is to make sure the AB/RC understand what assumptions went in to each piece of the Affordability Analysis, and if the assumptions should be changed, staff will do so.
    b. Thad asked what the scope of this document is. Lee answered that there are three memos: one related to engineering (AECOM), one related to operations (Jacobs), and one related to the financial modeling (Montague Derose Associates). Staff will create an overarching summary document that ties the three together.
    c. Jeff Herrin went through the document and summarized each section. Jeff noted that there are some limitations with the cost estimates. For example, additional geotechnical work would be needed to determine cost savings with a smaller reservoir. Many of these decisions can be pushed down the road and determined during preliminary design; you are not bound to the decisions you make today. Others should be determined in the near-term.
    d. Thad: are we using the proper amount of contingency? Jeff stated that the contingency is based on the risk assessment. Reclamation would like to use a higher contingency (25%), but AECOM feels that the amount of contingency used is appropriate. The WG would like to see the contingency used versus AACE standards.
4. Fletcher Geotechnical Work
    a. Lee provided an overview of the cost table.

b. Question: does Fletcher need to be build is there is no pump-back? Jeff Herrin said that no, it will not be needed, but there will be other facilities in that area. The data that is available is adequate for the Feasibility Study but will not be adequate for design.

c. Question: if we do not do this work, will Reclamation be able to use this money to assist in other ways? Jim stated that we are not sure what would happen with that money, though we do not have a Financial Assistance Agreement in place that would allow funds to be transferred from USBR to Sites. There is some chance that Reclamation would work to hire out for the downhole geophysics, though the schedule would probably be delayed.

d. Action item: tell USBR that we will not pay for the costs associated with the downhole geophysics.

DELTA STEWARDSHIP COUNCIL
A California State Agency

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SACRAMENTO, CALIFORNIA 95814
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(916) 445-5511

Chair
Randy Fiorini

Members
Frank C. Damrell, Jr.
Patrick Johnston
Susan Tatayon
Skip Thomson
Ken Weinberg
Michael Gatto

Executive Officer
Jessica R. Pearson

January 16, 2018

Rob Thomson, Project Manager
Sites Project Authority
P.O. Box 517
Maxwell, CA 95955

Via email: EIR-EIS-Comments@SitesProject.org

RE: Comments on Draft Environmental Impact Report/Environmental Impact Statement for the Sites Reservoir Project, SCH#2001112009

Dear Mr. Thomson:

Thank you for the opportunity to review and comment on the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIR/EIS) for the Sites Reservoir Project (Project) dated August 2017.

In March 2017, the Council transmitted comments on the Notice of Preparation for this project. In that letter we highlighted several Delta Plan regulatory policies that are relevant to your Project and provided recommendations for your consideration. Thank you for your consideration of our comments, which are intended to assist the Sites Project Authority (Sites Authority) in preparing environmental documents that can be a foundation to use in your Delta Plan consistency certification. Below we offer information on the relevance of the Project as a covered action under the Delta Plan; listing of relevant Delta Plan Policies and our recommendations on where and how they can be addressed in the Draft EIR/EIS; and offer Council services to provide early consultation to assist Sites Authority in filing a consistency certification.

Comments on the Draft EIR/EIS

The Draft EIR/EIS describes the proposed project facilities to be located in Glenn and Colusa counties. The Project proposes the following facilities: up to 11 dams; a pumping plant with associated power facilities; use of two existing Sacramento River diversions and associated canals; a proposed new inlet/outlet structure and pipeline; potential power generation facilities, up to five recreational areas; and miscellaneous roads and bridges for access. The Project

would divert water from the Sacramento River west to the proposed reservoir facilities for water storage until water is withdrawn from the reservoir to serve various Project partner entities.

The Draft EIR/EIS lists the Project primary objectives to:

- Enhance water management flexibility in the Sacramento Valley.
- Increase reliability of California water supplies.
- Provide storage and operational benefits for programs to enhance water supply reliability, both locally and State-wide, benefit Delta water quality, and improve ecosystems by providing:
    - Net improvements in ecosystem conditions in Sacramento River system and Delta
    - Net improvements in water quality conditions in the Sacramento River system and Delta
    - Net improvements in State-wide water supply reliability for agricultural and urban uses to help meet water demands during drought periods and emergencies, or to address shortages resulting from regulatory and environmental restrictions
    - Net improvements in water supply reliability for fish protection, habitat management (including refuges), and other environmental water needs

The Draft EIR/EIS states that the Sites Authority has submitted an application to the California Water Commission's Water Storage Investment Program (WSIP) to seek partial funding for public benefits from the Project under the Proposition 1 (Prop 1) Water Quality, Supply, and Infrastructure Improvement Act of 2014. A project is not eligible for WSIP funding "…unless it provides measurable improvements to the Delta ecosystem or to the tributaries to the Delta". (See Water Code section 79752.)

Based on the Project objectives, Council staff believe your Project meets the definition of a covered action. (See Water Code section 85057.5.) Although the Project's infrastructure will be located outside the legal Delta boundary, the Project nevertheless will "occur,…in part, within the boundaries of the Delta." (See *ibid.*). As stated in the Project's primary objectives, the Project's proposed operations will provide, "net improvements in ecosystem conditions and water quality in the Sacramento River system and Delta", as well as, "net improvements in water supply reliability for fish protection, habitat management and other environmental water needs". Furthermore, eligibility for Prop 1 funding for which you have applied requires the Project to provide "measureable improvements to the Delta ecosystem or to the tributaries to the Delta". (See Water Code section 79752.) This requires the filing of a certification of consistency with the Delta Plan's applicable policies. (See Water Code section 85225.)

The Draft EIR/EIS acknowledges the Council's jurisdiction and responsibility in Table 1-1 in the Introduction of the Draft EIR/EIS. The Council recommends that the 2009 Delta Reform Act, the Delta Plan, and the consistency certification requirement also be listed under section 4.2 *State Policies or Approvals under Chapter 4 Environmental Compliance and Permit Summary* of the Draft EIR/EIS.

The following Draft EIR/EIS chapters also offer opportunities to address relevant Delta Plan policies. Relevant Delta Plan policies are listed in parentheses next to the relevant Draft EIR/EIS chapters. Note that the Delta Plan Policy G P1 is a general policy to be addressed in the appropriate locations throughout the Draft EIR/EIS document.

- Chapter 6 Surface Water Resources (WR P1)
- Chapter 7 Surface Water Quality (ER P1)
- Chapter 8 Fluvial Geomorphology and Riparian Habitat (ER P1 and ER P5)
- Chapter 12 Aquatic Biological Resources (ER P1 and ER P5)
- Chapter 15 Wetlands and Other Waters (ER P1 and ER P5)

Delta Plan Policies and Consistency

The Delta Plan includes regulatory policies that are applicable to all covered actions. Below, we have highlighted a few key regulatory policies from the Delta Plan that may be specifically relevant to the Project and a potential Delta Plan certification of consistency.

Detailed Findings to Establish Consistency with the Delta Plan: Delta Plan Policy **G P1** (23 Cal.Code Regs section 5002) requires that ecosystem restoration and water management covered actions include adequate provisions for continued implementation of adaptive management, appropriate to the scope of the action. This requirement is satisfied through A) the development of an adaptive management plan that is consistent with the framework described in Appendix 1B of the Delta Plan (http://deltacouncil.ca.gov/sites/default/files/2015/09/Appendix%201B.pdf) and B) documentation of adequate resources to implement the proposed adaptive management plan. Funding of any monitoring, on-going mitigation, and the facilitation of the adaptive management plan needs to be identified and secure.

> Mitigations Measures: Delta Plan Policy **G P1** requires that actions not exempt from CEQA and subject to Delta Plan regulations must include applicable feasible mitigation measures consistent with those identified in the Delta Plan Program EIR or substitute mitigation measures that are equally or more effective. Mitigation Measures in the Delta Plan's Mitigation and Monitoring Report Program is available at: (http://deltacouncil.ca.gov/sites/default/files/documents/files/Agenda%20Item%206a_attach%202.pdf)
>
> Best Available Science and Adaptive Management: Delta Plan Policy **G P1** also states that actions subject to Delta Plan regulations must document use of best available science as relevant to the purpose and nature of the project. The regulatory definition of "best available science" is provided in Appendix 1A of the Delta Plan (http://deltacouncil.ca.gov/sites/default/files/2015/09/Appendix%201A.pdf). We recommend that the Project have an adaptive management strategy and plan consistent with the framework in Appendix 1B of the Delta Plan.

The Delta Science Program's Adaptive Management Liaisons are available to provide further consultation and guidance to help the District with the appropriate application of best available science and adaptive management. Please contact Darcy Austin (Darcy.Austin@deltacouncil.ca.gov) of the Delta Science Program to schedule an appointment.

Reduce Reliance on the Delta through Improved Regional Water Self-Reliance: Delta Plan Policy **WR P1** (23 Cal.Code Regs section 5003) requires proposed actions to export water from, transfer water through, or use water in the Delta shall contribute to reduced reliance on the Delta and improve regional self-reliance. If this action is deemed a covered action under the Delta Plan, the Project should describe how it will reduce reliance on the Delta, in particular to export of water, by improving regional water self-reliance.

Delta Flow Objective: Delta Plan Policy **ER P1** (23 Cal.Code Regs section 5005) requires that the State Water Resources Control Board's Bay Delta Water Quality Control Plan flow objectives shall be used to determine consistency with the Delta Plan. For purposes of Water Code section 85057.5(a)(3) and section 5001(j)(1)(E) this subsection covers a proposed action that could significantly affect flow in the Delta. This policy may apply because the Draft EIR/EIS listed a Project primary objective to provide, "Net improvements in State-wide water supply reliability for agricultural and urban uses to help meet water demands during drought periods and emergencies, or to address shortages resulting from regulatory and environmental restrictions". This objective could impede and/or alter Delta flows that are subject to meeting the Bay Delta Water Quality Control Plan flow objectives. The hydrology modeling, coordinated operations, and the system wide water management proposed for the DEIR could be used to show compliance with this policy. The Project should describe how it will operate to meet the Bay Delta Water Quality Control Plan flow objectives.

Avoid Introductions of and Habitat Improvements for Invasive Nonnative Species: Delta Plan Policy **ER P5** (23 Cal.Code Regs section 5009) calls for avoiding introduction and habitat improvements for invasive, nonnative species or mitigating these potential impacts in a manner that appropriately protects the ecosystem. This policy may apply because the Draft EIR/EIS listed a Project primary objective to provide, "Net improvements in water supply reliability for fish protection, habitat management (including refuges), and other environmental water needs." This objective may change or alter the ecology of fish and plant species in the project areas, "The potential for new introductions of or improved habitat conditions for nonnative invasive species, striped bass, or bass must be fully considered and avoided or mitigated in a way that appropriately protects the ecosystem." Alternating flow through Delta channels may induce and colonize invasive plant species, such as Egeria densa (Brazilian Water Weed) and/ or water hyacinth, which could choke off Delta channels. Proposed hydrology and fisheries analysis in the DEIR would be useful for demonstrating compliance with this policy. The Project should describe how it can avoid introduction of and habitat for invasive nonnative species.

Closing Comments

Council staff look forward to continued coordination through our early consultation process and discussions of the Project applicable Delta Plan policies. I encourage you to contact my staff Anthony Navasero (Anthony.Navasero@deltacouncil.ca.gov) with your questions, comments, or concerns.

Sincerely,



Cassandra Enos-Nobriga
Deputy Executive Officer
Delta Stewardship Council

DELTA STEWARDSHIP COUNCIL
A California State Agency

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Susan Tatayon
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Ken Weinberg

Executive Officer
Jessica R. Pearson

May 2, 2018

Rob Thomson, Project Manager
Sites Project Authority
P.O. Box 517
Maxwell, CA 95955

Via email: EIR-EIS-Comments@SitesProject.org

RE: Revised Comments on Draft Environmental Impact Report/Environmental Impact Statement for the Sites Reservoir Project, SCH#2001112009

Dear Mr. Thomson:

Thank you for the opportunity to review and comment on the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIR/EIS) for the Sites Reservoir Project (Project) dated August 2017. The Delta Stewardship Council (Council) previously sent a letter with comments on the Draft EIR/EIS on January 16, 2018. This letter supersedes comments previously provided by the Council on the Draft EIR/EIS. Please replace our January 16, 2018 letter with this version.

In March 2017, the Council transmitted comments on the Notice of Preparation for this project. Thank you for your consideration of our comments. Below we describe that Council staff believe the Project does not meet the definition of a covered action under the Delta Plan.

The Draft EIR/EIS describes the proposed project facilities to be located in Glenn and Colusa counties. The Project proposes the following facilities: up to 11 dams; a pumping plant with associated power facilities; use of two existing Sacramento River diversions and associated canals; a proposed new inlet/outlet structure and pipeline; potential power generation facilities, up to five recreational areas; and miscellaneous roads and bridges for access. The Project would divert water from the Sacramento River west to the proposed reservoir facilities for water storage until water is withdrawn from the reservoir to serve various Project partner entities.

The Draft EIR/EIS lists the Project primary objectives to:

- Enhance water management flexibility in the Sacramento Valley.
- Increase reliability of California water supplies.
- Provide storage and operational benefits for programs to enhance water supply reliability, both locally and State-wide, benefit Delta water quality, and improve ecosystems by providing:
    - Net improvements in ecosystem conditions in Sacramento River system and Delta
    - Net improvements in water quality conditions in the Sacramento River system and Delta
    - Net improvements in State-wide water supply reliability for agricultural and urban uses to help meet water demands during drought periods and emergencies, or to address shortages resulting from regulatory and environmental restrictions
    - Net improvements in water supply reliability for fish protection, habitat management (including refuges), and other environmental water needs

The Draft EIR/EIS states that the Sites Authority has submitted an application to the California Water Commission's Water Storage Investment Program (WSIP) to seek partial funding for public benefits from the Project under the Proposition 1 (Prop 1) Water Quality, Supply, and Infrastructure Improvement Act of 2014. A project is not eligible for WSIP funding "…unless it provides measurable improvements to the Delta ecosystem or to the tributaries to the Delta". (See Water Code section 79752.)

Based on the Project objectives, Council staff believe your Project would provide benefits to the Delta that are supportive of the coequal goals. As stated in the Project's primary objectives, the Project's proposed operations will provide, "net improvements in ecosystem conditions and water quality in the Sacramento River system and Delta", as well as, "net improvements in water supply reliability for fish protection, habitat management and other environmental water needs". Furthermore, eligibility for Prop 1 funding for which you have applied requires the Project to provide "measureable improvements to the Delta ecosystem or to the tributaries to the Delta". (See Water Code section 79752.) However, Council staff believe that the Project does not meet the definition of a covered action, as the construction and ongoing operation of improvements at the Sites Reservoir would be located upstream from the Delta, outside the legal Delta boundary (See Water Code section 85057.5.).

The Draft EIR/EIS acknowledges the Council's jurisdiction and responsibility in Table 1-1 in the Introduction of the Draft EIR/EIS. The Council recommends that the 2009 Delta Reform Act, and the Delta Plan also be listed under section 4.2 *State Policies or Approvals under Chapter 4 Environmental Compliance and Permit Summary* of the Draft EIR/EIS.

Council staff look forward to continued coordination through the Sites Reservoir approval and implementation processes. I encourage you to contact my staff Anthony Navasero (Anthony.Navasero@deltacouncil.ca.gov) with your questions, comments, or concerns.

Sincerely,



Jeff Henderson, AICP
Deputy Executive Officer
Delta Stewardship Council

From: Tom Stokely [tgstoked@gmail.com]
Sent: 1/9/2020 8:12:21 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Re: Draft letter for CACSST today
Attachments: pcffa_87, Stokely testimony.pdf; pcffa_126, Kamman testimony.pdf

Flag: Follow up

Sorry I didn't get you the letter sooner.

Sure. I'd be happy to meet with you. Mt. Shasta would be good. I'm really trying to limit my travel right now for health and time constraints. I will be having some somewhat major surgery within the next month, so I'm trying to live each day to the maximum and not get too overcommitted. My recovery is expected to be 2 months.

I will be in Redding sometime soon, probably in the next week for an MRI. I could let you know in advance and see if it fits with your schedule. If not, we could try Mt. Shasta.

I thought you did a good job too. I really appreciate your honesty in regard to the project. It's unusual in this business from what I've seen.

I think most of my concerns with the project are in the coalition letter and all the other letters (that I wrote).

However, I am attaching my testimony from the WaterFix hearing for your information about my overall concerns with both current threats and impacts to the Trinity River which I see Sites potentially adding onto cumulatively. I've also attached Greg Kamman's testimony as well. While these issues seem remote, every additional drop of water that comes from the Trinity is a problem and it's already a problem with no enforceable minimum cold water pool. Pretty much every project that comes along calls for more Trinity water, such as the Del Puerto reservoir project.

We can talk about a broad range of issues when we meet.

Tom

On Thu, Jan 9, 2020 at 6:13 PM Alicia Forsythe <aforsythe@sitesproject.org> wrote:

> Hi Tom - I hope you had a wonderful holiday and a safe and happy New Years celebration!
>
> Thank you for sending these over. I didn't have a chance to read them before the discussion but I think the discussion went well. I can understand that folks want more information and understanding of the project. I also appreciate all your kind words today.
>
> As we work to consider changes to the Project, would you be interested in chatting with me and a few members of the team about your concerns? I think the letters shed some light on them, but I'd like to talk in more detail so that we can hopefully address these concerns however we move forward (referring to whether we recirculate or finalize the current document).
>
> I realize you're in Mr Shasta. We can come to you. Or we could meet in Redding. We are flexible on location.
>
> Ali
>
> _____

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

---

From: Tom Stokely <tgstoked@gmail.com>
Sent: Thursday, January 9, 2020 12:34:32 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: Draft letter for CACSST today

I thought you ought to see this before we talk about it.

TS

STEPHAN C. VOLKER (CSB #63093)
ALEXIS E. KRIEG (CSB #254548)
STEPHANIE L. CLARKE (CSB #257961)
DANIEL P. GARRETT-STEINMAN (CSB #269146)
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Attorneys for PCFFA and IFR

BEFORE THE

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

HEARING IN THE MATTER OF THE CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UNITED STATES BUREAU OF RECLAMATION REQUEST FOR A CHANGE IN POINT OF DIVERSION FOR CALIFORNIA WATER FIX	**TESTIMONY OF THOMAS STOKELY**

WRITTEN TESTIMONY OF THOMAS STOKELY
SALMON AND WATER POLICY ANALYST
PACIFIC COAST FEDERATION OF FISHERMEN'S ASSOCIATIONS (PCFFA) AND THE INSTITUTE FOR FISHERIES RESOURCES (IFR) FOR PART 2 OF THE CALIFORNIA WATERFIX CHANGE IN POINT OF DIVERSION HEARING BEFORE THE STATE WATER RESOURCES CONTROL BOARD

I, Thomas Stokely, do hereby declare:

My name is Thomas Stokely. I am presenting this testimony on behalf of the PCFFA and IFR in this evidentiary hearing before the State Water Resources Control Board (State Water Board) concerning the petition to change the point of diversion for the California WaterFix for the State Water Project (SWP) and federal Central Valley Project (CVP), as specified in the licenses and permits of the US Bureau of Reclamation (USBR) and the California Department of Water Resources (DWR).

I have been working on Trinity River and Central Valley Project issues for approximately 30 years, most of which was spent as a planner with Trinity County. This included approximately ten years on the NEPA/CEQA Project Team that prepared the environmental document for approval of the Trinity River Record of Decision (PCFFA-98) as the CEQA representative for Trinity County. On behalf of Trinity County, I participated in the hearings that resulted in SWRCB Water Quality Order 89-18 (PCFFA-23) and Water Right Order 90-5 (SWRCB-24) regarding temperature management of the Sacramento and Trinity River, as well as the hearings on Decision 1641. I also served as an expert witness for the California Water Impact Network before the SWRCB regarding the 2009 petition by the Bureau of Reclamation and Department of Water Resources for a change in the Place of Use. I have made presentations to the State Board and North Coast Regional Water Quality Control Board six times each regarding the Trinity River and/or selenium issues (State Board only). I have made four presentations before the Central Valley Regional Water Quality Control Board regarding selenium issues and the Grasslands Bypass Project.

My statement of qualifications is PCFFA-88.

The State Water Board asks the following questions for Part 2 of the WaterFix CPOD Hearing:

3. Will the changes proposed in the petition unreasonably affect fish and wildlife or recreational uses of water, or other public trust resources?

   a. Will the proposed changes in points of diversion alter water flows in a manner that unreasonably affects fish, wildlife, or recreational uses of water?

   b. Will the proposed changes in points of diversion alter water quality in a manner that unreasonably affects fish, wildlife, or recreational uses of water?

   c. If so for a and/or b above, what specific conditions, if any, should the State Water Board include in any approval of the Petition to avoid unreasonable effects to fish, wildlife, or recreational uses?

   d. What Delta flow criteria are appropriate and should be included in any approval of the petition, taking into consideration the 2010 Delta flow criteria report, competing

beneficial uses of water, and the relative responsibility of the Projects and other water right holders for meeting water quality objectives?

4. Are the proposed changes requested in the petition in the public interest? What specific conditions, if any, should be included in any approval of the Petition to ensure that the changes are in the public interest?

5. Should the Final Environmental Impact Report be entered into the administrative record for the Petition?

In this testimony, I will answer questions 3 a-c and 4 in regard to the Trinity River and the Lower Klamath River. I will demonstrate that the Final EIR/EIS for the WaterFix does not analyze ANY impacts to the Trinity River and Lower Klamath River and their beneficial uses, and by not analyzing those impacts, the WaterFix does not identify specific mitigation measures or water permit terms and conditions to avoid unreasonable effects to fish, wildlife or recreational uses of the Trinity and Lower Klamath rivers.

In this testimony, I will demonstrate that full protection of Trinity and Lower Klamath River fisheries and water quality is required by both federal and state laws. I will also show that the WaterFix does not afford protection of the Trinity River in a manner that is consistent with law. The remedy is specific terms and conditions on Reclamation's Trinity River water permits that I will identify.

Trinity River Protection is Consistent with Existing Laws:

The unique protection afforded the Trinity River, its fisheries and water is embodied in State and federal law. The special legal status of the Trinity River, and the federal mandate to do no harm to its salmon runs, has been expressed in numerous legal opinions, court decisions and administrative actions at both the State and federal level. While the Trinity River Division is "*fully integrated*" with the CVP, its special status creates a priority for the use of Trinity River water for Trinity River fisheries and other in-basin uses that is legally superior to any other use of CVP water outside of the Trinity River basin. I will briefly summarize the applicable Federal and State policies that apply to protect the Trinity River.

Federal Laws and Policies:

The *Trinity River Act of 1955* (PL 84-386) (Page 2, PCFFA-89) "*directed and authorized*" the Secretary of Interior to "*preserve and propagate*" the fish and wildlife resources of the Trinity River.

Another provision in the *Trinity River Act of 1955* (Page 2, PCFFA-89) reserved 50,000 acre-feet for Humboldt County and downstream water users that is embodied in a 1959 water contract between the Humboldt County Board of Supervisors and the Bureau of Reclamation that is *separate* from fishery flows (PCFFA-124). A 2014 Interior Solicitor's Opinion (PCFFA-90) has reaffirmed this long-standing water contract and the fact that it is in addition to fishery flows under the Trinity River Record of Decision.[1] This year, the Ninth Circuit Court of Appeals confirmed the continued applicability of these provisions in a case that PCFFA intervened on behalf of the federal government.[2] (PCFFA-91)

The Trinity River Basin Fish and Wildlife Restoration Act of 1984 (PL 98-541) (PCFFA-92) clarified the "preserve and propagate" language from the 1955 Trinity River Act to mean ". . . *restoring fish and wildlife populations in the Trinity River basin to a level approximating that existed immediately before the construction of the Trinity River division.*"

The Trinity River Basin Fish and Wildlife Management Reauthorization Act of 1995 (PL 104-143) (PCFFA-93) clarified that the language in the 1984 Act that "*restoration is to be measured not only by returning adult anadromous fish spawners but by the ability of dependent tribal, commercial, and sport fisheries to participate fully, through enhanced in-river and ocean harvest opportunities, in the benefits of restoration.*" It also clarified that the role of the Trinity River Hatchery is to mitigate fish habitat loss above Lewiston Dam while not impairing efforts to restore and maintain naturally reproducing anadromous fish stocks within the basin.

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[1] "Trinity River Division's 50,000 Acre-Foot Proviso and the 1959 Contract Between the Bureau of Reclamation and Humboldt County", U.S. Department of Interior Solicitor Opinion M-37030, Hilary C. Tompkins, December 23, 2014. Accessed at https://www.doi.gov/sites/doi.opengov.ibmcloud.com/files/uploads/M-37030.pdf

[2] *San Luis Delta Mendota Water Authority and Westlands Water District v. Haugrud*, 848 F.3d 1216 (9th Cir. 2017) (No 14-17493, D.C. No. 1:13-cv-01232-LJO-GSA), February 21, 2017. Accessed at http://cdn.ca9.uscourts.gov/datastore/opinions/2017/02/21/14-17493.pdf, as corrected by http://cdn.ca9.uscourts.gov/datastore/opinions/2017/03/23/14-17493.pdf

According to a 1993 Interior Solicitor's Opinion (Page B-13, PCFFA-94)[3], the Tribal Trust Doctrine dictates that the federally reserved fishing rights of the Hoopa Valley and Yurok Tribes there are a property right associated with the flows of the Trinity River. These rights date back 10,000 years, making them senior to any water rights obtained by the Bureau of Reclamation for the Central Valley Project.

The Central Valley Project Improvement Act, P.L. 102-575 (CVPIA) (PCFFA-95) acknowledged the difference between the Trinity River (CVPIA Section 3406(B)(23)) and Central Valley (CVPIA Section 3406(B)(1)) streams by having separate fishery restoration goals for each basin.

The primacy of the waters of the Trinity River for use in the Trinity River basin is explained in a 1979 opinion by Interior Solicitor by Leo Krulitz (Page 2, PCFFA-96) on the water contract and drought shortage provisions with the Grasslands Water District:[4]

> *"...in authorizing the Trinity River Division in 1955, Congress specifically provided that in-basin flows (in excess of a statutorily prescribed minimum) determined by the Secretary to meet in-basin needs take precedence over needs to be served by out of basin diversions."*

The United States Environmental Protection Agency's 1992 approval of the Trinity River Water Quality Objectives under Federal Clean Water Act Section 303[5] (PCFFA-97) established a federal water quality standard that all federal agencies, including the Bureau of Reclamation must comply with. USEPA also stated in their approval that Trinity River diversions to the Sacramento River are a controllable factor in the protection of the Trinity River and have harmed the Trinity River.

The 2000 Trinity River Record of Decision (ROD page 17)[6] (PCFFA-98) clearly stated as follows:

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[3] https://www.doi.gov/sites/doi.opengov.ibmcloud.com/files/uploads/M-36979.compressed.pdf

[4] Interior Solicitor to Assistant Secretary for land and Water Resources regarding Proposed Contract with Grasslands Water District, December 7, 1979. Accessed at http://bit.ly/2vwa1dr

[5] Letter from USEPA Region IX Administrator to Chairman of the California State Water Resources Control Board, March 13, 1992. Accessed at http://bit.ly/2vG8QqL

[6] See https://www.fws.gov/arcata/fisheries/reports/technical/Trinity_ROD.pdf

"From the inception of the TRD, Congress directed this Department to ensure the preservation and continued propagation of the Trinity River's fishery resources and to divert to the Central Valley only those waters surplus to the needs of the Trinity Basin."

State Laws and Policies:

The Trinity River's fisheries also have protections under the concept of the Public Trust Doctrine, as expressed in the Mono Lake Opinion (*National Audubon Society vs. Alpine County Superior Court*). (PCFFA-99)[7] *"The public trust...is an affirmation of the duty of the state to protect the people's common heritage of streams, lakes, marshlands and tidelands...."* – Supreme Court of California, 1983.

The Area of Origin and Watershed Protection Statutes under California law also contain a priority for in-basin uses compared to out of basin uses. The waters of the Trinity River are subject to California's Watershed Protection, Area of Origin and County of Origin Statutes (California Water Code Sections 10505, 11128 and 11460 et seq.) (PCFFA-100) that limit the export of its waters to surplus flows only. Water Code Section 11128 specifically applies the watershed protection and county of origin statutes to the Bureau of Reclamation's Central Valley Project, which includes the Trinity River Division of the CVP.

The California Department of Fish and Game (DFG), in its 22 June 2004 comments on the Supplemental EIS/EIR for the Trinity River Mainstem Fishery Restoration Program[8] (PCFFA-101) stated that impacts to listed species in the Central Valley and Delta as a result of increased Trinity River flows (and decreased Trinity exports to the Sacramento River) do not require mitigation under the California Environmental Quality Act. DFG cited California's watershed protection and area of origin statutes as the rationale for the determination that the priority for Trinity River water is within that basin (Page 2, PCFFA-101):

"In California, the controls put in place governing a single source of water supply from two separate basins, requires needs for beneficial uses in the basin of origin be met first- then needs can be supplied for the other basin."

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[7]

[8] Trinity Supplemental EIS/EIR comments from California Department of Fish and Game Region 1 Manager to Russell Smith, USBR and Tom Stokely, Trinity County.

The North Coast Regional Water Quality Control Board and the California State Water Resources Control Board approved Trinity River temperature objectives (PCFFA-102) [9] in 1991, which were approved by USEPA in 1992.

The concept of doing no harm to the Trinity River is also manifested in Water Right Order 90-5 (Page 14, SWRCB-24), which contained a term and condition prohibiting harm to the Trinity River as it relates to the export of Trinity River water to the Sacramento River solely for temperature control on the Sacramento River. Unfortunately, as I demonstrate below, Water Right Order 90-5 does adequate protect the Trinity River fisheries from harm due to exhaustion of the cold-water supply in Trinity Reservoir and subsequent violation of North Coast Basin Plan Temperature Objectives for the Trinity River. (PCFFA-102)

The geographic basis for the North Coast Basin Plan temperature objectives and the protections for the Trinity River in WR 90-5, is Fish and Game Code Section 1505 (PCFFA-124), which designates the Trinity River between Lewiston Dam and the North Fork Trinity River confluence as a prime salmon and steelhead spawning area.

WaterFix Environmental Analysis Inadequate for Trinity and Lower Klamath Rivers

The WaterFix EIS/EIR states unequivocally that there will be no impacts to the Trinity River because there will be no change in CVP operations as a result of the WaterFix (Figure 4.3.1-4 Trinity Lake End of September Storage for Alternative 4A BDCP Recirculated DEIS/EIR, SWRCB-102).[10] While the CALSIM II computer modeling has assumptions about the reservoir carryover storage and other operational criteria, none of the criteria are proposed as part of a formal operations plan for approval by the State Water Resources Control Board. Furthermore, it appears that the Bureau of Reclamation changes reservoir carryover storage targets in ways

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[9] "Water Quality Control Plan for the North Coast Region" Footnote 5, Table 3-1, page 3-8.00: Accessed at http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/083105-bp/04_water_quality_objectives.pdf

Daily Average Not to Exceed	Period	River Reach
60°F	July 1- Sept 15	Lewiston to Douglas City Bridge
56°F	Sept 15-Oct 1	Lewiston to Douglas City Bridge
56°F	Oct 1- Dec 31	Lewiston to North Fork Confluence

[10] See http://baydeltaconservationplan.com/RDEIRS/Recirc_Figures/Fig_4.3.1.4_Trinity_Sept_Alt4A.pdf

that are not disclosed. More detail on the lack of realistic modeling can be found in a July 13, 2017 letter by California Water Research (PCFFA-125).

The WaterFix only has theoretical modeling and no clear operations plans to compare to. Trinity is already at risk and therefore WaterFix will do nothing to protect Trinity because no impacts have been identified. Without clear specific carryover storage criteria there is no protection for the Trinity River and its fisheries. Reservoir operations criteria and downstream operations in the WaterFix EIS/EIR are speculative at best.

The fallacy of the argument that there won't be changes to operations at Trinity cannot be overstated. The Central Valley Project is integrated as one system, including the Trinity River Division, as stated in Section 2 of Public Law 84-386 authorizing construction of the Trinity River Division (PCFFA-89). Operations north of the Delta are closely coordinated between Shasta, Trinity and Folsom. What affects one reservoir affects the others. A shortfall in Shasta or Folsom storage would therefore affect Trinity. As an example, the State Board adopted Order WR 2015-0043 (PCFFA-103) on December 15, 2015 regarding the Temporary Urgency Change Petition submitted by USBR and CDWR during the recent drought. In that Order, the State Board required an end of October 2016 Folsom storage level of 200,000 AF and 1.6 million AF for Shasta. However, there was no end of October reservoir storage requirement for Trinity, leaving Trinity completely vulnerable to a warm water crisis if the drought had continued.

Fortunately, the epic drought did not continue into 2016 and the minimum storage requirements at Folsom and Shasta were not needed. However, if the drought had continued into 2016, it is clear that Trinity storage would have taken a major hit, according to quotes from Don Bader, USBR Northern California Area Office Manager in a December 23, 2015 article in the Trinity Journal "**Shasta Target Level could impact Trinity.**" (PCFFA-104):

"From the federal Bureau of Reclamation's Northern California Area Office, Deputy Area Manager Don Bader said typically if the agency needed to keep Shasta full Reclamation would draw from Trinity, which we did last year."

"Bottom line is if they do require Shasta be kept fuller during the summer months it's going to be more of a draw on Trinity, if it's available," he said."

The WaterFix claim that there would be no change in operations to Trinity and no impacts to Trinity is totally unsubstantiated.

Additionally, despite a request from the Hoopa Valley Tribe , (PCFFA-105),[11] the WaterFix EIS/EIR did not include an analysis considering use of Humboldt County's 50,000 AF water contract. This omission does not consider that on April 20, 2017, the Bureau of Reclamation issued a Record of Decision for the Long Term Plan to Protect Adult Salmon in the Lower Klamath River Project[12] (Lower Klamath ROD) (PCFFA-106) based on a draft and Final Environmental Impact Statement[13] (PCFFA-107, PCFFA-108). The preferred alternative includes use of Humboldt County's 50,000 AF contract with additional releases beyond 50,000 AF. Historically these late summer releases from Trinity and Lewiston Dams into the Trinity River and Lower Klamath River have ranged from 17,500 AF (2013) to 64,000 AF (2014), with an average of 40,000 AF based on the years these releases have occurred (2003, 2004, 2012, 2013, 2014, 2015, and 2016) (PCFFA-107, page ES-1).

The Draft EIS for the Lower Klamath ROD identified that losses to CVP deliveries from the preferred alternative will be 24,000 AF in some drier years. (PCFFA-107, page ES-9).

Therefore, the WaterFix EIS/EIR does not address in any way WaterFix changes to Trinity River Division operations nor does it analyze current Trinity River Division operations in the WaterFix modeling.

Inadequate Water Right Protection for Trinity River Fisheries- Flow and Temperature

There is no assurance that the Trinity River and its cold-water fisheries will be protected from CVP operations because Reclamation's Trinity River water permits (SWRCB-15, SWRCB-16, SWRCB-17, SWRCB-18 and SWRCB-19 and permits 011966, 011970 and 011972) are not consistent with North Coast Basin Plan Trinity River temperature objectives and instream flows under the Trinity ROD and there is no carryover storage requirement. Additionally, the

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[11] See http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/DEIRS_Comment_Responses_Letters_1500-1548.sflb.ashx

[12] See https://www.usbr.gov/mp/nepa/documentShow.cfm?Doc_ID=28314

[13] See https://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=22021

600,000 acre -foot Trinity Reservoir minimum cold water carryover storage requirement in the 2000 NMFS Biological for the Trinity River[14] (PCFFA-109) is inadequate to prevent temperature induced mortality in the Trinity River, particularly during multi-year drought as detailed in the testimony by Greg Kamman (PCFFA-126).

Despite the existence of higher Trinity River fishery releases pursuant to the 2000 Trinity River Record of Decision, neither the WaterFix nor the CVP OCAP mitigate or prevent catastrophic loss of cold-water storage and basic flows to keep fish in good condition below Trinity and Lewiston Dams, as required by the federal government's Tribal Trust obligations and California Fish and Game Code Sections 1505 and 5937 (PCFFA-110 and PCFFA-124).

Multi-year drought increases the risk to the Trinity and Lower Klamath rivers of losing the cold water stored in Trinity Reservoir to out of basin export. It is essential to note that Trinity River water provides beneficial uses for Coho (listed as threatened) and Chinook salmon, as well as steelhead, Pacific Lamprey, green sturgeon and other species important to Tribal, recreational and commercial fishing communities from Central California to the Oregon/Washington border. Klamath-Trinity Spring Chinook are being proposed for listing as threatened by the Karuk Tribe (PCFFA-111).

In 1958, the Bureau of Reclamation, pursuant to section 8 of the 1902 Reclamation Act applied to the state for water rights to operate the TRD that were granted in 1959. However, those water rights still contain minimum fishery flows of only 120,500 AF (SWRCB-15, SWRCB-16, SWRCB-17, SWRCB-18 and SWRCB-19 and permits 011966, 011970 and 011972). Weighted annual average Trinity ROD flows are 594,500 AF annually, and combined with Humboldt County's 1959 50,000 AF CVP water contract amounts to average annual river releases of 644,500 AF. There are also tribal ceremonial flows requested by the Hoopa Valley Tribe in odd numbered years that have ranged from 4,100 AF to 11,100 AF (PCFFA-113)[15].

Reclamation has admitted that it does not operate to any "hard and fast" Trinity

[14] See https://www.fws.gov/arcata/fisheries/reports/technical/TREIS_BO_NMFS.pdf

[15] See http://www.trrp.net/restoration/flows/flow-volume-summary/

Reservoir carryover storage requirement and does not consider water quality objectives[16] (Pages 3, PCFFA-114) contained in the North Coast Basin Plan as water permit terms and conditions.

Trinity River temperature objectives to protect salmon and steelhead been adopted by the North Coast Regional Water Quality Control Board, the State Water Resources Control Board and USEPA (PCFFA-102) have not been fully incorporated into water permit requirements for the Bureau of Reclamation (SWRCB-15, SWRCB-16, SWRCB-17, SWRCB-18 and SWRCB-19 and permits 011966, 011970 and 011972), creating a regulatory gap.

Reclamation does consider Water Right Order 90-5 (WRO 90-5. SWRCB-24) to be a permit term and condition (PCFFA-114) but WRO 90-5 is not consistent with North Coast Basin Plan Temperature objectives for the Trinity River. WRO 90-5 includes Trinity River North Coast Basin Plan temperature requirements for the September 15- December 31 period, but omits the Basin Plan temperature objective for the Trinity River July 1- September 15 period that are protective of holding spring Chinook. Additionally, the WRO 90-5 September 15 through December 31 Trinity River temperature requirement only applies to transfers of Trinity River water to the Sacramento River for temperature control. All other uses of Trinity River water sent to the Sacramento River are not covered by the temperature requirements of WRO 90-5. Reclamation refuses to acknowledge that North Coast Basin Plan requirements are Clean Water Act Section 313 standards that they must comply with because they are not water permit terms and conditions. (PCFFA-114)[17] Thus, comprehensive Trinity River Basin Plan temperature objectives should be included in Reclamation's water permits as a mitigation measure to protect the Trinity River.

The NMFS 2000 Biological Opinion[18] (PCFFA-109) for the Trinity River, includes a minimum carryover storage in Trinity Reservoir on September 30 of 600,000 AF and requires

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[16] See 2/23/11 letter from Paul Fujitani, Chief of CVP Ops to Brian Person, Chairman Trinity Management Council; accessed at: http://bit.ly/2tulvQc

[17] Ibid : http://bit.ly/2tulvQc

[18] National Marine Fisheries Service (2000), Biological Opinion for the Trinity River Record of Decision, accessed at: http://www.fws.gov/arcata/fisheries/reports/technical/TREIS_BO_NMFS.pdf

reconsultation if storage falls below that level, which occurred in 2015. However, other analyses have found that a 600,000 AF minimum carryover storage is inadequate (See Kamman testimony (PCFFA-126). A 2012 report by Reclamation found that September 30 carryover storage requirement of less than 750,000 AF is "problematic" in meeting state and federal Trinity River temperature objectives protective of the fishery.[19] (PCFFA-115)

In 1992 Balance Hydrologics found that a minimum carryover storage of 900,000 AF was necessary to meet Basin Plan temperature objectives.[20] (PCFFA-116)

Analyses completed for Trinity County for the Trinity Record of Decision by Kamman Hydrologics indicated that September 30 Trinity Reservoir carryover storage of at least 1.25 million AF on September 30 is necessary at the beginning of a simulated 1928-1934 drought in order to meet Basin Plan temperature objectives. (PCFFA-117) During the recent drought, Trinity Reservoir storage fell below levels necessary to survive a historic multi-year drought such as 1928-1934.

Reclamation's Mid-Pacific office also produced a preliminary technical memorandum on the problem of excessive heating of Trinity Dam releases[21] (PCFFA-118) when they pass through the shallow 7-mile long Lewiston Reservoir. While Trinity Dam releases are normally 43-44°F, summer heating in Lewiston Reservoir can be severe unless approximately 900- 1,800 cfs is being released from Trinity Dam. Given that Trinity River summer base flows are only 450 cfs, water must be diverted to the Sacramento River to keep the Trinity River cold enough to meet Basin Plan temperature objectives. However, during severe drought or under certain operational circumstances, there may not be adequate water to provide base fishery flows and to divert water to the Sacramento River to keep the Trinity River cold. Several structural solutions have been identified in Reclamation's preliminary technical memorandum; however,

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[19] See Bender MD (2012) Trinity Reservoir Carryover Storage Cold Water Pool Sensitivity Analysis. Technical Memorandum No. 86-68220-12-06, U.S. Bureau of Reclamation, Technical Service Center, Denver, CO. Accessed at http://odp.trrp.net/Data/Documents/Details.aspx?document=1813

[20] See Balance Hydrologics (6/26/1992) "The Need for Standards for Minimum Carryover Storage in Trinity Reservoir" Accessed at http://tcrcd.net/trl-stor.htm

[21] See USBR (2012) Lewiston Temperature Management Intermediate Technical Memorandum, Lewiston Reservoir, Trinity County, California. Report by U. S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, CA. accessed at http://odp.trrp.net/Data/Documents/Details.aspx?document=1814

a full feasibility study and environmental document would need to be prepared to select a solution and no such plans exist at this time.

Additionally, during summer and fall, Trinity River diversions to the Sacramento River are usually warmer than Shasta Dam releases by three degrees Fahrenheit or more. (PCFFA-119). Diversion of large amounts of Trinity River water to the Sacramento can harm Sacramento River salmon from warming while depleting Trinity Reservoir of cold water.

The impact to Trinity fish from lack of cold water can be viewed in three reports from the California Department of Fish and Game on the effects of the 1977 drought on Trinity River water temperatures and Trinity River hatchery fish (PCFFA-120), (PCFFA-121) and (PCFFA-122). These reports support the conclusion that exhaustion of the cold-water pool in Trinity Lake during drought creates harm to Trinity River fish through warm water discharges that cause disease outbreaks and fish mortality.

Therefore, in order for the Trinity River to be protected, any water right order permitting the proposed WaterFix must require Reclamation to comply with the following terms and conditions and that Reclamation's Trinity River water permits be amended as well, as directed in the SWRCB's 1989 Water Quality Order 89-18.[22] (PCFFA-123). The conditions for Reclamation's Trinity River water permits should be as follows:

1. Conformance with the instream fishery flows contained in the Trinity River Record of Decision as minimum instream flows.
2. Provision for release of not less than Humboldt County's 50,000 AF contract water in addition to fishery flows and tribal ceremonial flows.
3. Inclusion of permit terms and conditions to require Reclamation to comply with the Trinity River temperature objectives contained in the Water Quality Control Plan for the North Coast Region (NCRWQCB) for all relevant time periods and for all uses of Trinity water diverted to the Sacramento River.
4. A requirement for a minimum cold water storage in Trinity Reservoir adequate to preserve

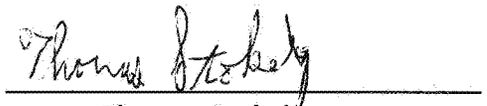
[22] See SWRCB Water Quality Order 89-18 (pages 18 and 19) at http://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/1989/wq1989_18.pdf

and propagate all runs of salmon and steelhead in the Trinity River below Lewiston Dam during multi-year drought. Based on studies to date, 1.25 million AF to 1.75 million AF is appropriate for starting storage, with storage levels not falling below 900,000 AF in any year.

5. Require Reclamation to address the temperature issue in Lewiston Reservoir through a feasibility study and NEPA document to follow up on the 2012 preliminary technical memorandum by Reclamation (PCFFA-118).

6. When releases from Spring Creek are more than one degree Fahrenheit warmer than releases from Shasta Dam, limit the export of Trinity River water to the Sacramento River to the amount necessary to meet Trinity River Basin Plan Temperature Objectives. This protects both Trinity and Sacramento River salmon.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct, and that I executed this declaration November 26, 2017 in Mount Shasta, California



Thomas Stokely

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Attorneys for PCFFA and IFR

BEFORE THE

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

HEARING IN THE MATTER OF THE CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UNITED STATES BUREAU OF RECLAMATION REQUEST FOR A CHANGE IN POINT OF DIVERSION FOR CALIFORNIA WATER FIX	TESTIMONY OF GREG KAMMAN

WRITTEN TESTIMONY OF GREG KAMMAN, HYDROLOGIST
PACIFIC COAST FEDERATION OF FISHERMEN'S ASSOCIATIONS (PCFFA) AND THE INSTITUTE FOR FISHERIES RESOURCES (IFR) FOR PART 2 OF THE CALIFORNIA WATERFIX CHANGE IN POINT OF DIVERSION HEARING BEFORE THE STATE WATER RESOURCES CONTROL BOARD

I, Greg Kamman, do hereby declare:

I. INTRODUCTION

My name is Greg Kamman. I am presenting this testimony on behalf of the PCFFA and IFR in this evidentiary hearing before the State Water Resources Control Board ("State Water Board") concerning the petition to change the point of diversion for the California WaterFix for the State Water Project ("SWP") and federal Central Valley Project ("CVP"), as specified in the licenses and permits of the US Bureau of Reclamation ("Reclamation") and the California Department of Water Resources ("DWR").

I am a hydrologist with over twenty-five years of technical and consulting experience in the fields of hydrology and hydrogeology. I have been providing professional hydrology and

geomorphology services in California since 1991 and routinely manage projects in the areas of surface- and groundwater hydrology, water supply, water quality assessments, and water resources management. Much of my work is located in the Coast Range watersheds of California, including the Klamath/Trinity and Eel River systems. My areas of expertise include: characterizing and modeling watershed-scale hydrologic and geomorphic processes; evaluating surface- and ground-water resources/quality and their interaction; assessing hydrologic, geomorphic, and water quality responses to land-use changes in watersheds and causes of stream channel instability; assisting and leading in the development of CEQA environmental compliance documents and project environmental permits; and designing and implementing field investigations characterizing surface and subsurface hydrologic and water quality conditions. On behalf of Trinity County, I completed numerous water operations and temperature modeling studies related to alternative operations of Trinity and Lewiston Lake with a focus on effects on downstream temperatures in the Trinity River. These studies were completed from 1997 through 2004. I co-own and operate the hydrology and engineering consulting firm Kamman Hydrology & Engineering, Inc. in San Rafael, California (established in 1997). I earned a Master of Science in Geology, specializing in Sedimentology and Hydrogeology as well as a Bachelor of Arts in Geology from Miami University, Oxford, Ohio. I am a California registered Professional Geologist (PG) and Certified Hydrogeologist (CHg). My resume and list of professional reports and publications are provided in Exhibit PCFFA-127.

II. OVERVIEW OF TESTIMONY

The purpose of this testimony is to demonstrate that the Final EIS/R for the WaterFix is inadequate to support the Petition because it does not analyze or propose mitigation measures for reasonably foreseeable adverse impacts to fishery and aquatic resources of the Trinity River. These foreseeable impacts stem from insufficient carryover storage in Trinity Lake and planned CVP operations and releases to the Trinity River that are unable to meet water quality objectives stipulated in the California State Regional Water Quality Control Board's Water Quality Control Plan for the North Coast Region. The rationale for this conclusion is presented below.

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III. CVP OPERATIONS AND WATER QUALITY OBJECTIVES FOR THE TRINITY RIVER DIVISION

Under the WaterFix, CVP operations and resulting instream flows in the Trinity River will be managed pursuant to the 2000 Trinity River Record of Decision ("ROD")[1] (PCFFA-98). Releases from Lewiston Lake via water stored in Trinity Lake provide water to meet the ROD Flows in the Trinity River. Water is released from Trinity Lake to Lewiston Lake where it is diverted to both the Sacramento River (via Clear Creek Tunnel) and the Trinity River. Annual hydrographs of average weekly ROD Flows for designated water year types are presented on page 13 in the Trinity ROD (PCFFA-98). Annual volumes by water year type are presented on page 12 in the Trinity ROD. *Id.* The 2000 National Marine Fisheries Service ("NMFS") Biological Opinion for the Trinity River (PCFFA- 109) states that Trinity Reservoir (Trinity Lake) would be operated to maintain a minimum carryover storage of 600 thousand acre-feet (TAF) between water years (bottom page 4, PCFFA-109). Implementation of drawdowns below the 600 TAF minimum end-of-year carryover level in Trinity Reservoir shall be determined by Reclamation, U.S. Fish and Wildlife Service ("USFWS"), and NMFS on a case by-case basis in dry and critically dry water years and Reclamation shall be prepared to make use of the auxiliary bypass outlets on Trinity Dam as needed (page 49, PCFFA-109).

The North Coast Regional Water Quality Control Board and California State Water Resources Control Board approved Trinity River temperature objectives in 1991, which were approved by the United States Environmental Protection Agency in 1992. These temperature objectives are presented in the Water Quality Control Plan for the North Coast Region ("Basin Plan") (footnote 5 to Table 3-1, page 3-8.00, PCFFA-102). The temperature objectives stipulate that specified daily average river water temperatures should not be exceeded during specific periods of the year in selected reaches of river.

IV. TRINITY LAKE STORAGE AND COLD WATER POOL

Ordinarily in late summer, water temperatures in Trinity Lake are well stratified,

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[1] Hereafter, the instream flow schedules for the Trinity River as specified in the ROD will be referred to as the "ROD Flows".

displaying a layer of warm water above a deeper pool of much colder water. During this time, releases from Trinity Lake to Lewiston Lake occur through a submerged powerhouse outlet. If the reservoir is drawn down to a relatively low level, the upper warm layer may intersect the powerhouse outlet, releasing warm water to Lewiston Lake. In turn, these warm temperatures are propagated through Lewiston Lake to the Trinity River. As presented herein, a number of studies have been completed to quantify the minimum October 1 carryover storage volume that is needed to protect against the introduction of warm summer water releases during various water year types and droughts. The main factors that affect and/or control the Trinity Lake storage volume and size of the cool water pool are: reservoir inflow temperatures and volumes; CVP diversions and operations; seasonal meteorological patterns; release schedules to the river; use of the auxiliary outlet and water year-types.

V. RESERVOIR OPERATION INFLUENCE ON RIVER RELEASE TEMPERATURES

Reclamation reports that CVP operators face seasonal challenges in meeting downstream temperature objectives on the Trinity River. It states, "The geometry, hydrodynamics, and incidence of direct solar radiation in Lewiston Reservoir can cause an increase in water temperature during travel of flows from Trinity Dam to Lewiston Dam, and into the Trinity River. This sometimes results in unsuitable mean daily temperatures for anadromous salmonids in the Trinity River below Lewiston Dam" (page 1, PCFFA-118). The rate of water flow through Lewiston Lake is controlled by releases to the Trinity River and diversions to the Sacramento River via the Carr power plant. When the Carr power plant diversions are at capacity, the rate of flow through Lewiston Lake is sufficient to displace its entire volume in about 2.5 days and water temperatures remain relatively cool (Section 4.2.1, page 9, PCFFA-127). On the other hand, when the Carr power plant is not operating, flow through Lewiston Lake stagnates and thermal stratification develops within days, typically leading to the warming of summer surface waters to between 60 and 70 degrees Fahrenheit (*ibid*). Water temperature modeling results suggest that total flow rates through Lewiston Lake (i.e. the sum of Carr power plant diversions and Trinity River releases) should be between approximately 800 cfs during the

late summer/early fall months of normal year-types and up to 1900 cfs during the summer/fall months of critically dry year-types in order to comply with downstream temperature objectives on the Trinity River (*ibid*).

VI. TEMPERATURE COMPLIANCE OF THE ROD FLOWS AND 600 TAF CARRYOVER STORAGE

As part of the preparation of the environmental analysis leading up to the Trinity River ROD, Trinity County hired Kamman Hydrology & Engineering, Inc. (KHE) to collaborate with Reclamation and USFWS modelers to evaluate how the ROD Flows comply with Trinity River water temperature objectives under a variety of different water year types (e.g., wet, normal, dry year types) (pages 3-4, PCFFA-127). Thermal evaluation of the ROD Flows was completed using a series of models that simulate flow and water temperatures for sequential portions of the upper Trinity River system for an individual water year type. These models included: the Bureau of Reclamation's Temperature Model (RTM) which simulates release volumes and temperatures from Trinity Lake[2]; a reservoir temperature model of Lewiston Lake based on the Box Exchange Transport Temperature and Ecology of Reservoirs model (BETTER); and USFWS' Stream Network Temperature Model (SNTEMP) which simulates water temperatures on the mainstem Trinity River below Lewiston Lake.

The objective of the temperature modeling studies was to predict water temperatures on the mainstem Trinity River in response to CVP operations to meet the ROD Flows. Simulated river water temperatures were then compared to the temperature objectives in the Water Quality Control Plan for the North Coast Region. Modeling was initiated using PROSIM and RTM to estimate release volumes and temperatures from Trinity Lake into Lewiston Lake. These data were then used by KHE as input into the BETTER model to estimate release temperatures from Lewiston Lake into the upper Trinity River.

In order to determine how simulated Lewiston Lake releases fared in meeting the

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[2] Input data for RTM comes from Reclamation's project simulation model (PROSIM) which is used to evaluate the CVP and State Water Project (SWP) systems. The close linkage between RTM and PROSIM means that PROSIM also plays an indirect role in the temperature analysis process.

downstream temperature objectives, a suite of Lewiston release rate and temperature relationships were developed by USFWS using the SNTEMP model that were determined necessary to meet downstream temperature objectives. Four sets of flow and release temperature relationships were developed for a variety of hydrometeorological year-type conditions, including: cold-wet; median; hot-dry; and extremely hot-critically dry. These relationships are presented Table 8 in (PCFFA-127).

Temperature compliance modeling results of CVP operations indicate that the ROD Flows with 600 TAF carryover storage achieve compliance with Trinity River temperature objectives during wet and normal water year types (Table 11, PCFFA-127). During dry year types, the ROD Flows achieve temperature objectives 86% of the time and only 36% of the time during critically dry year types (Tables 12 and 13, respectively; PCFFA-127). These results beg the question – how well do the ROD Flows achieve temperature objectives during a multi-year drought period when carryover storage is systematically reduced year-to-year?

VII. CARRYOVER STORAGE ANALYSIS: 1928-1934 DROUGHT PERIOD

In 1998, Trinity County retained KHE to evaluate how an intense multi-year drought would affect carryover storage in Trinity Lake (PCFFA-117). The study approach included an interannual accounting of Trinity Lake storage during a series of representative water year-types similar to those experienced during the 1928-1934 drought.[3] Water releases from Trinity Lake were based on the water year type Trinity Division operations[4] under the ROD Flows (page 13, PCFFA-98). A series of interannual Trinity Lake water budgets were developed with initial carryover storage volumes ranging from 750- to 2000-TAF. The results of this study are summarized in the table under the heading, "Flow Study Alternative" on page 2 of PCFFA-117.

Study results (page 2, PCFFA-117) indicate that under CVP operations to meet ROD Flows, there is a net annual increase in Trinity Lake storage during normal (1928) year-types, but decrease during dry (-17.5 TAF) and critically dry (-341 TAF) year-types. Thus, when starting

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[3] The interannual water budget accounting started in 1928, a normal water year type.

[4] It is likely that CVP operations would change during drought periods. However, we did not have the knowledge or expertise to define such changes. Thus, the analysis used operations consistent with the earlier PROSIM simulations.

with 750 TAF of storage, Trinity Lake storage would have dropped below 200 TAF after the third year of the drought, primarily driven by storage reductions experienced during critically dry years. Study results (page 2, PCFFA-117) also indicate that a starting storage volume of 1250 TAF is required to maintain a minimum carryover storage of 600 TAF through the drought. However, as presented above, even a 600 TAF does not fully achieve compliance with temperature objectives during dry and critically dry year types. This study suggests that a minimum carryover storage volume of between 1250- and 1500-TAF during the first year of drought is likely required in order to provide the necessary water release temperatures to the Trinity River to meet downstream temperature objectives.

VIII. OTHER RECOMMENDED CARRYOVER STORAGE VOLUMES

In addition to the work cited above, I am aware of two other studies focused on identifying the minimum Trinity Lake carryover storage necessary to provide the necessary cold water releases to satisfy river temperature objectives. In their 1992 testimony to the State Water Board, Finnerty and Hecht (PCFFA-116) concluded that Trinity Lake carryover storage of 900 TAF or slightly more may be needed to meet downstream temperature objectives during 90% of all years. Their conclusion was based on analysis of hydrology, reservoir operations and temperatures for 1991, a single critically dry year-type. The second study, completed by Deas in 1998 (PCFFA-128) on behalf of Trinity County, included water temperature simulations of Trinity Reservoir using the Water Temperature Simulation Model (WTSM). His analysis evaluated temperature compliance under 1990 dry year-type conditions assuming initial reservoir storage volumes of 750-, 1250- and 1500-TAF. Model simulation results indicated elevated water temperatures at the powerhouse intake elevation for the 750 TAF carryover storage scenario and minimal to no temperature concerns at initial carryover storage volumes of 1250- and 1500-TAF, respectively. Deas' findings of elevated temperatures associated with 750 TAF of carryover storage are corroborated in the 2012 report by Reclamation, which found that a September 30 carryover storage requirement of less than 750 TAF is "problematic" in meeting state and federal Trinity River temperature objectives protective of the fishery (PCFFA-115).

IX. TRINITY RIVER RESTORATION PROGRAM FLOW AND VOLUME MONITORING

Implementation of the ROD Flows on the Trinity River began in 2001. Table 1 presents a summary of Trinity Lake carryover storage volumes (on September 30 of each water year), annual changes in storage and flows directed to the Trinity River or diverted to the Central Valley.[5] Table 1 covers the 2001 through 2016 period. Table 1 also presents the annual combined total volume of water released to the river and diverted to the Central Valley along with the annual percentages of total releases to the river and diverted to the Central Valley. During the 2001-2016 period, the total volume of water moving through the Trinity Division was split relatively evenly between river releases and diversion to the Central Valley, with just slightly more water diverted to the Central Valley.

During the 2001-2016 period, there were two (2) three-year droughts experienced in the Trinity River watershed. The 2007 through 2009 drought consisted of three sequential dry years. The 2013 through 2015 drought consisted of a critically dry year-type sandwiched between dry water years. The carryover storage volumes at the start of each drought were 1800- and 1890-TAF, respectively. In contrast to the modeled decrease in annual Trinity Lake storage of 17 TAF during dry year types (see Section VII above), the measured decrease in reservoir storage ranged from approximately 60- to 497-TAF and averaged 286.5 TAF during all dry year types (2007-2009, 2013 and 2015). During the single critically dry year-type (2014) experienced during the 2001-2016 period, carryover storage was depleted by 697 TAF, a value over twice the modeled estimate of 341 TAF presented in Section VII, above.

At the end of the 2007-2009 drought, carryover storage was depleted to 919 TAF, a value similar to the minimum carryover storage volume established by Finnerty and Hecht and

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[5] Apart from the Trinity Lake storage values, the data in Table 1 comes from the "Flow Volume Summary" table found on the Trinity River Restoration Program website link at: http://www.trrp.net/restoration/flows/flow-volume-summary/. Trinity Lake (also known as Clair Engle Lake) storage volumes (USGS gauge # 11525400) for September 30 are provided at the USGS's National Water Information System: Web Interface website link at: https://waterdata.usgs.gov/ca/nwis/dv/?site_no=11525400&agency_cd=USGS&referred_module=sw.

discussed in Section VIII above. At the end of the second year (2014 critically dry year) of the 2013-2015 drought, carryover storage was depleted to approximately 606 TAF and further declined to approximately 546 TAF by the end of the three-year drought. With the exception of 2008 and 2015, more water was diverted to the Central Valley than released to the river, including during the critically dry year (2014), when diversion volumes to the Central Valley were nearly twice as high as water released to the Trinity River.

Table 1: Trinity River Restoration Program Flow and Volume Summaries: 2001-2016

Water Year (Oct. 1 through Sept. 30)	Water Year-Type	Trinity Lake End of Year (Sept. 30) Storage AF	Trinity Lake Change in Storage AF	Total Release to Trinity River (ac-ft)	Diversion to Central Valley (ac-ft)	Total River Release and Diversion to Central Valley (ac-ft)	% Total Release to Trinity River %	% Diversion to Central Valley %
2001	Dry	1,428,200		383,800	669,400	1,053,200	36%	64%
2002	Normal	1,500,100	71,900	482,700	629,000	1,111,700	43%	57%
2003	Wet	1,881,000	380,900	556,100	857,600	1,413,700	39%	61%
2004	Wet	1,591,000	(290,000)	768,300	987,500	1,755,800	44%	56%
2005	Wet	1,890,000	299,000	651,200	466,700	1,117,900	58%	42%
2006	Ext Wet	1,795,000	(95,000)	1,216,200	1,350,600	2,566,800	47%	53%
2007	Dry	1,461,000	(334,000)	457,800	614,400	1,072,200	43%	57%
2008	Dry	1,137,000	(324,000)	648,700	555,000	1,203,700	54%	46%
2009	Dry	919,000	(218,000)	456,600	539,200	995,800	46%	54%
2010	Wet	1,558,000	639,000	656,700	274,700	931,400	71%	29%
2011	Wet	2,167,000	609,000	732,600	473,100	1,205,700	61%	39%
2012	Normal	1,800,000	(367,000)	686,100	709,900	1,396,000	49%	51%
2013	Dry	1,303,000	(497,000)	480,500	852,200	1,332,700	36%	64%
2014	Crit Dry	605,600	(697,400)	435,300	618,600	1,053,900	41%	59%
2015	Dry	545,900	(59,700)	508,000	450,500	958,500	53%	47%
2016	Wet	969,400	423,500	748,000	278,900	1,026,900	73%	27%
Total 2001-2016 Averages				**616,788**	**645,456**	**1,262,244**	**49%**	**51%**
2007-2009 Drought Averages				**521,033**	**569,533**	**1,090,567**	**48%**	**52%**
2013-2015 Drought Averages				**474,600**	**640,433**	**1,115,033**	**43%**	**57%**

X. CONCLUSIONS

The study findings presented above indicate that initial October 1 carryover storage volumes of 600- and 750-TAF are not sufficient to satisfy Trinity River temperature objectives for a single dry/critically dry water year-type, let alone multi-year droughts. Thus, it is reasonable to foresee that current implementation of the ROD Flows without sufficient carryover

storage will not achieve Trinity River temperature objectives during such year-types. Both modeling results and monitoring data (Table 1) indicate that critically dry water year-types deplete reservoir carryover storage volumes at much higher rates than occurs during dry years. Whether dealing with dry or critically dry year-types, reservoir storage has no chance of being replenished during multi-year droughts under the current CVP operations.

As determined by Finnerty and Hecht, a minimum baseline carryover storage volume of 900 TAF is required to meet Basin Plan temperature objectives on the Trinity River during a single dry year. Studies by Deas and Kamman suggest this baseline carryover storage volume is likely higher. Regardless, significantly higher carryover storage volumes over the baseline value are required to preserve the necessary reservoir cool water pool during multi-year drought periods, in order to achieve temperature objectives. The data presented in Table 1 indicates that the volume of diversions to the Central Valley are greater than water released to the Trinity River during drought periods. Reducing the volume of water diverted to the Central Valley during drought periods would preserve the necessary reservoir carryover storage required to meet Trinity River Basin Plan water quality objectives. Modeling studies suggest carryover storage volumes of around 1750 TAF are sufficient to maintain adequate carryover storage to meet temperature objectives during multi-year droughts. However, monitoring data of the 2013-2015 drought indicate a carryover storage volume of 1800 TAF is drawn down to insufficient levels after two years of drought. Thus, a single minimum carryover storage volume cannot be developed without revising CVP operations that focus on preserving Trinity Lake carryover storage, most likely by reducing water that is diverted out of the Trinity River basin.

I declare under penalty of perjury under the laws of the State of California that the above is true and correct, and that I executed this declaration on November 28, 2017, in San Rafel, California.



Greg Kamman, PG, CHG, Principal Hydrologist
Kamman Hydrology & Engineering, Inc.

From: Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Sent: 1/10/2020 8:27:51 AM
To: Thad Bettner [tbettner@gcid.net]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Re: Sites - Delta Consistency Determination

Yes, we are going to have to send a notice of recirculation to all that provided previous comments, if the draft is recirculated:

15088.5. Recirculation of an EIR Prior to Certification

(a) A lead agency is required to recirculate an EIR when significant new information is added to the EIRafter public notice is given of the availability of the draft EIR for public review under Section 15087 but before certification. As used in this section, the term "information" can include changes in the project or environmental setting as well as additional data or other information. New information added to an EIRis not "significant" unless the EIR is changed in a way that deprives the public of a meaningful opportunity to comment upon a substantial adverse environmental effect of the project or a feasible way to mitigate or avoid such an effect (including a feasible project alternative) that the project's proponents have declined to implement. "Significant new information" requiring recirculation include, for example, a disclosure showing that:

(1) A new significant environmental impact would result from the project or from a new mitigation measure proposed to be implemented.

(2) A substantial increase in the severity of an environmental impact would result unless mitigation measures are adopted that reduce the impact to a level of insignificance.

(3) A feasible project alternative or mitigation measure considerably different from others previously analyzed would clearly lessen the environmental impacts of the project, but the project's proponents decline to adopt it.

(4) The draft EIR was so fundamentally and basically inadequate and conclusory in nature that meaningful public review and comment were precluded. (*Mountain Lion Coalition v. Fish and Game Com.* (1989) 214 Cal.App.3d 1043)

(b) Recirculation is not required where the new information added to the EIR merely clarifies or amplifies or makes insignificant modifications in an adequate EIR.

(c) If the revision is limited to a few chapters or portions of the EIR, the lead agency need only recirculate the chapters or portions that have been modified.

(d) Recirculation of an EIR requires notice pursuant to Section 15087, and consultation pursuant to Section 15086.

(e) A decision not to recirculate an EIR must be supported by substantial evidence in the administrative record.

(f) The lead agency shall evaluate and respond to comments as provided in Section 15088. Recirculatingan EIR can result in the lead agency receiving more than one set of comments from reviewers. The following are two ways in which the lead agency may identify the set of comments to which it will respond. This dual approach avoids confusion over whether the lead agency must respond to comments which are duplicates or which are no longer pertinent due to revisions to the EIR. In no case shall the lead agency fail to respond to pertinent comments on significant environmental issues.

(1) When an EIR is substantially revised and the entire document is recirculated, the lead agency may require reviewers to submit new comments and, in such cases, need not respond to those comments received during the earlier circulation period. The lead agency shall advise reviewers, either in the text of the revised EIR or by an attachment to the revised EIR, that although part of the administrative record, the previous comments do not require a written response in the final EIR, and that new comments must be submitted for the revised EIR. The lead agency need only respond to those comments submitted in response to the recirculated revised EIR.

(2) When the EIR is revised only in part and the lead agency is recirculating only the revised chapters or portions of the EIR, the lead agency may request that reviewers limit their comments to the revised chapters or portions of the recirculated EIR. The lead agency need only respond to (i) comments received during the initial circulation period that relate to chapters or portions of the document that were not revised and recirculated, and (ii) comments received during the recirculation period that relate to the chapters or portions of the earlier EIR that were revised and recirculated. The lead agency's request that reviewers limit the scope of their comments shall be included either within the text of the revised EIR or by an attachment to the revised EIR.

(3) As part of providing notice of recirculation as required by Public Resources Code Section 21092.1, the lead agency shall send a notice of recirculation to every agency, person, or organization that commented on the prior EIR. The notice shall indicate, at a minimum, whether new comments may be submitted only on the recirculated portions of the EIR or on the entire EIR in order to be considered by the agency.

(g) When recirculating a revised EIR, either in whole or in part, the lead agency shall, in the revised EIRor by an attachment to the revised EIR, summarize the revisions made to the previously circulated draft EIR.

Authority cited: Section 21083, Public Resources Code. Reference: Section 21092.1, Public Resources Code; *Laurel Heights Improvement Association v. Regents of the University of California* (1993) 6 Cal.4th 1112.

On Jan 10, 2020, at 8:06 AM, Thad Bettner <tbettner@gcid.net> wrote:

Thank you! I think we should still plan to meet with them and make sure they aren't again going to change their position, especially if we recirculate a new document.

Not sure if staff met with Jessica or some of the Stewardship Board but maybe something to add to the list on some outreach.

Thaddeus L Bettner
Glenn-Colusa Irrigation District
PO Box 150
Willows, CA 95988
530.934.8881 (office)
530.588.3450 (cell)
<image003.png>

From: Laurie Warner Herson [mailto:laurie.warner.herson@phenixenv.com]
Sent: Thursday, January 9, 2020 5:04 PM
To: Thad Bettner
Cc: Alicia Forsythe
Subject: RE: Sites - Delta Consistency Determination

Please see that attached DEIR/EIS comment letters from the Delta Stewardship Council. The May 2018 letter states that:

...Council staff believe that the Project does not meet the definition of a covered action, as the construction and ongoing operation of
improvements at the Sites Reservoir would be located upstream from the Delta, outside the legal Delta boundary (See Water Code section 85057.5.).

From: Laurie Warner Herson
Sent: Thursday, January 9, 2020 4:49 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Cc: Thad Bettner (tbettner@gcid.net) <tbettner@gcid.net>
Subject: Re: Sites - Delta Consistency Determination

Yes, I'll pull the letters and send them to Thad. You are correct that they sent a second letter superseding the first and stated that there was no need for a consistency determination.

On Jan 9, 2020, at 4:24 PM, Alicia Forsythe <aforsythe@sitesproject.org> wrote:

Laurie - Thad and I were talking the other day and the question of needing a Delta Plan Consistency determination came up. My recollection is that they sent us 2 comment letters on the Draft EIR/EIS — one they said we'd need a consistency determination and then a second one that said in fact, we did not need one. I haven't had a chance to dig these out and refresh my memory. Can you shed some light on this for Thad and I? And can you also send the letters to Thad? Thank you!!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

File Provided Natively

File Provided Natively

Sites

January 15, 2020

Mr. Rex Bohn, Chairman
Board of Supervisors
County of Humboldt
825 5th Street, Suite 111
Eureka, CA 95501-1153

Subject: Request to Protect Humboldt County's Trinity River Interests from Adverse Impacts that may be Caused by Sites Reservoir Project

Dear Chairman Bohn:

Thank you for your letter of December 17, 2019 and for the opportunity for Alicia Forsythe of the Sites Project Authority (Authority) to come speak at your December 10, 2019 Board of Supervisors meeting.

The Authority remains committed to the assurances that we provided in our January 15, 2018 letter – the construction and operation of the Sites Reservoir Project will result in no additional demands for diversions of Trinity River water to the Sacramento River Basin or otherwise adversely affect the Trinity River. We remain committed to continue working with Humboldt County to address your concerns as the Project's facilities and operations are refined. Ms. Forsythe, Sites Project Authority Environmental Planning and Permitting Manager, will contact you to determine how best to move forward with this effort.

The Sites Project Authority, as the California Environmental Quality Act (CEQA) State lead agency, and the Bureau of Reclamation (Reclamation), as the National Environmental Policy Act (NEPA) Federal lead agency, have prepared the Sites Reservoir Project Draft Environmental Impact Report / Environmental Impact Statement (Draft EIR/EIS) to address the environmental effects of the Sites Project, including the No-Action Alternative and four action alternatives. The Draft EIR/EIS was made available for a 154-day public review and comment period, from August 14, 2017 to January 15, 2018. In your recent letter, you identify a January 21, 2019 report prepared by Kamman Engineering and Hydrology in which Mr. Kamman identifies two concerns affecting the Trinity River based on information and analyses in the Project's Draft EIR/EIS. We are reviewing the Kamman Report in detail and will consider your December 17, 2019 letter, as well as the January 21, 2019 Kamman Engineering and Hydrology Report, as a comment to the Site Project's Draft EIR/EIS and respond to both in detail in the Final EIR/EIS.

P.O. Box 517
Maxwell, CA 95955
530.438.2309

Sites

We appreciate the continued support from the Humboldt County Board of Supervisors and are committed to working collaboratively to resolve your concerns.

Sincerely,

Fritz Durst

Fritz Durst, Chair

cc: Senator Dianne Feinstein
Senator Kamala Harris
Congressman Jared Huffman
Congressman John Garamendi
Congressman Doug LaMalfa
Senator Mike McGuire
Trinity County Board of Supervisors
Karuk Tribal Council
Hoopa Valley Tribal Council
Yurok Tribal Council
California Water Commission
Charles Bonham, California Department of Fish and Wildlife
Karla Nemeth, California Department of Water Resources
Ernest Conant, Bureau of Reclamation

P.O. Box 517
Maxwell, CA 95955
530.438.2309

Ad Hoc Environmental Work Group Agenda - DRAFT

Sites Program Management Team

Date: January 29, 2020 **Location:** Dial in: 866-583-7984; 1977661#
ICF -

Time: 1:00 PM to 5:00 PM

Leader:	Thad Bettner	**Recorder:**	HDR – Sites Integration

Purpose: Re-initiation of the Environmental Work Group for 2020

Attendees:

Thad Bettner, GCID	Randall Neudeck, MWD	Ali Forsythe, Sites Authority
Mike Azevedo, Colusa Co.	Dan Ruiz, Westside WD	Laurie Warner Herson, Sites Integration
Robert Cheng, CVWD	Jeff Sutton, TC-4	John Spranza, Sites Integration
Jeff Davis, SGPWA	Bill Vanderwaal, RD 108	Linda Fisher, Sites Integration
Rob Kunde, WR-M WSD	Ben Barker, PCWA	Jelica Arsenijevic, Sites Integration
Eric Leitterman, SCVWD	Heather Dyer, SBVMWD	

Agenda:

Discussion Topic	Topic Leader	Time Allotted
1. Introductions	Thad/Ali	5 min
2. Current Status		
a. Work completed as of October 2019	Ali/Laurie/John	20 min
b. Additional activities to date	Ali/Laurie/John/	20 min
i. CDFW update	Ali/Thad	10 min
c. Value Planning	Ali	30 min
d. Reclamation Status and Updates	Ali	10 min
3. Restart		
a. Project Approach		
i. Project Description Development	XX	20 min
ii. Operations Criteria	XX	20 min
b. Permitting Focus	XX	30 min
c. CEQA/NEPA		
i. Recirculation	XX	20 min

ii. Joint Documentation vs. Separate Documentation	XX	10 min
4. Upcoming Work and Priorities	XX	20 min
5. Schedule next meeting	XX	5 min
6. Action Item Review	All	5 min

From: Frederiksen, Lee E. [Lee.Frederiksen@hdrinc.com]
Sent: 1/13/2020 3:02:16 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: FW: Stony Creek Diversion

Lee Frederiksen, PE
D 916.817.4883 M 916.213.0569

hdrinc.com/follow-us

From: Herrin, Jeff [mailto:jeff.herrin@aecom.com]
Sent: Monday, January 13, 2020 2:00 PM
To: Spranza, John <John.Spranza@hdrinc.com>
Cc: Frederiksen, Lee E. <Lee.Frederiksen@hdrinc.com>; Rude, Pete/RDD (Pete.Rude@jacobs.com) <Pete.Rude@jacobs.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: Stony Creek Diversion

John,

After you left the call this morning, Pete noted that there are likely to be greater fishery concerns for diverting into the GCID Main Canal because it is much further downstream from Black Butte Reservoir/closer to the river. We would potentially impact fish in between the T-C Canal and GCID Main Canal with this alternative.

Jeff Herrin
Water Resources Planner, Water Business Unit, Sacramento, CA
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From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 1/14/2020 6:33:09 AM
To: Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]; Alicia Forsythe [aforsythe@sitesproject.org]; Laurie Warner Herson [laurie.warner.herson@phenixenv.com]
Subject: RE: Value Planning - CDFW Discussion with Ian

Great info. Thanks Jelica.

John Spranza

D 916.679.8858 M 818.640.2487

From: Arsenijevic, Jelica
Sent: Monday, January 13, 2020 3:12 PM
To: Alicia Forsythe <aforsythe@sitesproject.org>; Spranza, John <John.Spranza@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: Value Planning - CDFW Discussion with Ian

Hey there
Spoke to Ian Boyd on Friday.

From his "terrestrial" perspective, CDFW mentioned the following concerns or things we should keep in mind:

- Riparian habitat – maintaining the habitat
- Foothill yellow legged frogs (but we discussed that this is way downstream of suitable habitat)
- Western pond turtle – recognizes not a listed species…but is a species of concern.
- Coordination with stakeholders (adjacent property owners, mitigation bank, etc.) regarding potential flows into basin drain, river, etc.
- GGS (especially in CBD) – will increase in flow into drain benefit GGS.

He did recommend that questions related to water quality etc. , flows into the Sacramento River should be followed up with CDFW fisheries staff

Please note that Ian has transferred into the Timberlands division. He will continue supporting us on an interim basis until they find a replacement for his position.

Thanks

Jelica Arsenijevic
Environmental Project Manager

HDR
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833
D 916-679-8854
M 209-329-6897

Jelica.Arsenijevic@hdrinc.com

From: Spranza, John [John.Spranza@hdrinc.com]
Sent: 1/14/2020 8:03:42 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: FW: Stony Creek Diversion

May be more complicated than we thought. We will run this to ground.

John Spranza

D 916.679.8858 M 818.640.2487

From: Spranza, John
Sent: Tuesday, January 14, 2020 8:02 AM
To: 'Rude, Pete/RDD' <Pete.Rude@jacobs.com>; Herrin, Jeff <jeff.herrin@aecom.com>
Cc: Frederiksen, Lee E. <Lee.Frederiksen@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Arsenijevic, Jelica <Jelica.Arsenijevic@hdrinc.com>
Subject: RE: Stony Creek Diversion

That is a solid point, I'm not sure we broached the inflatable dam questions with them. I will not be on the trip today but Jelica will be there and it would be good for you two to talk this over.

Was there a previous project that included an inflatable on Stoney? I'm wondering about the history here.

John Spranza

D 916.679.8858 M 818.640.2487

From: Rude, Pete/RDD [mailto:Pete.Rude@jacobs.com]
Sent: Tuesday, January 14, 2020 7:27 AM
To: Spranza, John <John.Spranza@hdrinc.com>; Herrin, Jeff <jeff.herrin@aecom.com>
Cc: Frederiksen, Lee E. <Lee.Frederiksen@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Arsenijevic, Jelica <Jelica.Arsenijevic@hdrinc.com>
Subject: RE: Stony Creek Diversion

Hi John - Glad you are talking to NMFS and CDFW. The concern is impacts during construction within Stoney Creek and if you were going to put in an inflatable dam in the Creek. They will raise concerns. We can discuss today if you are on the field trip or later.

Peter H. Rude, PE (*CA, HI, CO*) /Jacobs/ Civil Engineer & Principal Project Manager
1-530-229-3396 (office)/ 1-530-917-4164 (mobile)/ 2525 Airpark Drive, Redding, CA 96001
pete.rude@jacobs.com / www.jacobs.com

From: Spranza, John <John.Spranza@hdrinc.com>
Sent: Tuesday, January 14, 2020 6:25 AM
To: Rude, Pete/RDD <Pete.Rude@jacobs.com>; Herrin, Jeff <jeff.herrin@aecom.com>
Cc: Frederiksen, Lee E. <Lee.Frederiksen@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>; Arsenijevic, Jelica <Jelica.Arsenijevic@hdrinc.com>
Subject: [EXTERNAL] RE: Stony Creek Diversion

Hi Pete,

Thanks for the heads up on this. We have been speaking with both NMFS and CDFW about Stoney and as we would be taking winter flood flows they did not raise any significant concerns that would kill the alternative. The creek is listed in the 2004 salmonid recovery plan and there is a request in there for summer flow augmentation for steelhead habitat but we would not be affecting that. So, I'm just not seeing what I expected would be a substantial issue with the agencies as of yet.

If you have any specific items that have come up before I would be very interested to hear them though.
Thanks.

John

John Spranza

D 916.679.8858 M 818.640.2487

From: Rude, Pete/RDD [mailto:Pete.Rude@jacobs.com]
Sent: Monday, January 13, 2020 3:19 PM
To: Herrin, Jeff <jeff.herrin@aecom.com>; Spranza, John <John.Spranza@hdrinc.com>
Cc: Frederiksen, Lee E. <Lee.Frederiksen@hdrinc.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: RE: Stony Creek Diversion

Hi John,

You may already know this but, Just some quick geography for folks. The GCID canal siphons under Stoney Creek 3 miles upstream of the Sacramento River Main stem. The TCCA canal siphons under Stoney Creek 13 miles upstream of the Sac River Main Stem. Black Butte Dam is 25 miles upstream of the Sac River Main Stem.

Thus the fishery impacts will be much greater at the GCID canal crossing then at the TCCA canal crossing.

Peter H. Rude, PE (*CA, HI, CO*) /Jacobs/ Civil Engineer & Principal Project Manager
1-530-229-3396 (office)/ 1-530-917-4164 (mobile)/ 2525 Airpark Drive, Redding, CA 96001
pete.rude@jacobs.com / www.jacobs.com

From: Herrin, Jeff <jeff.herrin@aecom.com>
Sent: Monday, January 13, 2020 2:00 PM
To: Spranza, John <John.Spranza@hdrinc.com>
Cc: 'Lee.Frederiksen@hdrinc.com' <Lee.Frederiksen@hdrinc.com>; Rude, Pete/RDD <Pete.Rude@jacobs.com>; Laurie Warner Herson <laurie.warner.herson@phenixenv.com>
Subject: [EXTERNAL] Stony Creek Diversion

John,

After you left the call this morning, Pete noted that there are likely to be greater fishery concerns for diverting into the GCID Main Canal because it is much further downstream from Black Butte Reservoir/closer to the river. We would potentially impact fish in between the T-C Canal and GCID Main Canal with this alternative.

Jeff Herrin
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Chair
Darren Mierau

Vice Chair
Mitch Farro

Members
Vivian Helliwell
Matt Clifford
Gayland Taylor
James Stone
Mike Orcutt
Ted Grantham

Contact:
Darren Mierau
1380 9th Street
Arcata, CA 95521

dmierau@caltrout.org

Web Site
http://fisheries.legislature.ca.gov/content/related-statutes-and-committees

January 9, 2020

Charlton H. Bonham, Director
California Department of Fish and Wildlife
1416 Ninth St., 12th Floor
Sacramento, CA 95814

VIA ELECTRONIC TRANSMISSION

Subject: Concerns with Sites Reservoir Salmon Impacts and Accelerated Approvals/Permitting Called for In Draft Water Resilience Portfolio

Dear Chuck;

The California Advisory Committee on Salmon and Steelhead is tasked with advising you, the director of the California Department of Fish and Wildlife, in preparing and maintaining "a comprehensive program for the protection and increase of salmon, steelhead trout, and anadromous fisheries" in California.[1]

In our capacity as your advisor, we are expressing to you our concerns about the proposed Sites Reservoir's potential impacts to salmon and steelhead in the Sacramento River and Delta. We recommend that you request preparation of a Supplemental/Recirculated Draft EIS/EIR for the project. Additionally, we recommend that you oppose accelerated approvals and permitting for Sites Reservoir that have been identified in the Draft Water Resilience Portfolio.

Furthermore, we recommend that you oppose any efforts to reduce minimum instream flow requirements in the Sacramento River below what has been recommended by your agency in 2016- 15,000 cfs. The Sites Project Authority is requesting minimum instream flows of 5,000 cfs at Wilkins Slough, much less than your agency's recommendations and much less than environmental coalition recommendations that no diversions be allowed until there are flows as high as 35,000 cfs at Freeport (see Attachment 1).

The Sites Reservoir, while billed as using "surplus" water from wet years to be used in drier years, was modeled in the Draft EIS/EIR to take minimum instream flows in the Sacramento River well below safe levels for downstream aquatic resources (3,250 cfs at Red Bluff, 4,000 cfs at Hamilton City and 5,000 cfs at Wilkins Slough). An analysis by Kamman Hydrology found that the Sites DEIS/EIR modeling includes significant changes in the timing of diversions from the Trinity River that would increase Trinity River temperatures during critical spawning periods in the fall, while also not

1 California Fish and Game Code § 6920 (2008)

accounting for a water contract with Humboldt County and a federal record of Decision to release Trinity River water for Lower Klamath River fisheries (see Attachment 2). Furthermore, the attached March 17, 2019 Coalition letter (Attachment 3) identifies 38 issues that are inadequately addressed in the Sites Draft EIS/EIR, necessitating a recirculated/supplemental DEIS/EIR.[2] These are issues that cannot be remedied in a final EIS/EIR- a recirculated draft is required.

The need for a recirculated DEIS/EIR for Sites is in stark contrast to the Draft Water Resilience Portfolio that contains statements on pages 19 and 35:

"Accelerate state permitting and approvals of projects selected under the Water Storage Investment Program (Proposition 1) so that they are ready to go; for example, advance the largest off-stream reservoir in the suite of projects – Sites Reservoir – in a manner that protects and enhances fish and wildlife and water reliability."

We fail to see how accelerated permitting and approvals of Sites will provide for protection and enhancement of fish and wildlife and water quality. To the contrary, a recirculated/supplemental DEIS/EIR is necessary to protect public trust resources such as salmon and steelhead.

The Sites Project Authority has already misrepresented benefits to the Sacramento River salmon that were debunked by your staff at CDFW, and as a result the California Water Commission (CWC) removed salmon benefits from public funding under Proposition 1. The Sites Project Authority is in the process of downsizing the project and has yet failed to provide a viable operations plan. Nonetheless, Sites has received approval for over $816 million in public funding from the CWC for benefits to wildlife refuges and Delta smelt, with nearly $41 million being provided up front.
The California Advisory Committee believes that the public funding benefits are based on providing a volume of water that will impair salmon and steelhead in the Sacramento River. Our committee does not believe that it is a wise use of public funds to diminish a public trust asset (salmon), regardless of the other benefits (refuges and Delta smelt) claimed by the proponents. Your Department's mission is to ensure that this does not happen as a result of a truncated permitting process and reducing minimum instream flow requirements.

---

§ 6920. Preparation and maintenance of program; Consultation with public agencies
(a) The department shall, with the advice of the Advisory Committee on Salmon and Steelhead Trout and the Commercial Salmon Trollers Advisory Committee, prepare and maintain a detailed and comprehensive program for the protection and increase of salmon, steelhead trout, and anadromous fisheries.

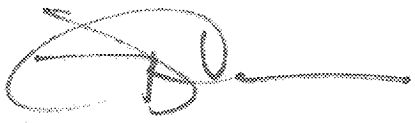
[2] The 38 issues in the March 17, 2019 Environmental/Fisheries Coalition letter include: Foreseeable Impacts to Trinity River Water Temperature Objectives Associated with Sites Project Operations Need to be Evaluated with an Accurate Temperature Model, Foreseeable Impacts to Trinity River Associated with Trinity Lake Carryover Storage, Inaccurate Existing (Baseline) TRD Water Operations, Incomplete Cumulative Impact Assessment Pertaining to TRD Operations, Mitigation for Trinity/Lower Klamath Impacts, Narrow Scope of Alternatives, No Action Alternative and Existing Conditions, Sites Project Water Rights and Potential Unforeseen/Undisclosed Impacts, Cumulative Impacts,

In conclusion, we urge you to consider the following:

- Recommend that the Sites Project Authority and the Bureau of Reclamation prepare a supplemental/recirculated DEIS/EIR for Sites Reservoir
- Oppose language in the draft Water Resiliency Portfolio to accelerate permitting and approvals for Sites
- Stand firm with your agency staff recommendation to oppose Sacramento River minimum instream bypass flows of less than 15,000 cfs per CDFW's 2016 recommendation.

Thank you for considering these recommendations.

Sincerely,



Darren Mierau
Chair, CACSST

Attachments:

1. Sites Reservoir Criteria For An Environmentally Responsible Project
2. Kamman Hydrology Report on Sites Reservoir
3. March 17, 2019 Coalition Letter Requesting Supplemental/Recirculated Sites DEIS/EIR

cc:
Governor Newsom
Resources Secretary Wade Crowfoot
CalEPA Secretary Jared Blumenfeld
Senator Mike McGuire
Senator Toni B. Atkins

Sites Reservoir Operating Procedures/Priorities Absent, Tribal Consultation and Mitigation Absent, Compliance with California Endangered Species Act (CESA), Hydropower Licensing, Environmental Baseline/Modeling, Bypass Flows and Diversion Rates, Reduced Delta Outflows and impacts on Delta Smelt and Other Important Bay-Delta Species, Delta and Longfin Smelt Impacts due to Old and Middle River Reverse Flows, Sacramento River Flow and Temperature Modeling, Sacramento River Temperature Effects, Impacts to Floodplain Habitat, Evaluation of Fishery Impacts Lacking, Water Quality – Toxic Metals, Methylmercury, Noxious Algal Blooms, Water Quality – Salinity, Geomorphology, Entrainment Losses of Native Fish, Fish Screens, Impacts on Funks and Stone Corral creeks, Reservoir Fishery Impacts from Pumping Plant Operation, Recreation, Wildlife Mitigation Actions, Need for a Natural Community Conservation Plan (NCCP), Nesting Birds, Giant Garter Snake, Botanical Surveys and Botanical Resources Mitigation.

Senator Jerry Hill
Senator Jim Nielsen
Assembly Member Mark Stone
Assembly Member Megan Dahle
Assembly Member Monique Limón
Assembly Member Philip Y. Ting
Joe Yun, Executive Officer California Water Commission
Fritz Durst, Chairman Sites Project Authority

Sites

January 15, 2020

Mr. Rex Bohn, Chairman
Board of Supervisors
County of Humboldt
825 5th Street, Suite 111
Eureka, CA 95501-1153

Subject: Request to Protect Humboldt County's Trinity River Interests from Adverse Impacts that may be Caused by Sites Reservoir Project

Dear Chairman Bohn:

Thank you for your letter of December 17, 2019 and for the opportunity for Alicia Forsythe of the Sites Project Authority (Authority) to come speak at your December 10, 2019 Board of Supervisors meeting.

The Authority remains committed to the assurances that we provided in our January 15, 2018 letter – the construction and operation of the Sites Reservoir Project will result in no additional demands for diversions of Trinity River water to the Sacramento River Basin or otherwise adversely affect the Trinity River. We remain committed to continue working with Humboldt County to address your concerns as the Project's facilities and operations are refined. Ms. Forsythe, Sites Project Authority Environmental Planning and Permitting Manager, will contact you to determine how best to move forward with this effort.

The Sites Project Authority, as the California Environmental Quality Act (CEQA) State lead agency, and the Bureau of Reclamation (Reclamation), as the National Environmental Policy Act (NEPA) Federal lead agency, have prepared the Sites Reservoir Project Draft Environmental Impact Report / Environmental Impact Statement (Draft EIR/EIS) to address the environmental effects of the Sites Project, including the No-Action Alternative and four action alternatives. The Draft EIR/EIS was made available for a 154-day public review and comment period, from August 14, 2017 to January 15, 2018. In your recent letter, you identify a January 21, 2019 report prepared by Kamman Engineering and Hydrology in which Mr. Kamman identifies two concerns affecting the Trinity River based on information and analyses in the Project's Draft EIR/EIS. We are reviewing the Kamman Report in detail and will consider your December 17, 2019 letter, as well as the January 21, 2019 Kamman Engineering and Hydrology Report, as a comment to the Site Project's Draft EIR/EIS and respond to both in detail in the Final EIR/EIS.

P.O. Box 517
Maxwell, CA 95955
530.438.2309

Sites

We appreciate the continued support from the Humboldt County Board of Supervisors and are committed to working collaboratively to resolve your concerns.

Sincerely,

Fritz Durst

Fritz Durst, Chair

cc: Senator Dianne Feinstein
Senator Kamala Harris
Congressman Jared Huffman
Congressman John Garamendi
Congressman Doug LaMalfa
Senator Mike McGuire
Trinity County Board of Supervisors
Karuk Tribal Council
Hoopa Valley Tribal Council
Yurok Tribal Council
California Water Commission
Charles Bonham, California Department of Fish and Wildlife
Karla Nemeth, California Department of Water Resources
Ernest Conant, Bureau of Reclamation

P.O. Box 517
Maxwell, CA 95955
530.438.2309

BOARD OF SUPERVISORS
COUNTY OF HUMBOLDT
825 5th Street, Suite 111, Eureka, CA 95501-1153
Telephone (707) 476-2390 Fax (707) 445-7299

RECEIVED
DEC 17 2019
SITES PROJECT AUTHORIT

Fritz Durst, Chairman
Sites Project Authority
P.O. Box 517
Maxwell, CA 95955

Subject: Request to Protect Humboldt County's Trinity River Interests from Adverse Impacts caused by the Sites Reservoir Project

Dear Chairman Durst:

In a letter dated January 9, 2018, the Humboldt County Board of Supervisors expressed conditional support for the proposed Sites Reservoir Project, if robust and binding assurances are provided that:

1. Construction and operation of the Sites Reservoir Project will result in no additional demands for diversions of Trinity River water to the Sacramento Basin, and

2. The Sites Project Authority and the Bureau of Reclamation will work with Humboldt County and other Trinity River stakeholders to identify opportunities to reduce out-of-basin transfers of Trinity River water as part of the coordinated operations of the Central Valley Project and the future Sites Reservoir Project.

You replied with a letter (dated January 15, 2018) to the chair of the Board of Supervisors in which you asserted that no Trinity River water would be diverted into Sites Reservoir and therefore no additional demands on the Trinity River would occur as a result of the project. However, we find that this letter is not sufficiently robust and binding.

Subsequently, we are in receipt of the January 21, 2019 report by Kamman Engineering and Hydrology in which two significant impacts affecting the Trinity River were identified within the Sites Reservoir Project Draft Environmental Impact Report/Environmental Impact Statement ("Draft EIR/EIS") as follows:

1. The surface water modeling does not include an accounting of Humboldt County's 1959 water contract with the Bureau of Reclamation for annual releases of not less than 50,000 acre-feet of Trinity River water, nor does it include the anticipated flow releases described in the Bureau of Reclamation's Long-Term to Protect Adult Salmon in the Lower Klamath River (2017 Record of Decision), and

2. The surface water modeling identifies a significant change in the pattern of Trinity River exports to the Sacramento River from fall to spring in some water year types, thereby increasing residence time of water in Lewiston Reservoir and increasing Trinity River water temperatures. This change would likely violate North Coast Basin Plan Trinity River temperature objectives and SWRCB Water Right Order 90-05; however, the document fails to disclose the increased potential for temperature violations.

It is our understanding that Sites Project Authority representatives have stated that the temperature modeling results have limited accuracy due to the methods and assumptions; however, we are not reassured. Although your letter assured us that no harm would be caused to the Trinity River, we are concerned that the modeling results published in your Draft EIR/EIS show that the operations of the Sites Project would likely cause irreversible harm to migrating salmon and the document does not discuss alternatives or mitigations to address these impacts.

Based on the findings by Kamman Hydrology and the lack of robust and binding assurances, we specifically request that a water right term and condition be placed on the water rights application for the Sites Reservoir Project as follows:

"Trinity River water shall not be used to fill Sites Reservoir unless the Trinity River Division of the Central Valley Project is releasing water as a result of storage conditions requiring "Safety of Dams" releases beyond normal operating plans and concurrently when Shasta Reservoir is making flood control releases. Furthermore, Humboldt County's 1959 water contract with the Bureau of Reclamation, Trinity River Record of Decision (ROD) flows, and releases to implement the Bureau of Reclamation's Long-Term Plan to Project Adult Salmon in the Lower Klamath River shall not be reduced or negatively impacted in any way as a result of any Sites Reservoir decisions, modeling, operational plans, and water rights petitions."

Alternatively, we would consider entering into a Memorandum of Understanding with the Bureau of Reclamation and Sites Project Authority with clearly defined obligations and commitments to ensure that Humboldt County's 1959 water contract with the Bureau of Reclamation and our interests in the Trinity River are sufficiently protected.

We request a response by January 15, 2020, after which we will consider whether to withdraw our conditional support for the proposed Sites Reservoir Project.

Sincerely,

Rex Bohn, Chairman
Humboldt County Board of Supervisors

cc: Senator Dianne Feinstein
Senator Kamala Harris
Congressman Jared Huffman
Congressman John Garamendi
Congressman Doug LaMalfa
Senator Mike McGuire
Trinity County Board of Supervisors
Karuk Tribal Council
Hoopa Valley Tribal Council
Yurok Tribal Council
California Water Commission
Charles Bonham, Director CA Dept. of Fish and Wildlife
Karla Nemeth, Director CA Department of Water Resources
Ernest Conant, Regional Director Bureau of Reclamation

Sites Project Reservoir Operations Work Group Conference Call:

Date/Time: Wed, Nov 6, 1:30 pm to 3:00 pm

Call-In Phone: 310-372-7549 (tentative - if it changes, a followup email will be sent)

Call-In Passcode: 661517

No RSVP is required - I have your availability from the prior polling email.

The Call will primarily be status reports. At this time, there is no written material.

Agenda:

0.5 Roll Call, Brown Act compliance, other introductions

1. Rob Leaf (Jacobs) will provide a summary of the new BiOps for Reclamation and DWR, their anticipated effect on Reclamation and DWR operations, and their potential effects on Sites future operations (to the extent this can be qualitatively estimated at this early stage). *Rob Leaf was not available.*

2. Sites staff are working on a new "chainsaw" affordability analysis for the November 15 Workshop and Nov 21 Reservoir Project Committee. Rob Tull will report on what Operations assumptions are included/not included in this analysis to date.

Tull: 2 parallel paths working (1) affordability (2) CDFW

Affordability – refining per Freeport & spring outflow, agreed to assume a range of Holthouse deliveries to provide to Brian Grubbs for financing, Grubbs now doing analysis for range of Holthouse deliv and AECom costs, under review, will bracket outcomes

CDFW – per CDFW comments re CWF criteria (now accepted by Sites), now in the weeds on modeling Freeport ops and bypass flows and NDOI, and developing interpretations thereon, challenge is apply NOD Freeport diversion to 200 miles N to Sites, much of Freeport based on fish presence which Tull is trying to convert to flow criteria

- Looking into more detailed analysis at Fremont weir, prior work found higher flow requirements from daily model vs CALSIM model, try to determine which is right, daily model probably too high, trying to coordinate with DWR on notch modeling, think CALSIM underestimates requirement
- Per Bettner, NDOS modeling was very conservative & included 6 week GCID maintenance interval, has been reduced to 2 week interval which increases diversion time interval
- Assumption is 1.5 MAF project or 1.3 MAF reservoir, no Delevan vs 1 pipe vs 2 pipe to find sensitivity
- Fremont existing weir notch for sturgeon primarily, proposed notch is a larger project in preliminary design
- Thomson: per EL ?, affordability will be if $A cost and B AF, then $/AF; we have not done some of the other models yet e.g. temperature models for Shasta & Sites
- Tull: expect to have some +/- info regarding potential yields, will also provide detailed backup on assumptions, will also provide "balance sheet" on inflows/outflows/losses

3. Rob Tull will report on the status of discussions with Reclamation regarding operational exchanges between Shasta and Sites. Such exchanges will be critical to lowering the Project Cost through the Value Planning alternatives.

- Tull: past analyses have always assumed some Shasta exchanges for enviro water with Reclamation not an investor
- these exchanges rely on Reclamation/DWR/Sites agreements, so more complex
- fundamentally, still Holthouse deliveries locally to allow Sites water exchanged into Shasta
- under this scenario, no carryover storage in Shasta
- had calls CWhite BuRec, Thomson, Bettner, Tull; BuRec seems open to idea; requires substantial codework; alternately proposed to BuRec that this analysis be based on post-processing to identify scenarios – did 8 scenarios with changes in facilities, vacate date in Shasta, other changes, and provided to BuRec 4 weeks ago, BuRec reviewed but has not responded yet due to BiOps
- in summary, concept appears viable to provide temperature benefits and flow stability and exports through Banks, based on Bettner thinking of 2014/15 holding water in Shasta for temperature control
- waiting on feedback from BuRec; after receiving same, then can start codework
- preliminary 80TAF to 180TAF into Shasta, exchange capacity avail in 1/3 of years depending on BuRec criteria
- BuRec – would have to achieve certain storage thesholds for there to be sufficient temperature benefits
- Thomson – starting to have conversations regarding water rights per request from BuRec Acting RD, barely starting on this issue
- next: have Bettner push CVO for response
- Tull: ability to exchange water into Shasta does not depend ??
- during C water years, TC will need both Sites and Shasta water and not allow exchanges
- EL: discusses differences in cost allocation if some of Delevan capacity xfr'd into Shasta
- Sutton: Shasta exchange will probably be year to year, no carryover storage

4. Rob Tull will provide a status report on updating the CALSIM code to allow analyses of Sites/Shasta exchanges. – see above

5. Rob Tull will provide a status report on 2D water quality modeling for Shasta and Sites.

- working on 2D water quality model for Sites; there are already good models for Shasta; have done testing to run 2D model outputs with daily modeling during 82 year CALSIM period; includes mixing at Holthouse (which might be obsolete)
- preliminary results are that temperatures of Sites releases would be lower than ambient Sac R temperature for Alt D; would need to modify for 1.5MAF size (easy), and changes in plumbing e.g. open channel versus pipeline; once we have a project description, can refine
- model also has other parameters of WQ, but analysis to date just for temperature – all internal so far – nothing to CDFW which has solely been diversion impacts, not release impacts
- Sutton: old timers know how warm the River was before Shasta; Thomson – RWQCB criteria is 5 deg F max for releases to Sac R
- Ali: release T have been ancillary with CDFW so far, important to NRDC

6. Rob Tull will provide a status report on preparation of an updated Operations Plan that includes written description of Modeling assumptions and (b) how Sites/Shasta exchanges may be implemented.

- Ali has produced outline of Ops Plan with RDT input, notes incorporates assumptions in Storage Policy
- Ali – outline in development for presentation to Ops WG

(Sutton insists on inclusion re

7. Rob Cooke will report on DWR interest in becoming a Sites investor.
   - Primary benefit to DWR of Sites participation is to meet X2 obligations (primarily fall) of significant volume of release capacity
   - Thomson: provides opportunity to finesse water rights issues
   - working with Deputy Director to prepare Director briefing
   - overwhelming input from SWC worth further discussion
   - guesses 100TAF at 2.5% of SWP would be a target to release from Sites in lieu of Oroville to meet WQ requirements
   - open question whether DWR would manage any indiv SWC Sites water
   - Sutton likes the idea. Lends itself to good conversation

8. Rob K – status of delivery pattern polling for storage/release ratios
   - Tull hoping for no indiv accounts in Sites, wants groupings e.g. Table A pattern (which was sent to Rob K), take water anytime export capacity was available, and a hybrid
   - Sac V info still in development

9. Rob K – need for call regarding Shasta Exchange operational scenarios
   Thomson outline of Shasta exchange to SWC Participants
   Thomson, Tull, Forsythe, Cooke, Johns, Kunde, Ruiz, 1 Sac Valley per Ruiz, 1 SWC per Kunde
   - need for meeting DWR/Jacobs re SOD modeling assumptions

10. Thomson/Forsythe – additional comments - none

From: Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]
Sent: 1/16/2020 1:42:10 PM
To: Heydinger, Erin [Erin.Heydinger@hdrinc.com]; Spranza, John [John.Spranza@hdrinc.com]
CC: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Stony Creek BiOp
Attachments: final revised Stony Creek BO-GC edits- FINAL.PDF

Hey Erin
The BiOp acknowledges that TCC was diverting from Stony Creek (see PDF page 12/83).

There is this paragraph that includes some discussion of quantity:

PDF Page 12/83
Tehama Colusa Canal/Constant Head Orifice
Since 1993, the CHO has been used in reverse to divert stored CVP water released from Black Butte Lake into the TCC when RBDD is not operating. Daily diversions at the CHO have averaged approximately 180 cfs when taken, between 1993 and 2000. Although never rated for a maximum capacity, the CHO diversions have at times been as high as 685 cfs. Rediversion operations involve the construction of a gravel berm upstream of the TCC/CHO to direct water into the canal. The berm construction/rediversion operations have been conducted under informal consultations with NMFS since 1993. Bypass culverts are installed to allow a minimum of 40 cfs down Stony Creek during rediversion, as required by the State Water Resources Control Board (SWRCB) permit. Reclamation proposes to continue annual rediversions of CVP stored water from Black Butte Lake, as described above, until a long-term solution to fish passage and water delivery limitations at RBDD is reached.

PDF Page 13/83
State Water Resources Control Board Permit
According to SWRCB permit #13776, the TCCA can only receive CVP water during the operation season of April 1 through May 15 and September 15 through October 29, for an annual maximum of 38,293 acre-feet. Other flow constraints include (1) maintaining a continuous bypass flow of not less than 40 cfs immediately downstream of the CHO when rediverting water, (2) ramping stream flows down at a rate of no more than 30 percent per hour or 50 cfs, whichever is greater, and (3) providing a fish distribution flow of not less than 100 cfs for a period of 24 hours prior to rediversion. The intended purpose of this distribution flow is to flush juvenile fish out of the area above the CHO so that they will not become entrained into the diversion.

See PDF page 34/83 for a description of hydrologic conditions and flood releases from Black Butte.

Let me know if this helps.
Jelica Arsenijevic
D 916-679-8854
M 209-329-6897

hdrinc.com/follow-us

From: Heydinger, Erin
Sent: Thursday, January 16, 2020 1:03 PM

To: Arsenijevic, Jelica <Jelica.Arsenijevic@hdrinc.com>; Spranza, John <John.Spranza@hdrinc.com>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: Stony Creek BiOp

Hi Jelica and John,

At our meeting with Jacobs yesterday, modeling Stony Creek came up. I believe you two have the Stony Creek BiOp – do you know if there is anything in there that suggests what bypass flow would be reasonable to assume for modeling purposes?

Thanks!
Erin

Erin Heydinger, PE, PMP
Asst. Project Manager
Water/Wastewater

HDR
2379 Gateway Oaks Dr, #200
Sacramento, CA 95833
D 916.679.8863 M 651.307.9758

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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

JUN 20 2008

In response refer to:
2007/08985

Mr. Brian Person
Area Manager
Bureau of Reclamation
Northern California Area Office
16349 Shasta Dam Blvd.
Shasta Lake, California 96019-8400

Colonel Chapman
District Engineer, Sacramento District
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Dear Mr. Person and Colonel Chapman:

Please find enclosed NOAA's National Marine Fisheries Service's (NMFS) final biological opinion concerning the effects of lower Stony Creek water management operations on the endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), the Central Valley steelhead (*O. mykiss*), and the designated critical habitats for Central Valley spring-run Chinook salmon and Central Valley steelhead.

The final biological opinion concludes that the proposed action is not likely to jeopardize the continued existence of the above-listed species, nor will it result in the adverse modification of their respective designated critical habitats. Because NMFS believes there is the likelihood of incidental take of listed species as a result of the proposed water management operations, an incidental take statement also is attached to the biological opinion. This take statement includes reasonable and prudent measures that NMFS believes are necessary and appropriate to avoid, minimize, or monitor project impacts. Terms and conditions to implement the reasonable and prudent measures are presented in the take statement and must be adhered to in order for take incidental to this project to be authorized.

We appreciate your continued cooperation in the conservation of listed species and their habitat, and look forward to working with you and your staff in the future. If you have any questions regarding this document, please contact Mr. Michael Tucker in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814. Mr. Tucker may be reached by telephone at (916) 930-3604 or by Fax at (916) 930-3629.

Sincerely,

Russell M Strach

for Rodney R. McInnis
Regional Administrator

cc: Copy to file: ARN151422SWR2000SA5904
NMFS-PRD, Long Beach, CA

Enclosure 1

BIOLOGICAL OPINION

Agencies: U.S. Bureau of Reclamation and U.S. Army Corps of Engineers

Activity: Lower Stony Creek Water Management

Consultation Conducted By: Southwest Region, NOAA's National Marine Fisheries Service (TN 2000/1910)

Date Issued: JUN 2 0 2008

I. CONSULTATION HISTORY

From March 2000 through March 2002, the U.S. Bureau of Reclamation (Reclamation) and the U.S. Army Corps of Engineers (Corps) conducted informal and eventually formal consultation with NOAA's National Marine Service (NMFS) concerning the two agencies' integrated water management operations on lower Stony Creek in Glenn and Tehama Counties, California.

On March 11, 2002, a final biological opinion (BO) was issued to Reclamation and the Corps by NMFS concerning these operations. An expiration date was established for the 2002 BO such that the total time period covered under that BO was not to exceed 3 years from the date of its issuance. The time limit was established because several important studies were underway which were expected to provide extensive new information on the environmental impacts associated with lower Stony Creek water management operations and the potential methods to address those impacts. The research work included a fisheries monitoring and habitat evaluation study on lower Stony Creek, a Northside Diversion Dam barrier analysis, a fish passage/water supply study at Red Bluff Diversion Dam (RBDD), a Stony Creek watershed water supply analysis, and two feasibility studies on the potential rehabilitation of the Orland Project distribution system. Aside from the fish passage/water supply study at Red Bluff Diversion Dam, which has been postponed indefinitely, all of these studies and analyses have now been completed.

In a letter dated February 28, 2005, Reclamation requested reinitiation of formal consultation on the integrated water management operations conducted by Reclamation and the Corps on lower Stony Creek. In a subsequent letter dated March 9, 2005, Reclamation requested that the time period covered by the 2002 BO be extended until the new consultation and BO could be completed.

NMFS replied to Reclamation's February 28, 2005, letter on April 5, 2005, stating that additional information concerning the proposed operations' impacts on listed species and critical habitat would be required prior to reinitiation of formal consultation. In a

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subsequent letter dated April 11, 2005, NMFS replied to Reclamation's March 9, 2005, request for a time extension on the 2002 BO with an amendment extending the BO through March 11, 2006.

Reclamation provided additional information on the project, and in a letter dated August 5, 2005, again requested reinitiation of formal consultation. Since that time additional information on the current project description has been requested by NMFS and provided by Reclamation and the Corps, with the most recent submission provided via e-mail on February 15, 2006.

In a letter dated March 9, 2006, NMFS confirmed that all information necessary to complete an updated, comprehensive analysis of the effects of the proposed project on listed salmonids had been received. In this letter, NMFS also extended the time period covered by the 2002 BO through May 30, 2006. A second letter, dated October 5, 2006, again extended the time period covered by the 2002 BO through January 31, 2007. A third letter, dated April 2, 2007, again extended the time period covered by the 2002 BO through November 30, 2007.

NMFS issued a final draft BO to Reclamation and the Corps on January 29, 2007. Comments and proposed edits were received back from Reclamation and the Corps over a period of several months, with the final comments received on January 31, 2008. NMFS responded to those comments and has now issued this final BO.

II. DESCRIPTION OF THE PROPOSED ACTION

Reclamation and the Corps are proposing to continue to manage the water resources of the Stony Creek watershed by controlling the release of flows from Black Butte Lake (in coordination with upstream reservoir operations) for the purposes of flood control, water delivery for agricultural use, recreation, and natural resource management.

A. Delineation and Description of the Action Area

The projects and specific facilities associated with Stony Creek water management operations include the Orland Project (East Park Dam and Reservoir; Stony Gorge Dam and Reservoir; Rainbow Diversion Dam and East Park Feeder Canal; South Diversion Intake and South Canal; and Northside Diversion Dam (NDD) and the North Canal), Black Butte Project (Black Butte Dam, Lake and Powerplant), and the Central Valley Project (CVP) (Black Butte Lake storage; and the Tehama Colusa Canal (TCC) with associated Constant Head Orifice (CHO)).

The action area for this project includes the active stream channels and riparian corridors of Stony Creek and Little Stony Creek below Rainbow Diversion Dam and East Park Reservoir respectively. Although the listed salmonids addressed in this opinion have long been excluded from the upper watershed above Black Butte Dam, discretionary actions taken during standard operations of the impoundments and facilities in the upper

watershed have direct impacts on the timing and magnitude of flows and other habitat conditions in the lower creek. These areas must be considered as part of the action area.

B. Facilities and Operations

1. Orland Project

The Orland Project was authorized by the Secretary of the Interior on October 5, 1907, to store water for irrigation purposes. The project incorporates parts of neighboring Glenn, Tehama, and Colusa Counties. Although not officially authorized by the project, additional beneficial uses include recreation and fish and wildlife habitat enhancement. The main facilities of the Orland Project include East Park Dam and Reservoir (51,000 acre-feet storage capacity); Stony Gorge Dam and Reservoir (50,300 acre-feet storage capacity); Rainbow Diversion Dam/East Park Feeder Canal; South Diversion Intake/South Canal; and NDD/North Canal. The South and Northside Diversions supply water to almost 17 miles of canals and 139 miles of smaller lateral ditches.

a. *East Park Dam*

East Park Dam is located on Little Stony Creek in Colusa County approximately 2 miles from the confluence with Stony Creek at creek mile (CM) 62. East Park Reservoir extends 2.25 miles up Little Stony Creek and 4.5 miles up Indian Creek. Runoff from Little Stony Creek watershed provides water to the reservoir. East Park Reservoir also receives inflows from the East Park Feeder Canal which diverts water from Stony Creek at the Rainbow Diversion Dam (approximately CM 65). The East Park Feeder Canal is 7 miles long and has a design capacity of 300 cubic feet per second (cfs). The canal provides water from the main stem of Stony Creek into East Park Reservoir. Releases and spills from East Park Reservoir flow down Stony Creek 18 miles for re-storage in Stony Gorge Reservoir.

The Orland Unit Water Users Association (OUWUA) proposes to operate the East Park Dam based on demand according to the following standard operational procedures. Storage in East Park Reservoir will be maintained as close to the maximum level as possible and water levels will be kept stable until at least June 1 of each year, unless irrigation demands necessitate releases. When necessary, East Park Reservoir storage will be released for irrigation to the minimum storage of 5,000 acre-feet. In the last 16 years (1991 through 2006), East Park Reservoir has been maintained close to the maximum storage for 13 of 16 years and has consistently re-filled in the winter/spring following the draw-down years. The 1964 Exchange Agreement allows Orland Project water held in East Park Reservoir to be exchanged with CVP water stored in Black Butte Lake; releases of Orland Project water are then made from Black Butte Lake storage instead of from East Park Reservoir.

OUWUA proposes to operate the Rainbow Diversion Dam and the East Park Feeder Canal on an as-needed basis to provide supplemental water to East Park Reservoir.

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b. *Stony Gorge Dam/Reservoir*

Stony Gorge Dam is located on Stony Creek at CM 46 in Glenn County. It regulates flows along the middle reaches of Stony Creek and stores surplus water for irrigation purposes. Releases from the reservoir travel 22 to 26 miles down Stony Creek to the Orland Project's diversion points at Black Butte Dam (South Diversion Intake/South Canal) and NDD/North Canal, respectively.

OUWUA proposes to operate the Stony Gorge Dam based on demand according to the following standard operational procedures. Winter storage at Stony Gorge is restricted to 38,311 acre-feet (10 feet below the full storage capacity) in order to provide a buffer to prevent overtopping of the dam during high flow events. Operating procedures state that Stony Gorge Reservoir has no flood storage and is therefore operated to pass all high flows above the maximum winter elevation of 831 feet. Spilling above the 831-foot level continues until approximately the end of February depending upon the long-range forecast. Storage in Stony Gorge Reservoir will be maintained as close to the maximum allowable storage level as possible, unless irrigation demands necessitate releases. When necessary, Stony Gorge Reservoir storage can be released for irrigation to the minimum storage of 7,500 acre-feet. The 1964 Exchange Agreement allows Orland Project water held in Stony Gorge Reservoir to be exchanged with CVP water stored in Black Butte Lake; releases of Orland Project water are then made from Black Butte Lake storage instead of from Stony Gorge. Water left in Stony Gorge Reservoir early in the season is available for releases into lower Stony Creek later in the summer or early fall.

c. *South Diversion Intake and South Canal*

The South Diversion Intake and South Canal were built in conjunction with Black Butte Dam in 1963. Water from Black Butte Dam is released into an afterbay before it is either diverted into the South Diversion Intake structure or allowed to flow downstream into lower Stony Creek. The South Diversion Intake is located approximately 300 yards downstream of Black Butte Dam and at the southern end of the 5- to 10-acre afterbay. The water flows by gravity from the afterbay into the headworks of the South Canal. Orland Project water can originate from several sources including: (1) water released from storage directly from East Park or Stony Gorge Reservoirs, (2) water stored in East Park or Stony Gorge Reservoirs that is exchanged with CVP water stored in Black Butte Lake, or (3) water resulting from available natural inflows.

The maximum design capacity of the South Canal inlet structure is 530 cfs; however, the maximum operating capacity is 250 cfs between Black Butte Dam and Interstate 5 (I-5). Below I-5, the capacity is reduced to 200 cfs, and further reduced to 80 cfs in Lateral 40.

OUWUA proposes to operate the South Diversion Intake and South Canal based on demand for the life of the Orland Project according to the following standard operational procedures. Diversions typically will occur from March through November. Year-round operation may occur depending on water demands and weather patterns. In conjunction with the terms of the Exchange Agreement, diversions into the South Diversion Canal

may result in reductions of Black Butte Lake storage, reducing the amount of water available for release down lower Stony Creek.

d. *Northside Diversion Dam and North Canal*

NDD and North Canal were completed in 1913 and are located on lower Stony Creek approximately four miles below Black Butte Dam. NDD consists of a low concrete weir rising approximately 10 feet above the base streambed level, on top of which metal jacks and wooden flashboards are installed to impound water during the irrigation season. The weir is 375 feet long, trapezoidal, and situated on a clay base. There is an associated concrete apron on the downstream side of the weir that is approximately 20 feet wide along the entire length of the weir. The north end of the diversion dam structure contains a 36-foot-long sluiceway which contains a 12-foot-long by 6-foot-wide, electronically operated drum gate that allows water to be bypassed downstream during diversions into the North Canal. The North Canal headworks is also located on the north side of the dam and is approximately 10 feet wide with two mechanically operated metal gates placed within a concrete frame. The North Canal intake has a maximum design capacity of 150 cfs, however the maximum operating capacity is 130 cfs.

When the flashboards are placed into the diversion dam structure, water from lower Stony Creek is diverted into the North Canal headworks up to a maximum of 130 cfs with an associated minimum bypass of 30 cfs. When water is no longer needed for irrigation or when flood control criteria are triggered, the flashboards are removed to allow Black Butte Lake releases to flow downstream unimpeded. Typically, flashboards are installed in the spring and removed in the fall. However, flashboards may be installed and removed several times during the year due to major flood control releases (*e.g.*, boards were installed/removed three times in the spring of 1998 with the heavy rainfall and flows). If Black Butte Lake is in flood control stage during the irrigation season, the OUWUA is notified by Reclamation prior to major releases (>1500 cfs) and the flashboards are removed to prevent damage to the dam structure. The boards are re-installed after flood releases subside if there is continued demand for irrigation water. If the irrigation demand is 35 cfs or less, diversion can occur without installing the boards. It typically takes 4 to 5 hours to install and remove the flashboards. During placement and removal, flows in the creek must be limited to a maximum of 30 cfs for approximately 24 hours for workers to safely access flashboards.

During diversions into the North Canal, an operational bypass of 30 cfs flows into lower Stony Creek by informal agreement between Reclamation, the California Department of Fish and Game (DFG) and the OUWUA. The Orland Project is entitled to natural flow not to exceed 279 cfs (or 553 acre-feet per day) which is typically taken first if available, plus a maximum of 102,000 acre-feet per year of storage water, if available.

Reclamation retains ownership of the Orland Project facilities, however the facilities have been operated since 1954 by the OUWUA under contract #14-06-200-3502 dated August 26, 1954.

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e. *Exchange Agreement*

An Exchange Agreement (contract #14-06-200-1020A) was implemented between Reclamation and the OUWUA in 1964. This agreement allows the exchange of CVP water stored in Black Butte Lake with Orland Project water stored in Stony Gorge and East Park Reservoirs. As a result of the 1964 Exchange Agreement minimum reservoir storage was established for East Park (5,000 acre-feet to protect the fisheries), Stony Gorge Reservoir (5,000 acre-feet, subsequently amended to 7,500 acre-feet, to protect the fisheries and provide municipal water supplies to Elk Creek and water users along Stony Creek), and Black Butte Lake (20,000 acre-feet to protect the fisheries). A recent update to the Area and Capacity Table for Black Butte Lake (September 2001), showed that storage capacity behind Black Butte Dam has been lost to sedimentation. Consequently, the interim water control diagram indicates that in the event maximum storage behind Black Butte Dam is necessary, between 15 December and 5 April the minimum reservoir storage will be zero; not 20,000 acre-feet. East Park Reservoir is the most difficult of the three Stony Creek reservoirs to fill, and carryover storage left in East Park Reservoir at the end of the irrigation season normally is retained.

f. *Memorandum of Understanding (MOU)*

In 1971, Reclamation, the Corps, DFG and OUWUA entered into an MOU and set forth a document entitled "General Operating Objectives for Stony Creek Reservoirs." The objective of the MOU is to provide stable water levels during a 3 week period in late spring for the maintenance of crappie (*Pomoxis* spp.) spawning habitat in Stony Gorge Reservoir (odd years) and Black Butte Lake (even years). The guidelines state that when water surface temperatures reach 60 °F in the spring, all agencies will endeavor to limit reservoir elevation fluctuations to within plus or minus 2 feet for 3 weeks. In order to accomplish this, a water exchange is made with OUWUA to maintain the 2-foot criteria in Black Butte Lake. Under normal operating conditions, Stony Gorge Reservoir elevation in most years remains within the 2-foot criteria and requires minimal manipulation during the crappie spawning period. This MOU has subsequently been adopted and revised within the State Water Resource Control Board permit #13776 to state that the period for stable water levels be increased from 3 weeks to 4 to 5 weeks.

g. *Ongoing and Proposed Future Orland Project Operations*

OUWUA proposes to continue diversions into the North and South Canals based on water demands and to continue coordinating operations of East Park, Stony Gorge, and Black Butte Dams with Reclamation according to the 1964 Exchange Agreement and the 1971 MOU, with a minimum 30 cfs bypass below the North Canal during diversion activities. Diversions for the Orland Project typically will occur between March and November; however, diversions for irrigation purposes can occur in every month of the year, depending on weather patterns and demand. Based on past operations, annual diversions can be expected to range from 73,900 to 104,824 acre-feet per year although the only restrictions on amounts of irrigation water used are available natural flow not to

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exceed 279 cfs plus a maximum of 102,000 acre-feet per year of storage from the upper reservoirs, if available.

As described above, flashboards will be installed at NDD prior to diversion into the North Canal, and will be removed after irrigation demands no longer exist. If releases in excess of 1500 cfs are called for, Reclamation will notify the OUWUA and allow them the opportunity to remove the flashboards to protect the diversion structure, conditions permitting. For safety purposes, it is necessary to reduce flows from Black Butte Dam to 30 cfs for 24 hours during the removal of the boards. Once the boards are removed, the releases will commence. Once releases are no longer necessary, flashboards may be reinstalled if there are continued irrigation demands, requiring another 24-hour period of 30 cfs flows for reinstallation. However, it is recognized that given the uncertainty in forecasting hydrometeorological conditions, that rare instances may occur which do not allow for 24-hour notification prior to increasing releases from Black Butte Dam. In these instances the communication and coordination of releases will be increased.

2. Black Butte Project

The Corps retains ownership of the Black Butte Project facilities except for the Orland South Canal Diversion Intake. Black Butte Dam flood control operations are determined by the Corps. Reclamation determines irrigation releases during the irrigation season which typically occurs from March to November, but can occur during any month of the year. Operations of the facilities are coordinated between the Corps and Reclamation as established under P.L. 91-502 (1970). Although Black Butte Dam is owned by the Corps, authorizing legislation did not identify an agency responsible for maintaining the channel capacity of Stony Creek below Black Butte Dam.

The Corps' operations of Black Butte Dam and Lake are governed by the Stony Creek Water Control Manual which includes a Water Control Plan and a Flood Control Diagram for Black Butte Lake. These documents provide guidance on when and how to make flood control releases from Black Butte Dam. The Corps proposes to continue operating Black Butte Dam in accordance with the Water Control Plan and Flood Control Diagram as it has since 1963. The Corps is in the process of rewriting the Water Control Manual; the Water Control Plan and Flood Control Diagram are not being changed except to reformat as required by regulation to indicate the reduction in total storage that has occurred due to sedimentation and to reflect a shift in the Water Control Diagram forward 15 days (from September 1-June 15 to September 15-July 1). Corps inspections or maintenance of the outlet works or powerplant facilities will require some outlet gates to be closed, however, a minimum of 30 cfs flow will be maintained during these outages by keeping at least two gates open. Annual and 5-year inspections typically will occur during mid-November.

a. *Flood Control Diagram*

Since 1962 the Corps, Sacramento District, has operated the Black Butte Project for flood control in accordance with the Flood Control Diagram of the Water Control Manual.

Flood control reservation in Black Butte Lake increases uniformly from 0 acre-feet on September 15 to a maximum reservation of 136,200 acre-feet (gross pool) by December 15. A minimum reservation of 106,400 acre-feet is required from November 25 to February 6, Conditional flood control reservation is up to a maximum of 136,200 acre-feet from December 15 to April 5, decreasing again to zero on June 30. The required reservation is determined by use of a ground wetness index during this period.

The maximum scheduled flood control release from Black Butte Dam is 15,000 cfs depending on a release schedule that correlates peak inflow for a specific event and the percentage of the flood control storage reserve in use. The controlled capacity through the outlet works is 22,800 cfs. The rated spillway capacity (uncontrolled weir) for the dam is 76,600 cfs. Flood control operations by the Corps begin when the storage in Black Butte Lake exceeds the flood control space required at any particular time as determined by the Flood Control Diagram.

According to the Flood Control Diagram, "required gross flood control reservation in Black Butte Lake may be reduced by creditable flood control space known to exist in East Park and Stony Gorge Reservoirs. The flood control requirement in Black Butte Lake is equal to the gross flood control reservation minus the total creditable transfer space."

b. *Operations Forecasting*

The California-Nevada River Forecast Center (CNRFC) provides the Corps with both 6-hour full natural flow forecasts for the Black Butte Project and 6-day Quantitative Precipitation Forecasts (QPF). Respectively, these forecasts extend 60 and 72 hours into the future. Even though the Corps' Water Control Plan does not currently require using forecasted data to operate the projects, these forecasts are used in Corps flood control models and to operate the Black Butte project. It is the Corps's intention to formally incorporate forecasting into the Water Control Plan in the near future.

c. *Reclamation Operations*

Reclamation directs Black Butte Project operations for water conservation storage and to supply water for irrigation during the non-flood control season. The only space allocation made in Black Butte Lake for CVP operations is a 20,000 acre-feet minimum pool storage for recreation and fisheries purposes. Any rainfall and natural inflows into Black Butte Lake that are in excess of what the Orland Project uses are stored as CVP water. Available CVP water has been defined by Reclamation as excess water during the non-flood period projected to be available for use based on storage as of June 1 of each year, accounting for required water rights. Factors of evaporative losses, minimum releases, minimum pools, and conditions of the permit are accounted for in the determination of available water. The average annual yield after all accounting is approximately 56,000 to 59,000 acre-feet.

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Reclamation proposes to continue water management of the three reservoirs in coordination with the OUWUA and the TCCA when the flood season is over, and to coordinate irrigation deliveries to the TCCA during the periods of April 1 through May 15 and September 15 through October 29 when water is needed, and if there is allowable storage of CVP water in the three reservoirs. Irrigation deliveries will not exceed 38,293 acre-feet annually according to the SWRCB permit #13776 issued April1, 1996. Reclamation will continue to coordinate irrigation deliveries with the OUWUA meeting Orland Project demands when water is available.

If Black Butte Lake is not encroached, Reclamation uses ramping rates of 30 percent per hour or 50 cfs, whichever is greater, to prevent overtopping when the lake is full and to provide water deliveries in a timely fashion.

104,657 acre-feet of water is needed to meet the exchange agreement requirements, maximum irrigation demands and current minimum instream flows below Black Butte Dam. This 104,657 acre-foot amount includes:
20,000 acre-feet of minimum pool in Black Butte Lake,
12,500 acre-feet of minimum pool in East Park and Stony Gorge reservoirs,
16,364 acre-feet of the 30 cfs minimum instream flow below Black Butte Dam from April-December,
15,715 evaporation losses from April-December,
1,785 acre-feet of additional 10 cfs minimum instream flow during rediversion below the TCC (90 days maximum), and
38,293 acre-feet of CVP water (maximum) to the TCCA for irrigation deliveries.

The Orland Project also maintains a right to divert up to 279 cfs of natural inflow into Black Butte Lake from the upper basin. These requirements in Black Butte Lake for water allocation and water exchanges can stay in effect in a dry year. Water indices such as the Sacramento Valley Water Year Hydrologic Index (based on carryover storage and rainfall in Shasta Lake) are useful but not reliable in forecasting conditions on Stony Creek and, because conditions change monthly, weekly and sometimes daily in the Stony Creek watershed, forecasting has not been used by Reclamation water managers. Factors such as late storms and high inflow after April 1 can drastically change allocations which are reassessed on a daily basis. Reclamation manages all water exchanges to maximize water conservation in the upstream reservoirs in preparation for potential future drought conditions. Should conditions occur such that more than 104,657 acre-feet are present, or expected to run off into Black Butte Lake on or after April 1, and the upstream reservoirs are full, Reclamation could release greater instream flows for fishery benefits so long as such releases do not affect the Orland Project's right to divert up to 279 cfs of daily inflow.

When basin conditions are dry and storage at Black Butte is low, operational options dictate using some or all of the upstream storage using the 1964 exchange agreement. Only 12, 500 AF would be exchanged for maintaining minimum pools in East Park (5,000 AF) and Stony Gorge (7,500 AF). East Park, being the most difficult to fill, would be the last to be used. Operations would use Stony Gorge storage first, drawing it

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down to 25,000 AF, and then drawing down East Park to 23,000 AF. If demands dictate, Stony Gorge would be drawn down to the minimum pool of 7,500 AF. If demands continue, East Park could be drawn down to the minimum pool of 5,000 AF.

d. *CVP Integration*

The Black Butte Project was financially and operationally integrated with the other storage features of the CVP in 1970 (P.L. 91-502, 84 Stat. 1097). As a result, Black Butte Lake now provides the maximum practicable amount of storage for conservation of irrigation water without impairment of the flood control functions. Water conserved in Black Butte Lake is authorized to be used for irrigation purposes and to meet such domestic, municipal, and industrial demands as may occur. The estimated conservation yield of Black Butte Lake was 59,000 acre-feet. On the average, it was estimated that 10,600 acre-feet of water would be made available for use in the watershed area above Black Butte Lake and an additional 48,600 acre-feet average annual yield would be available below the dam.

Releases are determined by the needs of the downstream water users during the irrigation season through Reclamation, and by flood control parameters during the flood control season through the Corps. The major downstream water users are the OUWUA authorized through the Orland Project and the CVP contractor districts served through the CVP facilities operated by the Tehama Colusa Canal Authority (TCCA).

e. *Tehama Colusa Canal/Constant Head Orifice*

The TCC was constructed as part of the CVP facilities in 1965 for the distribution of water diverted from the Sacramento River at RBDD. The TCC and the Corning Canal, which are integral parts of the TCCA canal system, both receive their primary water supply from RBDD, and are operated and maintained by the TCCA under a long term contract with Reclamation. The TCC extends from RBDD for 111 miles through Tehama, Glenn, and Colusa Counties with its terminus in Yolo County. The originating capacity of the TCC at RBDD is 2,530 cfs, reducing to 1,700 cfs at the downstream end.

The TCC, which intersects with lower Stony Creek approximately 30 miles below RBDD, siphons water under Stony Creek. At this crossing, the CHO was constructed in 1974 to divert water from the TCC into the creek for fishery enhancement purposes, but this diversion was discontinued in 1975 when a plan to restore Stony Creek's winter-run, fall-run and steelhead spawning habitat was abandoned due to the high cost of stream channel and gravel rehabilitation as well as problems such as land acquisition and access.

Since 1993, the CHO has been used in reverse to divert stored CVP water released from Black Butte Lake into the TCC when RBDD is not operating. Daily diversions at the CHO have averaged approximately 180 cfs when taken, between 1993 and 2000. Although never rated for a maximum capacity, the CHO diversions have at times been as high as 685 cfs. Rediversion operations involve the construction of a gravel berm upstream of the TCC/CHO to direct water into the canal. The berm

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construction/rediversion operations have been conducted under informal consultations with NMFS since 1993. Bypass culverts are installed to allow a minimum of 40 cfs down Stony Creek during rediversion, as required by the State Water Resources Control Board (SWRCB) permit. Reclamation proposes to continue annual rediversions of CVP stored water from Black Butte Lake, as described above, until a long-term solution to fish passage and water delivery limitations at RBDD is reached.

f. *State Water Resources Control Board Permit*

According to SWRCB permit #13776, the TCCA can only receive CVP water during the operation season of April 1 through May 15 and September 15 through October 29, for an annual maximum of 38,293 acre-feet. Other flow constraints include (1) maintaining a continuous bypass flow of not less than 40 cfs immediately downstream of the CHO when rediverting water, (2) ramping stream flows down at a rate of no more than 30 percent per hour or 50 cfs, whichever is greater, and (3) providing a fish distribution flow of not less than 100 cfs for a period of 24 hours prior to rediversion. The intended purpose of this distribution flow is to flush juvenile fish out of the area above the CHO so that they will not become entrained into the diversion.

g. *Coordinated Management*

In addition to the operating objectives of the 1971 MOU between Reclamation, the Corps, OUWUA and DFG, and the 1964 Exchange Agreement between Reclamation and the OUWUA for water transfer between East Park, Stony Gorge, and Black Butte Lakes, Reclamation manages water releases from Black Butte Lake cooperatively with the Corps when releases are needed during the flood control season. Reclamation's Willows office and the Corps' water management staff communicate daily during the flood control season regarding inflows, predicted precipitation, storage, demand, and other operation issues. When Black Butte Lake water is no longer released for flood control, any water remaining in the lake is considered CVP water.

h. *Miscellaneous Diversions in the Upper Watershed*

In 2005 Reclamation executed the renewal of five binding agreement water contracts in the Black Butte Unit of the Sacramento River Division and entered into Section 7 consultation for the long-term (40 year) renewal. The water contractors were: Stony Creek Water District for a diversion of 2,920 acre-feet, Stonyford for a diversion of 40 acre-feet, Whitney Construction for a diversion of 25 acre-feet, 4-E Water District for a diversion of 20 acre-feet, and the U.S. Forest Service for a diversion of 55 acre-feet, for a the total amount of 3,060 acre-feet of water. The contracts expire in 2010, 2020, or 2024. Reclamation initiated consultation on the effects of renewal of these contracts with NMFS on April 16, 2004. In a letter dated January 10, 2005, NMFS provided a determination that the effects of these contract renewals were analyzed and covered under previous biological opinions. A February, 2005 memorandum from the U.S. Fish and Wildlife Service provided a "not likely to adversely affect listed species or critical habitat" determination.

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The Elk Creek Community Services District, another diverter on upper Stony Creek, chose not to enter into a Binding Agreement with Reclamation pursuant to §3404(c)(3) of the CVPIA, and therefore did not participate in the 2005 long-term water service contract renewal process. The District's existing long-term water service contract expires on August 20, 2007. The Region is unable to execute a long-term renewal contract (LTRC) pursuant to §3404(c) of the Central Valley Project Improvement Act (Title XXXIV PL102-575, 106 Stat. 4706) (CVPIA) with the District until the U.S. Fish & Wildlife Service and NOAA Fisheries complete Section 7 consultations under the ESA regarding the revised CVP Operations Criteria and Plan (OCAP). An interim renewal contract (IRC) will be necessary to provide continued delivery of a supplemental supply of CVP water to the District pending completion of the CVP OCAP consultations. By law, the initial interim contract would be limited to 3 years, but it may be limited to 2.5 years to coincide with a termination date of the last day in February (similar to other contracts) of the applicable year, and lasting until the OCAP is completed. Subsequent renewals, if needed, would be for two years, and the long term contract, to be negotiated after the OCAP is completed, would be for 40 years. Both the IRC and the LTRC will incorporate the applicable provisions of the CVPIA and will be modeled after the form of the recently negotiated interim and long-term renewal contracts. This biological opinion does not analyze or authorize these water contracts under the ESA. Reclamation intends to pursue separate environmental documentation and section 7 consultation for these actions.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally listed species (Evolutionarily Significant Units (ESU) or Distinct Population Segments (DPS)) and designated critical habitat occur in the action area below Black Butte Dam and may be affected by water management operations:

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

The threatened southern DPS of North American green sturgeon (*Acipenser medirostris*) is not found in Stony Creek and therefore will not be affected by the proposed project.

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A. Species and Critical Habitat Listing Status

Sacramento River winter-run Chinook salmon were originally listed as threatened in August 1989, under emergency provisions of the Endangered Species Act (ESA), and formally listed as threatened in November 1990 (55 FR 46515). The ESU consists of only one population that is confined to the upper Sacramento River in California's Central Valley. NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). They were reclassified as endangered on January 4, 1994 (59 FR 440), due to increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and a 99 percent decline between 1966 and 1991. Critical habitat area was delineated as the Sacramento River from Keswick Dam, (river mile (RM) 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta (Delta), including Kimball Island, Winter Island, and Brown's Island; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge. Although juvenile winter-run Chinook salmon are known to use the lower portion of the action area for non-natal rearing, the area is not included as critical habitat for winter-run Chinook salmon.

Central Valley spring-run Chinook salmon were listed as threatened on September 16, 1999 (50 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. A final rule designating critical habitat for Central Valley spring-run Chinook salmon was published on September 2, 2005 (70 FR 52488). The rule became effective on January 2, 2006. The designation includes numerous streams and stream reaches throughout the Central Valley, including portions of lower Stony Creek from the mouth upstream to NDD.

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 River (inclusive of and downstream of the Merced River) basins in California's Central Valley. A final rule designating critical habitat for Central Valley steelhead was published on September 2, 2005 (70 FR 52488). The rule became effective on January 2, 2006. The designation includes numerous streams and stream reaches throughout the Central Valley, including lower Stony Creek from the mouth upstream to Black Butte Dam.

The critical habitat designations for Central Valley spring-run Chinook salmon and Central Valley steelhead identify the primary constituent elements (PCEs) of critical habitat which include those physical and biological features of the habitat that are essential to the conservation of the species. The PCEs of critical habitat for these species are made up of specific physical and biological components such as water of an appropriate quality and quantity, suitable spawning substrates, forage and food sources, and natural cover such as shade, submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. PCEs within lower Stony Creek include freshwater spawning sites, freshwater rearing sites and

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freshwater migration corridors. The condition of these PCEs in lower Stony Creek has been impacted by past human activities and will be described more fully below in the Environmental Baseline section of this document.

NMFS recently has completed an updated status review of 16 salmon ESUs, including Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon, and concluded the species' status should remain as previously listed (70 FR 37160). On January 5, 2006, NMFS published a final listing determination for 10 steelhead DPSs, including Central Valley steelhead. The new listing determination became effective on February 6, 2006 (71 FR 834), and concludes that Central Valley steelhead DPS will remain listed as threatened.

B. Species Life History and Population Dynamics

1. Chinook Salmon

a. *General Life History*

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

Chinook salmon mature between two and six years of age (Myers *et al.* 1998). Freshwater entry and spawning timing generally are thought to be related to local water temperature and flow regimes (Miller and Brannon 1982). Runs are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

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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 also are necessary to allow adult passage to upstream holding habitat. The preferred temperature range for upstream migration is 38 °F to 56 °F (Bell 1991, DFG 1998). Adult winter-run Chinook salmon enter San Francisco Bay from November through June (Hallock and Fisher 1985) and migrate past Red Bluff Diversion Dam (RBDD) from mid-December through early August (NMFS 1997). The majority of the run passes RBDD from January through May, and peaks in mid-March (Hallock and Fisher 1985). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Adult spring-run Chinook salmon enter the Delta from the Pacific Ocean beginning in January and enter natal streams from March to July (Myers *et al.* 1998). In Mill Creek, Van Woert (1964) noted that of 18,290 spring-run Chinook salmon observed from 1953 to 1963, 93.5 percent were counted between April 1 and July 14, and 89.3 percent were counted between April 29 and June 30. 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.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs; 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 (FWS 1995). The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad. Bell (1991) identifies the preferred water temperature for adult spring-run Chinook salmon migration as 38 °F to 56 °F. 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 fish can become stressed as temperatures approach 70 °F. Reclamation reports that spring-run Chinook salmon holding over the summer prefer water temperatures below 60 °F, although salmon can tolerate temperatures up to 65 °F before they experience an increased susceptibility to disease. The upper preferred water temperature for spawning Chinook salmon is 55 °F to 57 °F (Chambers 1956, Reiser and Bjornn 1979). Winter-run Chinook salmon spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick dam and RBDD (Vogel and Marine 1991). The majority of winter-run Chinook salmon spawners are three years old. Physical Habitat Simulation Model (PHABSIM) results (FWS 2003) indicate winter-run Chinook salmon suitable spawning velocities in the upper Sacramento River are between 1.54 feet per second (ft/s) and 4.10 ft/s, and suitable spawning substrates are between 1 and 5 inches in diameter. Initial habitat suitability curves (HSCs) show spawning suitability rapidly decreases for water depths greater than 3.13 feet (FWS 2003). 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). PHABSIM results indicate spring-run Chinook salmon suitable spawning velocities in Butte Creek are between 0.8 ft/s and 3.22 ft/s, and suitable spawning substrates are between 1 and 5 inches in diameter

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(FWS 2004). The initial HSC showed suitability rapidly decreasing for depths greater than one foot, but this effect was most likely due to the low availability of deeper water in Butte Creek with suitable velocities and substrates rather than a selection by spring-run Chinook salmon of only shallow depths for spawning (FWS 2004).

The optimal water temperature for egg incubation is 44 °F to 54 °F (Rich 1997). Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, disease, predation, poor gravel percolation, and poor water quality. Studies of Chinook salmon egg survival to hatching conducted by Shelton (1955) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. The length of time required for eggs to develop and hatch is dependent on water temperature and is quite variable. Alderdice and Velsen (1978) found that the upper and lower temperatures resulting in 50 percent pre-hatch mortality were 61 EF and 37 EF, respectively, when the incubation temperature was constant.

Winter-run Chinook salmon fry begin to emerge from the gravel in late June to early July and continue emerging through October (Fisher 1994), generally at night. Spring-run Chinook salmon fry emerge from the gravel from November to March and spend about 3 to 15 months in freshwater habitats prior to emigrating to the ocean (Kjelson *et al.* 1981). 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 small insects and crustaceans.

When juvenile Chinook salmon reach a length of 50 to 75 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures. In the mainstems of larger rivers, juveniles tend to migrate along the margins and avoid the elevated water velocities found in the thalweg of the channel. When the channel of the river is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1982). Stream flow and/or turbidity increases in the upper Sacramento River basin are thought to stimulate emigration. Emigration of juvenile winter-run Chinook salmon past RBDD may begin as early as mid-July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991, NMFS 1997). From 1995 to 1999, all winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). Spring-run Chinook salmon emigration is highly variable (DFG 1998). Some may begin outmigrating soon after emergence, whereas others over summer and emigrate as yearlings with the onset of intense fall storms (DFG 1998). The emigration period for spring-run Chinook salmon extends from November to early May, with up to 69 percent of young-of-the-year outmigrants passing through the lower Sacramento River and Delta during this period (DFG 1998).

Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, Delta, and their tributaries. Spring-run Chinook salmon juveniles have been observed rearing in the lower part of non-natal tributaries and intermittent streams during the winter months (Maslin *et al.* 1997, Snider 2001). Within the Delta, juvenile Chinook

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salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels and sloughs (McDonald 1960, Dunford 1975). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, Sommer *et al.* 2001, MacFarlane and Norton 2002).

Winter-run Chinook salmon fry remain in the San Francisco Bay estuary until they reach a fork length of about 118 mm (*i.e.*, 5 to 10 months of age) and then begin emigrating from the estuary to the open ocean as early as November and continue through May (Fisher 1994, Myers *et al.* 1998). Little is known about estuarine residence time of spring-run Chinook salmon. 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 (McFarlane and Norton 2002). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon), MacFarlane and Norton (2002) concluded that unlike populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry. Spring-run Chinook yearlings are larger in size than fall-run Chinook and ready to smolt upon entering the Delta; therefore, they probably spend little time rearing in the Delta.

b. *Population Trend – Sacramento River Winter-run Chinook Salmon*

The distribution of winter-run Chinook salmon spawning and rearing historically was limited to the upper Sacramento River and tributaries, where spring-fed streams allowed for spawning, egg incubation, and rearing in cold water (Slater 1963, Yoshiyama *et al.* 1998). The headwaters of the McCloud, Pit, and Little Sacramento Rivers, and Hat and Battle Creeks, provided clean, loose gravel, cold, well-oxygenated water, and optimal flow in riffle habitats for spawning and incubation. These areas also provided the cold, productive waters necessary for egg and fry survival, and juvenile rearing over summer. Construction of Shasta Dam in 1943 and Keswick Dam in 1950 blocked access to all of these waters except Battle Creek, which is blocked by a weir at the Coleman National Fish Hatchery and other small hydroelectric facilities (Moyle *et al.* 1989, NMFS 1997). Approximately, 299 miles of tributary spawning habitat in the upper Sacramento River is now blocked. Yoshiyama *et al.* (1998) estimated that the Upper Sacramento River in 1938 had a "potential spawning capacity" of 14,303 redds. Most components of the winter-run Chinook salmon life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the habitat blockage in the upper Sacramento River.

Following the construction of Shasta Dam, the number of winter-run Chinook salmon initially declined but recovered during the 1960s. The initial recovery was followed by a steady decline, subsequent to the construction of RBDD, from 1969 through the late 1980s (FWS 1991). Since 1967, the estimated adult winter-run Chinook salmon population ranged from 117,808 in 1969, to 186 in 1994 (NMFS 1997). The population declined from an average of 86,000 adults in 1967 to 1969 to only 1,900 in 1987 to 1989, and continued to remain low, with an average of approximately 2,500 fish for the period from 1998 to 2000 (Table 1). Between the time Shasta Dam was built and the listing of

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winter-run Chinook salmon as endangered, major impacts to the population occurred from warm water releases from Shasta Dam, juvenile and adult passage constraints at RBDD, water exports in the southern Delta, acid mine drainage from Iron Mountain Mine, and entrainment at a large number of unscreened or poorly-screened water diversions (NMFS 1997).

Population estimates from 2001 through 2004 show relatively consistent population levels with at least 4,000 more adults than any of the previous 15 years (Table 1). The 2005 run (15,829 fish) was the highest since the listing. Also, there is an increasing trend in the five-year moving average (491 from 1990-1994 to 9,483 from 2000-2005), and the five-year moving average of cohort replacement rates has increased and appears to have stabilized over the same period.

Table 1. Winter-run Chinook salmon population estimates from Red Bluff Diversion Dam counts, and corresponding cohort replacement rates for the years since 1986.

Year	Population Estimate (RBDD)	5-Year Moving Average Population Estimate	Cohort Replacement Rate	5-Year Moving Average of Cohort Replacement Rate
1986	2,596	-	-	-
1987	2,186	-	-	-
1988	2,885	-	-	-
1989	696	-	0.27	-
1990	430	1,759	0.20	-
1991	211	1,282	0.07	-
1992	1,240	1,092	1.78	-
1993	387	593	0.90	0.64
1994	186	491	0.88	0.77
1995	1,297	664	1.05	0.94
1996	1,337	889	3.45	1.61
1997	880	817	4.73	2.20
1998	3,002	1,340	2.31	2.49
1999	3,288	1,961	2.46	2.80
2000	1,352	1,972	1.54	2.90
2001	8,224	3,349	2.74	2.76
2002	7,441	4,661	2.26	2.26
2003	8,218	5,705	6.08	3.02
2004	7,701	6,587	0.94	2.71
2005	15,829	9,483	2.13	2.83

c. *Status - Sacramento River Winter-run Chinook Salmon*

Numerous factors have contributed to the decline of winter-run Chinook salmon through degradation of spawning, rearing, and migration habitats. The primary impacts include blockage of historical habitat by Shasta and Keswick Dams, warm water releases from Shasta Dam, juvenile and adult passage constraints at RBDD, water exports in the

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southern Delta, heavy metal contamination from Iron Mountain Mine, high ocean harvest rates, and entrainment in a large number of unscreened or poorly screened water diversions. Secondary factors include smaller water manipulation facilities and dams, low recruitment of spawning gravel due to blockage behind upstream dams, loss of rearing habitat in the lower Sacramento River and Delta from levee construction, marshland reclamation, and interaction with and predation by introduced species (NMFS 1997).

Since the listing of winter-run Chinook salmon, several of the factors that led to the decline of the species have been addressed and improved through restoration and conservation actions. The impetus for initiating restoration actions stem primarily from the following: (1) ESA section 7 consultation reasonable and prudent alternatives on temperature, flow, and operations of the CVP and State Water Project; (2) SWRCB decisions requiring compliance with Sacramento River water temperature objectives which resulted in the installation of the Shasta Temperature Control Device in 1998; (3) a 1992 amendment to the authority of the CVP through the Central Valley Project Improvement Act (CVPIA) to give fish and wildlife equal priority with other CVP objectives; (4) fiscal support of habitat improvement projects from the CALFED Bay-Delta Program (*e.g.*, installation of a fish screen on the Glenn-Colusa Irrigation District diversion); (5) establishment of the CALFED Environmental Water Account (EWA); (6) Environmental Protection Agency (EPA) actions to control acid mine runoff from Iron Mountain Mine; and (7) ocean harvest restrictions implemented in 1995.

Due to these restoration and recovery efforts, water temperatures in the upper river have generally been maintained within an acceptable range for winter-run migration, incubation and rearing, suitable spawning gravel has been replenished through gravel augmentation programs below Keswick Dam, and migrational barriers have been reduced at RBDD and Anderson-Cottonwood Irrigation Dam (ACID).

The susceptibility of winter-run Chinook salmon to extinction remains linked to the elimination of access to their historical spawning grounds and the reduction of their population structure to a single, relatively small population. Recent trends in winter-run Chinook salmon abundance and cohort replacement are positive and may indicate some recovery since the listing. However, the population remains below the draft recovery goals established for the run (NMFS 1997). In general, the recovery criteria for winter-run Chinook salmon includes a mean annual spawning abundance over any 13 consecutive years to be 10,000 females and the geometric mean of the cohort replacement rate over those same years to be greater than 1.0.

d. *Population Trend – Central Valley Spring-run Chinook Salmon*

Historically, spring-run Chinook salmon were predominant throughout the Central Valley occupying 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). The Central Valley drainage as a whole is estimated to have

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supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and the 1940s (DFG 1998). Before construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry 1961). Following the completion of Friant Dam, the native population from the San Joaquin River and its tributaries (*i.e.*, the Stanislaus and Mokelumne Rivers) was extirpated. Spring-run Chinook salmon no longer exist in the American River due to the operation of Folsom Dam. Naturally spawning populations of Central Valley spring-run Chinook salmon currently are restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (DFG 1998).

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the Feather River Hatchery (FRH). In 2002, FRH reported 4,189 returning spring-run Chinook salmon, which is 22 percent below the 10-year average of 4,727 fish. However, coded-wire tag (CWT) information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run Chinook salmon populations in the Feather River due to hatchery practices. Because Chinook salmon are not temporally separated in the hatchery, spring-run Chinook and fall-run Chinook are spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon. 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. The genetic integrity of this population is at question because there is significant temporal and spatial overlap between spawning populations of spring-run and fall-run Chinook salmon (Good *et al.* 2005). For the reasons discussed previously, Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance.

Since 1969, the Central Valley spring-run Chinook salmon ESU (excluding Feather River fish) has displayed broad fluctuations in abundance ranging from 25,890 in 1982 to 1,403 in 1993 (DFG unpublished data). Even though the abundance of fish may increase from one year to the next, the overall average population trend has a negative slope during this time period. The average abundance for the ESU was 12,499 for the period of 1969 to 1979, 12,981 for the period of 1980 to 1990, and 6,542 for the period of 1991 to 2001. In 2003 and 2004, total run size for the ESU was 8,775 and 9,872 adults respectively, well above the 1991 to 2001 average.

Evaluating the ESU as a whole, however, masks significant changes that are occurring among metapopulations. For example, while the mainstem Sacramento River population has undergone a significant decline, the tributary populations have demonstrated a substantial increase. Average abundance of Sacramento River mainstem spring-run Chinook salmon recently has declined from a high of 12,107 for the period 1980 to 1990, to a low of 609 for the period 1991 to 2001, while the average abundance of Sacramento River tributary populations increased from a low of 1,227 to a high of 5,925 over the same periods. Although tributaries such as Mill and Deer Creeks have shown positive escapement trends since 1991, recent escapements to Butte Creek, including 20,259 in 1998, 9,605 in 2001, and 8,785 in 2002 are responsible for much of the increase in

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tributary abundance (DFG 2002, DFG unpublished data). The Butte Creek estimates however, do not include prespawning mortality. In the last several years as the Butte Creek population has increased, mortality of adult spawners has increased from 21 percent in 2002 to 60 percent in 2003 due to disease associated with high water temperatures and over-crowding. This trend may indicate that the population in Butte Creek may have reached its carrying capacity (Ward *et al.* 2003) or are near historical population levels.

The extent of spring-run Chinook salmon spawning in the mainstem of the upper Sacramento River is unclear due to overlapping spawning periods with fall-run Chinook salmon. During aerial redd counts very few redds (less than 15 per year) were observed during September (generally accepted as the primary spawning period for spring-run Chinook salmon) from 1989 to 1993, and none in 1994 (FWS 2003). Recently, the number of redds in September has varied from 29 to 105 during 2001 though 2003 depending on the number of survey flights (DFG, unpublished data). In 2002, based on RBDD ladder counts, 483 spring-run Chinook adults are estimated to have spawned in the mainstem Sacramento River (DFG 2004). In 2003, that estimate dipped to zero, and in 2004 the number of spring-run Chinook adults estimated to have spawned in the mainstem Sacramento River was 575 (DFG 2004).

e. *Status of Spring-run Chinook Salmon and Critical Habitat*

The initial factors that led to the decline of spring-run Chinook salmon were related to the loss of upstream habitat behind impassable dams. Since this initial loss of habitat, other factors have impacted spring-run Chinook salmon critical habitat, contributed to the instability of the population and affected the ESU's ability to recover. These factors include a combination of physical, biological, and management factors that have reduced the quantity and quality of critical habitat PCEs and directly reduced population numbers. Climatic variation, water management activities, hybridization with fall-run Chinook salmon, predation, and harvest have all impacted spring-run Chinook salmon critical habitat and population numbers (DFG 1998).

Since spring-run Chinook salmon adults generally hold over for several months in small tributaries before spawning they are extremely susceptible to the effects of low flows and high water temperatures. During the drought from 1986 to 1992, Central Valley spring-run Chinook salmon populations declined substantially (DFG 1998). Dry hydrologic conditions result in reduced flows and warm water temperatures which negatively impact adults, eggs, and juveniles. For adult spring-run Chinook salmon, reduced instream flows delay, or in some instances completely block access to holding and spawning habitats. Water management operations including reservoir releases and unscreened or poorly-screened diversions along spring-run Chinook salmon migration routes compound drought-related problems by further reducing river flows, warming river temperatures, and entraining juveniles.

Several actions have been taken to improve and increase the PCEs of critical habitat for spring-run Chinook salmon, including improved management of Central Valley water

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(*e.g.*, through use of CALFED EWA and CVPIA (b)(2) water accounts), implementing new and improved screen and ladder designs at major water diversions along the mainstem Sacramento River and tributaries, removal of several small dams on important spring-run Chinook salmon spawning streams, and changes in ocean and inland fishing regulations to minimize harvest. Although protective measures and critical habitat restoration likely have contributed to recent increases in spring-run Chinook salmon abundance, the ESU is still below levels observed from the 1960s through 1990. Threats from hatchery production (*i.e.*, competition for food between naturally spawned and hatchery fish, and run hybridization and homogenization), climatic variation, reduced stream flows, high water temperatures, predation, and large scale water diversions persist. Because the Central Valley spring-run Chinook salmon ESU is confined to relatively few remaining streams and continues to display broad fluctuations in abundance, the population is at a moderate risk of extinction.

2. Steelhead

a. *General Life History*

Based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, steelhead can be divided into two life history types: stream-maturing and ocean-maturing. Stream-maturing steelhead enter freshwater in a sexually immature condition and require several months to mature and spawn, whereas ocean-maturing steelhead enter freshwater with well-developed gonads and spawn shortly after river entry. These two life history types are more commonly referred to by their season of freshwater entry (*i.e.* summer [stream-maturing] and winter [ocean-maturing] steelhead). Only winter steelhead are currently found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento River system prior to the commencement of large-scale dam construction in the 1940s (Interagency Ecological Program [IEP] Steelhead Project Work Team 1999). At present, summer steelhead are found only in North Coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

Winter steelhead generally leave the ocean from August through April, and spawn between December and May (Busby *et al.* 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and the associated lower water temperatures. The preferred water temperature for adult steelhead migration is 46 °F to 52 °F (McEwan and Jackson 1996, Myrick 1998, Myrick and Cech 2000). Thermal stress may occur at temperatures beginning at 66 °F and mortality has been demonstrated at temperatures beginning at 70 °F. The preferred water temperature for steelhead spawning is 39 °F to 52 °F, and the preferred water temperature for steelhead egg incubation is 48 °F to 52 °F (McEwan and Jackson 1996, Myrick 1998, Myrick and Cech 2000). The minimum stream depth necessary for successful upstream migration is 13 cm (Thompson 1972). Preferred water velocity for upstream migration is in the range of 40-90 cm/s, with a maximum velocity, beyond which upstream migration is not likely to occur, of 240 cm/s (Thompson 1972, Smith 1973).

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Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Nickleson *et al.* 1992, Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapolov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams. Most steelhead spawning takes place from late December through April, with peaks from January though March (Hallock *et al.* 1961). Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity, and may spawn in intermittent streams as well (Everest 1973, Barnhart 1986).

The length of the incubation period for steelhead eggs is dependent on water temperature, dissolved oxygen concentration, and substrate composition. In late spring and following yolk sac absorption, fry emerge from the gravel and actively begin feeding in shallow water along stream banks (Nickelson *et al.* 1992).

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. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. 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 refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Some older juveniles move downstream to rear in large tributaries and mainstem rivers (Nickelson *et al.* 1992). Juveniles feed on a wide variety of aquatic and terrestrial insects (Chapman and Bjornn 1969), and emerging fry are sometimes preyed upon by older juveniles.

Steelhead generally spend two years in freshwater before emigrating downstream (Hallock *et al.* 1961, Hallock 1989). Rearing steelhead juveniles prefer water temperatures of 45 °F to 58 EF and have an upper lethal limit of 75 EF. Reiser and Bjornn (1979) recommended that dissolved oxygen concentrations remain at or near saturation levels with temporary reductions no lower than 5.0 mg/l for successful rearing of juvenile steelhead. During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Bell (1973) found that silt loads of less than 25 mg/l permit good rearing conditions for juvenile salmonids.

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. Some may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Barnhart (1986) reported that steelhead smolts in California range in size from 140 to 210 mm (fork length). Hallock *et al.* (1961) found that juvenile steelhead in the

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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.

b. *Population Trends – Central Valley Steelhead*

Steelhead historically were well distributed throughout the Sacramento and San Joaquin Rivers (Busby *et al.* 1996). Steelhead were found from the upper Sacramento and Pit River systems (now inaccessible due to Shasta and Keswick Dams), south to the Kings and possibly the Kern River systems (now inaccessible due to extensive alteration from water diversion projects), and in both east- and west-side Sacramento River tributaries (Yoshiyama *et al.* 1996). The present distribution has been greatly reduced (McEwan and Jackson 1996). The California Advisory Committee on Salmon and Steelhead (1988) reported a reduction of steelhead habitat from 6,000 miles historically to 300 miles today. Historically, steelhead probably ascended Clear Creek past the French Gulch area, but access to the upper basin was blocked by Whiskeytown Dam in 1964 (Yoshiyama *et al.* 1996). Steelhead also occurred in the upper drainages of the Feather, American, Yuba, and Stanislaus Rivers which are now inaccessible (McEwan and Jackson 1996, Yoshiyama *et al.* 1996).

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

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

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

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The only consistent data available on steelhead numbers in the San Joaquin River basin come from DFG mid-water trawling samples collected on the lower San Joaquin River at Mossdale. These data indicate a decline in steelhead numbers in the early 1990s, which have remained low through 2002 (DFG 2003). In 2004, a total of 12 steelhead smolts were collected at Mossdale (DFG, unpublished data).

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996).

Recent snorkel surveys (1999 to 2002) indicate that steelhead are present in Clear Creek (J. Newton, FWS, pers. comm. 2002, as reported in Good *et al.* 2005). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other streams previously thought to be void 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 (Demko *et al.* 2000). It is possible that naturally spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999).

c. *Status of Central Valley Steelhead and Critical Habitat*

Both the BRT (Good *et al.* 2005) and the Artificial Propagation Evaluation Workshop (69 FR 33102) concluded that the Central Valley steelhead DPS is "in danger of extinction." However, in the proposed status review NMFS concluded that the DPS in-total is "not in danger of extinction, but is likely to become endangered within the foreseeable future" citing benefits of restoration efforts and a yet-to-be funded monitoring program (69 FR 33102). Central Valley steelhead already have been extirpated from most of their historical range. Critical habitat concerns for steelhead focus on the widespread degradation, destruction, and blockage of freshwater habitat within the region, and impacts to PCEs are similar to those discussed for Chinook salmon above. Widespread hatchery steelhead production within this DPS also raises concerns about the potential ecological interactions between introduced stocks and native stocks. Because the Central Valley steelhead population has been fragmented into smaller isolated tributaries without any large source population and the remaining habitat continues to be degraded by water diversions and other land use practices, the population is at high risk of extinction.

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IV. ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem within the action area (USFWS and NMFS 1998). The action area includes Stony Creek and its riparian corridor from East Park Reservoir downstream to the confluence with the Sacramento River. The main focus of this analysis centers on the area that is accessible to anadromous species and is designated as critical habitat for Central Valley steelhead, the lower 24.6 miles of Stony Creek between Black Butte Dam and the confluence with the Sacramento River. The lower 19.7 miles of this reach, from NDD to the confluence with the Sacramento River also is designated as critical habitat for Central Valley spring-run Chinook salmon.

Stony Creek is the second largest tributary of the Sacramento River on the west side of the Sacramento Valley, and drains approximately 741 square miles along the eastern slopes of the California Coastal Range. The Stony Creek watershed is characterized by cool, wet winters with high flows, and hot dry summers with low summer and fall flows, with an average precipitation of 15 inches in the lower watershed. Within the upper watershed, variable winter rains and snow (annual precipitation of 32 inches) provide inflow into three reservoirs which affect water releases to lower Stony Creek.

A. Status of the Listed Species within the Action Area

Although Chinook salmon and steelhead are known to occur in lower Stony Creek (Corwin and Grant 2004; Brown 1994; DFG 1983; Reavis 1983), information on recent spawning is greatly limited (Corwin and Grant 2004). The installation of the Glenn Colusa Irrigation District (GCID) siphon under Stony Creek in 1999 has opened up much of the lower creek to anadromous salmonid use over a much greater portion of the year. Prior to installation of the siphon, a gravel berm was constructed during each irrigation season from 1911-1999 at the GCID canal crossing of Stony Creek at CM 3.3, which created an intermittent barrier to both upstream and downstream salmonid migration (Mike Hughes, personal communication, 2007). In many years this berm was able to withstand winter flows and therefore blocked passage throughout the year. In those years that the berm was washed out by high winter flows, it was generally rebuilt early in the spring (March or April) to allow irrigation water delivery. Even with the removal of this intermittent barrier, the potential for recovery of salmonid populations within lower Stony Creek currently is limited by passage barriers and diversions such as the CHO gravel berm during the irrigation season (typically late March to mid May), the NDD, and Black Butte Dam, as well as frequent fluctuations in stream flows with extended periods of extremely low base flows, elevated water temperatures and limited spawning and rearing habitat.

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

Spring-run Chinook salmon are known to have historically spawned in the Stony Creek watershed (Yoshiyama *et al.* 1996). There is documentation of salmon spawning at the

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confluence of Stony Creek and Little Stony Creek, although habitat conditions in this reach would indicate that these were likely fall-run Chinook salmon. The spring-run are likely to have spawned further up in the watershed above 2,000 feet of elevation, as they do in other tributaries to the Sacramento River. Prior to the placement of irrigation dams, Stony Creek was considered "a very good salmon stream" (Clark 1929). By 1928 spring-run Chinook salmon were nonexistent on Stony Creek due to irrigation diversions that blocked migration to the upper watershed and kept the lower stream dry except during the rainy season (Clark 1929). There is no evidence or documentation of winter-run Chinook salmon spawning in Stony Creek.

The life history and spawning strategies of spring-run Chinook salmon require them to reach upstream cold-water habitats during the spring, summer and early fall seasons. The construction of the GCID diversion, Stony Gorge and Black Butte Dams blocked the spring run from accessing the cold water habitats of upper Stony Creek in order to complete their life cycle. This loss of access to cold water habitats has caused the complete extirpation of spawning populations of spring-run Chinook salmon from the Stony Creek watershed (Yoshiyama et al 1996). It is unlikely that any action short of the removal of these dams or construction of fish passage facilities on these dams could facilitate the return of a spawning population of spring-run Chinook salmon to the system.

Several sampling efforts conducted over the past 20 years have captured juvenile spring- and winter-run Chinook salmon and steelhead in Stony Creek, mostly near the confluence with the Sacramento River (Reavis 1983, Maslin and McKinney 1994, Brown 1994, Corwin and Grant 2004). In addition, juvenile Chinook salmon (undetermined ESU) have been collected as far upstream as CM 12.9 (DFG 1983). As stated above, habitat conditions in lower Stony Creek do not support spring- or winter-run Chinook salmon spawning and it is therefore assumed that all juveniles of these two ESUs found within Stony Creek represent non-natal rearing. However, fall-run Chinook salmon spawning has been documented in lower Stony Creek and newly hatched fall-run fry have been collected in the creek (Corwin and Grant 2004).

2. Central Valley Steelhead

There have been only limited efforts to determine the presence or extent of steelhead spawning in Stony Creek and those limited efforts have not detected any such spawning. Murphy (1946) conducted a survey of the upper reaches of Stony Creek and Grindstone Creek (a tributary to Stony Creek) in August of 1946, prior to the existence of Black Butte Dam, during which he documented abundant rainbow trout. The existence of rainbow trout (and possibly juvenile steelhead) in these areas during the late summer of a drought year indicates that the habitat was suitable to support steelhead on a year round basis. Although steelhead production has not been documented in Stony Creek, the suitability of the habitat coupled with the documentation of anadromous Chinook salmon accessing these areas upstream of present-day dams (Yoshiyama *et al.* 1996) is a strong indication that steelhead would have spawned in Stony Creek as well (McEwan 2001).

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Corwin and Grant (2004) conducted limited spawning surveys in lower Stony Creek from 2001 through 2004, primarily looking for Chinook salmon spawners. No adult steelhead were detected during this study. However, the extent of these surveys was greatly limited by high turbidity and lack of access to most of the creek (due to denial of access to private lands). Therefore the researchers concluded that they could neither confirm nor discount the presence of steelhead spawning during that period (Reclamation 2004).

The same study (Corwin and Grant 2004) monitored for juvenile salmonids through fyke netting and beach seining on lower Stony Creek. Again, no natal steelhead were detected during the 4-year study period. However, the scope of sampling was limited both spatially (many areas of the creek could not be sampled due to lack of landowner permission) and temporally (sampling efforts were not persistent throughout the study period). While the failure to detect natal juvenile steelhead under this sampling regime is a strong indication that there was no significant steelhead production in Stony Creek during this period, the possibility of successful steelhead spawning can not be definitively excluded, as sampling efforts were intermittent and access to suitable monitoring sites was not granted by landowners (Reclamation 2004).

Other sampling efforts that have captured juvenile steelhead in Stony Creek (Maslin and McKinney 1994, Brown 1994) found only larger juveniles (>100 mm) in the lower reaches of the creek, and concluded that they were likely non-natal to Stony Creek.

B. Status of Critical Habitat within the Action Area

The PCEs of critical habitat for spring-run Chinook salmon and steelhead in Stony Creek have been severely impacted and degraded by human activities and manipulation of the creek. The PCEs that have been most heavily impacted include suitable migration corridors, spawning sediments, creek hydrology including timing and magnitude of flows, suitable water temperatures, and shaded riparian aquatic (SRA) habitat including large woody debris.

1. Migrational Barriers

Migration of anadromous salmonids into sections of the upper Stony Creek watershed was originally blocked by East Park Dam on Little Stony Creek, and the associated Rainbow Diversion Dam on Stony Creek, in 1910 and 1914 respectively. The GCID gravel berm near the mouth of Stony Creek also intermittently blocked migration from 1911-1999. In 1928, the construction of Stony Gorge Dam further prevented salmonid passage into the reach between Stony Gorge Dam and the previously built dams. Since 1963, anadromous salmonids have been restricted to the lower 24.6 miles of Stony Creek by the construction of Black Butte Dam.

NDD located at CM 19.7 is a weir structure spanning the entire creek. The concrete spillway creates a nearly vertical drop to the downstream water surface which has been determined to impede upstream adult passage under most flow conditions, and makes it impossible for juveniles to move upstream of the dam at any time (Corwin and Grant

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2004). On top of this spillway, flashboards are typically put in place from March through October to allow water diversions into the North Canal. However, these flashboards have, at times, been in place during all months of the year dependent on water demands and weather patterns. When flashboards are in place they create a total barrier to upstream passage so that adult and juvenile salmonids are unable to access the area above NDD. In addition, any juveniles migrating downstream from above the dam during irrigation diversions would have a strong likelihood of entrainment into the North Canal as the majority of summer flows are diverted into the canal. NDD flashboards are typically in place during much of the fall-run Chinook salmon adult migration period and during the latter part of the fall-run Chinook salmon, and steelhead juvenile emigration periods.

Since 1993, a seasonal passage impediment has existed at the CHO (CM 13) during rediversion operations which may occur from April 1 through May 15 and September 15 through October 29. During CHO operations, a gravel barrier is placed across Stony Creek to facilitate the diversion of water into the TCC via the CHO. Although a minimum bypass flow of 40 cfs is maintained downstream of this seasonal berm during the operation of the CHO, this temporary barrier may impede both upstream and downstream passage of salmonids. As with NDD, any juveniles migrating downstream from above the diversion structure would have a strong likelihood of entrainment into the TCC as the majority of the water flowing downstream is diverted into the canal during the diversion period. Upstream passage may be prevented or delayed during the fall-run Chinook salmon adult immigration period and during the fall- and spring-run Chinook salmon, and steelhead juvenile emigration periods.

Prior to 1999, a gravel berm was constructed (or maintained) on the creek each spring at the GCID main canal (approximately 3 miles upstream of the confluence of Stony Creek and the Sacramento River) and left in place through the irrigation season (generally March through November). The berm created a barrier which prevented fish passage into and out of the creek during the irrigation season, and in years when the berm was not blown out by winter flows, it remained a barrier to fish passage throughout the year. In 1999, a siphon was placed under Stony Creek at this site, and there is no longer any structural barrier there.

2. Spawning Substrate

Black Butte Dam blocks the transport of all but the finest sediment from the upper basin into lower Stony Creek. Prior to construction of the dam, the channel was a high gradient, bedload dominated system with sharp fluctuations in discharge, where the channel carrying the main flow shifted periodically. Post-dam, the flood peaks have been attenuated, and spring runoff often is stored for planned releases. Channel width and sediment transport have been reduced in the upper reaches and significant channel realignment has occurred. The sources of most bedload and suspended sediment have been eliminated by Black Butte Dam. High volume releases can produce accelerated bank erosion below the dam, which is the primary source of coarse bedload recruitment into the lower creek.

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Several spawning sediment analyses have been conducted on lower Stony Creek over the past 40 years. Puckett (1969) conducted a spawning habitat survey during the mid-1960s, shortly after the completion of Black Butte Dam, before the impacts of the dam on substrate composition and distribution would have been apparent. Puckett (1969) sampled within three half-mile reaches of lower Stony Creek. These sites were at the U.S. Geological Survey (USGS) gage near Hamilton City, one-half mile downstream of the Road P crossing near Orland, and two miles below Black Butte Dam. The results of this investigation determined that the average substrate particle size was too small in the two lower study areas, but was adequate for Chinook salmon spawning in the upper most location, above NDD. Again, this study was conducted shortly after the construction of Black Butte Dam, and it is likely that the substrate characteristics throughout lower Stony Creek have changed significantly in the ensuing 35 years of dam operations.

In the late 1990s, David Vogel (1998) conducted an investigation of spawning gravel substrate in lower Stony Creek. Vogel concentrated a large majority of his sampling effort (15 of 18 samples) within the upper two miles of the creek, directly below Black Butte Dam. The decision to concentrate on this area was apparently based on Puckett's finding that this area had contained the highest quality spawning substrate some 30 years prior. Vogel (1998) concluded that "nearly all samples possessed a level of fine particles (mostly sand) within the level of concern for salmonid reproduction".

The combination of high winter flushing flows and a lack of sediment recruitment has severely impacted the uppermost stretch of lower Stony Creek, below Black Butte Dam. While Puckett (1969) determined that this section of the creek had the highest quality of spawning gravels shortly after Black Butte Dam was constructed, recent analysis of this area revealed that most of the channel has become incised down to a bed of older resistant alluvium (existing conditions report) and some areas have become completely denuded of all gravels and sediments with only bed rock and hard pan clay remaining, leaving the area unusable as spawning habitat (personal observation, Mike Tucker, June 2006).

The most recent scientific analysis of spawning substrate in lower Stony Creek was conducted by Corwin and Grant (2004). These investigators collected samples from 8 locations between the mouth of Stony Creek and I-5 at CM 16.2 (see Table 2). There were no samples taken above the I-5 site (upper 8.4 miles of lower Stony Creek) in the area most heavily concentrated on by the previous two studies, again due to denial of access by private landowners.

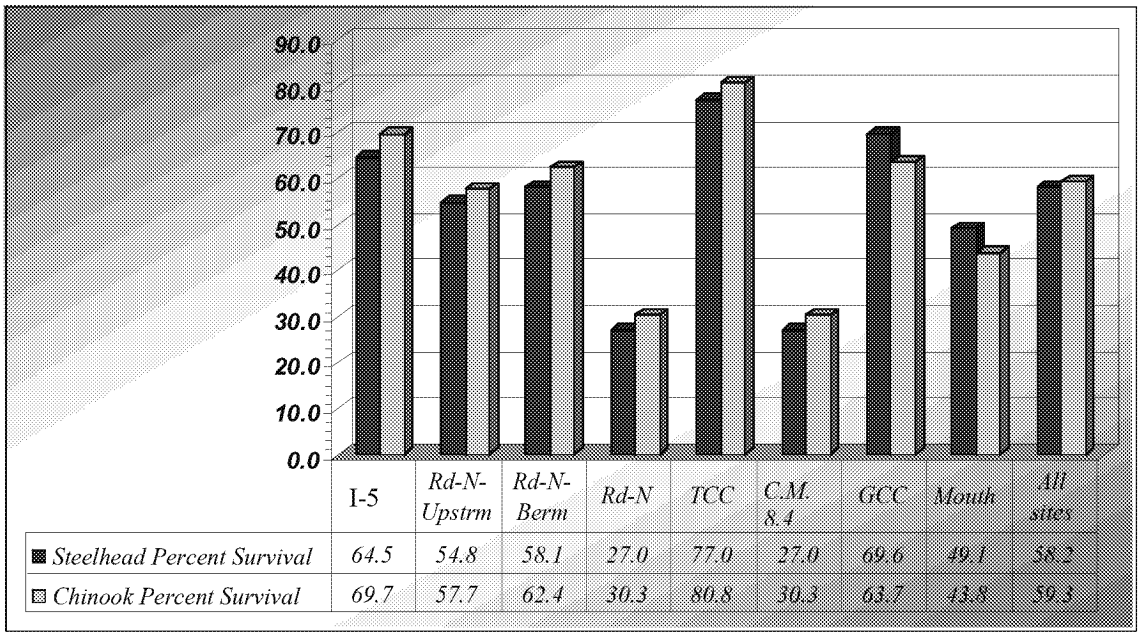
Table 2. Sampling sites for 2004 sediment study.

Sediment Sample Site	Creek Mile
I-5	16.2
Road N – Upstream	14.2
Road N - Berm	14.1
Road N	14.1
Tehama Colusa Canal (TCC)	13.9

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Creek Mile 8.4	8.4
Glen Colusa Canal (GCC)	3.9
Mouth	0.2

In an analysis provided as supplemental information to Corwin and Grant's initial report (Reclamation 2005a), the investigators used two second order equations taken from Tappel and Bjornn (1983) to describe the relationship between the particle size ratios found in the sediment samples taken from lower Stony Creek and the expected percent survival of Chinook salmon and steelhead that might be spawned in that gravel.



	I-5	Rd-N-Upstrm	Rd-N-Berm	Rd-N	TCC	C.M. 8.4	GCC	Mouth	All sites
Steelhead Percent Survival	64.5	54.8	58.1	27.0	77.0	27.0	69.6	49.1	58.2
Chinook Percent Survival	69.7	57.7	62.4	30.3	80.8	30.3	63.7	43.5	59.3

Figure 1. Predicted percent survival of salmonid embryos to emergence for lower Stony Creek substrate samples. Percent survival is based on two second-order equations developed by Tappel and Bjornn, 1983 (Figure taken from Reclamation 2005a)

As indicated by the graph in Figure 1, estimated percent survival to emergence was below 70 percent for all gravel samples except for the TCC sample which had a percent survival for steelhead and Chinook salmon of 77 percent and 81 percent, respectively. The mean percent survival among all sites for steelhead was 53 percent (Standard Deviation (SD) = 18.4) and ranged from 27 percent for gravel analyzed from Road N and CM 8.4 to 77 percent for the TCC gravel. The mean percent survival for Chinook salmon was found to be 55 percent (SD = 18.4) and ranged from a low of 30 percent for gravel from Road N to 80.8 percent for the TCC gravel. From this analysis the investigators concluded that the quality of gravel for salmonid spawning was fair to poor in the areas sampled (Reclamation 2005a). However, it is important to note that the capture of newly emergent Chinook salmon fry within these reaches proves that successful spawning, incubation, and emergence is occurring in these areas, although the actual percent survival of embryos to emergence is unknown at this time.

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3. Hydrologic Conditions

Natural flow patterns within Stony Creek have been disturbed since 1910 with the construction of East Park Dam. Changes in the natural flow regime have altered the natural cycles by which juvenile and adult salmonids base their migrations. The dams have also decreased gravel and large woody debris recruitment to the lower creek. While storage of natural runoff can reduce flows in the lower creek during certain times of year, at other times dam releases can provide higher flows for longer periods of time than would occur under natural conditions. The existing streamflow conditions below Black Butte Dam are variable and highly dependent on flood control operations, diversions, seepage, and evaporation. Historic records indicate that before the construction of Black Butte Dam (1963), flows in the lower valley reach of Stony Creek diminished to zero or nearly zero in the late summer months of most years. This situation continues to occur today as minimum releases (30 cfs below NDD) can be diminished through evaporation, direct pumping, or absorption into the fluvial substrate of the valley floor before reaching the Sacramento River. In the spring, when Reclamation is diverting at the CHO, flows below NDD (the area currently accessible to anadromous salmonids) are generally higher and colder than they would otherwise be without the existence of Black Butte Dam. This situation may provide improved conditions for salmonids in the area above the CHO for this short period in the spring. However, the majority of these increased flows are diverted into the unscreened CHO, increasing the likelihood of entrainment of juvenile salmonids into the TCC

As a result of the 2002 BO, the Corps refined their flood control ramping rates and other water release protocols in order to improve habitat conditions for listed salmonids on lower Stony Creek. The current ramping rates followed during flood control operations are described below.

The rates of change for increasing flood releases from minimum flow to 1,000 cfs are as follows[1]:

1. When storage encroaches 0 percent to 25 percent of the required flood control space, releases will be increased by no more than 250 cfs/hour.

2. When storage encroaches 25 percent to 50 percent of the required flood control space, releases will be increased by no more than 500 cfs/hour.

3. When storage encroaches 50 percent or more of the required flood control space, releases will be increased by no more than 1,000 cfs/hour.

When flood releases are above 1,000 cfs, releases shall be increased by no more than 1,000 cfs/hour. Exceptions to this requirement shall be allowed to insure the structural integrity of the Corps' facilities[2] and in emergency situations, to protect human lives and property from flood damages.

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The rate of change for decreasing releases are as follows[1]:

1. When flood release is 15,000 cfs to 5,000 cfs, releases will be decreased by no more than 500 cfs/hour.

2. When flood release is 5,000 cfs to 500 cfs, releases will be decreased by no more than 250 cfs/hour.

3. When flood release is 500 cfs to 100 cfs, releases will be decreased by no more than 250 cfs/day at a rate not greater than 30 cfs/hr.

4. When flood release is at or below 100 cfs, releases will be decreased in approximately 10 cfs/hour increments.

[1]*All releases are expected to be within +/- 5 percent of those targeted.*

[2]*Operating experience has shown that when upward release changes are required within the range of 4,000 cfs to 6,500 cfs (depending on reservoir storage) the gates should be operated in such a way as to force a hydraulic jump below the outlet portal by temporarily increasing the release by approximately 2,000 cfs. Once the hydraulic jump is established, the 1,000 cfs per hour (or less) rate of release would resume.*

The Corps has also initiated alternative flood release protocols during the last 5 to 7 percent of floodwater encroachment in Black Butte Lake. These new protocols are intended to provide more reliable and suitable conditions for successful spawning and survival of anadromous salmonids in lower Stony Creek. The basic strategy of these newly adopted release protocols has been to cut releases to between 100 and 200 cfs when the decreasing encroachment level reaches 5 to 7 percent (instead of maintaining higher releases until the reservoir is no longer encroached), with the intent of maintaining minimum releases of 100 cfs or greater for as long as possible during flood control operations while avoiding impacts to the Corps' flood control abilities below Black Butte Dam. These new release protocols have been generally successful in maintaining minimum flows of 100 to 200 cfs during the winter and spring flood control periods since late 2003 when the protocols were initiated.

Reclamation conducted an analysis of water use and water availability on lower Stony Creek in 2004 (Reclamation 2004) to investigate the potential effects on the available water supply from implementing minimum instream flow requirements of 100 and 150 cfs during the cold water periods (*i.e.*, generally November through May). A water resources model was required to address the system impacts of increasing minimum flows. As a result, CALSIM was selected as the model to evaluate potential long-term impacts on reservoir storage and water supply deliveries. Based on 80 years of available data, the study period analyzed was Water Years1921 through 2000.

The model described OUWUA's average contract demands of 104.9 TAF and TCCA's maximum demands of 38.3 TAF which can only be met by the available water supply within the basin. To estimate the water available through the peak irrigation season,

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April through September, allocations were determined by the following method and are supported by historical deliveries (1966-98):

1. The sum of the end of March storage in the three reservoirs;
2. Plus an estimate of the April-September unimpaired flow, above what OUWUA is diverting;
3. Minus a minimum system carryover storage target of 32.5 TAF; and,
4. Minus contingencies including 25% of an initial allocation estimate to account for channel recharge to the aquifer and an estimate for irrigation season evaporation.

Reservoir operating criteria were also identified. Reservoir storage-discharge relationships and current area-capacity-elevation tables were incorporated in the model. In addition, each reservoir is operated under the following set of priorities (in order), when possible:

1. Comply with current flood control and/or dam safety requirements;
2. Meet current minimum flow requirements;
3. Stabilize Black Butte Lake or Stony Gorge Reservoir in alternate years for in-lake fishery enhancement by limiting drawdown during the crappie (*Pomoxis* spp.) spawning season; and,
4. Satisfy contractual water supply demands to the OUWUA and the TCCA. Water in excess of these demands remains in storage.

Results of this analysis indicated that implementation of increased minimum flow releases would provide instream benefits for fish when temperatures are suitable, but that in dryer years, would result in lower reservoir system storage, thereby reducing water availability needed for irrigation. The model used the Sacramento Valley Water Year Hydrologic Index to compare hydrological trends in Stony Creek in response to alternative operations, since a hydrologic classification of Stony Creek does not exist

The analysis indicated that 100 percent of Orland Project agricultural demands could be met under the increased 100 cfs minimum flow during all "wet", "above normal", and all but two (out of 14) "below normal" year types (as defined under the Sacramento Valley Water Year Hydrologic Classifications) which occurred in 65 percent of years over the 80-year period of analysis. However, as OUWUA has rights to 100% of the water stored in East Park and Stony Gorge Reservoirs, only flood releases and CVP water stored in Black Butte Lake were considered available to meet the proposed minimum flows in Reclamation's analysis.

The likelihood of meeting full agricultural demands was significantly reduced during most "dry" and almost all "critical" year types. Unfortunately, it is impossible to predict in November, through reservoir storage or long range forecasting, the type of hydrologic classification that will develop as the water year progresses.

Due to the unpredictability of spring reservoir storage and hydrological conditions in the Stony Creek basin, Reclamation conducted an additional cursory analysis which found that if more than 104,657 acre-feet are present, or expected to run off into Black Butte

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Lake on or after April 1, in years when the upstream reservoirs are also full on April 1, Reclamation could release greater instream flows for fishery benefits without impacting agricultural deliveries or minimum pool requirements.

4. Water Temperature

Lower Stony Creek water temperatures are directly influenced by ambient air temperature, solar radiation, shading, channel geometry, volume of water being released down the creek, the water temperatures of Black Butte Lake releases, and, to a lesser degree, the other upstream reservoirs. Releases made from Black Butte Lake are made from the outlet located at the bottom of the lake, ensuring the coldest temperatures possible. Thermal monitoring within Black Butte Lake has indicated that, while there is a slight to moderate thermal stratification during the late spring and summer months (April-September), by the early fall at lowest pool elevations, temperatures within the reservoir can be relatively uniform, generally in the mid-60s °F (Corps 1987). Based on analysis of daily mean temperatures from four monitoring locations on lower Stony Creek from July 1995 to December 1997, temperatures remained fairly consistent from year to year during the winter months. Also, stream temperatures were not significantly different with regard to location during the winter months but increased as much as 18 °F in a downstream direction between CM 24 and CM 7 during the summer months (*i.e.,* May to August).

Mean daily water temperatures at the Black Butte gage (CM 24) in October from 1979 through 1994 (65.8 °F) were just below the maximum threshold of temperature tolerances for prespawning Chinook salmon (66 °F) reported by Ward and Kier (1999). During 1979 through 1994, water temperatures from November through March remained within the optimal range for adult migration, spawning, egg incubation and juvenile rearing for Chinook salmon and steelhead of 38 °F to 56 °F (Bell 1986, McEwan and Jackson 1996). Stream temperatures then remained within the optimal range (<65 °F) for fry/juvenile Chinook and steelhead rearing through at least April and sometimes to mid-June (Reclamation and Corps 2001).

The Black Butte gage is at the upstream portion of lower Stony Creek and is not always reflective of downstream temperatures during the spring, summer, and early fall. Temperature monitoring during 2002 and 2003 showed that water temperatures increased rapidly during May and were higher in a downstream direction (Corwin and Grant 2004). The sampling also demonstrated that any steelhead fry attempting to migrate out of the creek during those years would have encountered lethal conditions in lower Stony Creek by early June.

The multi-agency technical team examining the feasibility of restoring steelhead to the Upper Yuba River watershed formulated recommended water temperatures based on optimal, suboptimal, and chronic to acute stress for steelhead life stages (Table 3).

Table 3_. Recommended temperatures for steelhead in the Upper Yuba River basin (adapted from Stillwater Sciences 2006).

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Steelhead Life Stage	Temperature		
	Optimal[1]	Suboptimal[2]	Chronic to Acute Stress[3]
Upstream migration/adult residence	< 52°F	52-70°F	>70°F
Spawning	<52°F	52-55°F	>55°F
Egg incubation	<52°F	52-55°F	>55°F
Fry & juvenile rearing and outmigration	<65°F	65-68°F	>68°F

[1] Feeding and growth occur; growth dependent on food availability. No sublethal or lethal effects.

[2] No direct mortality, but may result in a higher probability of diminished success (i.e., sublethal effects), especially at high end of range.

[3] Chronic exposure at the low end of the range results in sublethal effects, including reduced growth, reduced competitive ability, behavioral alterations, and increased susceptibility to disease. At higher temperatures in this zone, short-term exposure (minutes to days) results in death.

Using these criteria, water temperatures in Stony Creek at the NDD are suboptimal for steelhead rearing by mid- to late-May and reach chronic to acutely stressful conditions by mid-June. Lower-most Stony Creek becomes lethal to steelhead fry by early June and all of lower Stony Creek becomes lethal during the summer based on sampling in 2002 and 2003 (Corwin and Grant 2004).

5. Riparian Vegetation

The overall habitat quality of the riparian plant communities observed for lower Stony Creek is low with respect to species composition, extent and level of reestablishment, and stand maintenance (Harvey and Associates 2006). There are some small pockets of moderate to high-quality riparian habitat mostly above CM 15, above the TCC, and in the lowermost 2 miles. Interpretation of 1992 aerial photographs shows scattered patches of shrubs, typically well removed from the active channel. Much of the riparian habitat is severely infested with invasive species such as giant reed and salt cedar. To provide maximum contribution to steelhead PCEs, the riparian vegetation would have to be adjacent to the wetted channel to provide shade, cover, habitat complexity, and food sources (terrestrial insects).

Giant reed and salt cedar have displaced native riparian vegetation and have become well established along much of lower Stony Creek. These species can often out-compete native vegetation for a variety of reasons, including their superior ability to colonize disturbed areas (Reclamation 1998). The presence of these species diminishes the overall habitat quality of the stream corridor as they do not provide the erosion resistance of native riparian species and do not contribute large woody material to the stream channel.

Giant reed most likely first appeared in lower Stony Creek sometime shortly before 1950. Although it was largely absent in 1950 according to aerial photography, a few individuals

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were apparent between CM 14.5 and CM 15.0 (Reclamation 1998). The most substantial stands within lower Stony Creek also occurred in this area in 1992 according to aerial photographs. In approximately 1965, shortly after the installation of Black Butte Dam, giant reed began expanding at an increased rate. For example, from 1968 to 1995, giant reed increased in area from 2 to 17 acres between CM 14.5 and CM 15 (Reclamation 1998). Giant reed was well established along most of lower Stony Creek from CM 0 to approximately CM 17 with substantial stands present between CM 10.5 and CM 16 in 1998 (Reclamation 1998). By 2005, giant reed existed as far upstream as CM 22 (Harvey and Associates 2006). It has established in dense thickets, especially in disturbed areas, such as gravel mining sites. Giant reed has also displaced native vegetation along unstable channel reaches since stem and root fragments easily flow downstream and rapidly establish in open substrate.

Along with giant reed, salt cedar is replacing native vegetation along the lower Stony Creek stream corridor and reducing overall riparian habitat quality (Reclamation 1998). According to 1992 aerial photographs, the invasion of both salt cedar and giant reed along lower Stony Creek was most prevalent downstream of the I-5 bridge (CM 16). Like giant reed, salt cedar likely also spread at an increased rate along the corridor after the construction of the Black Butte Dam since salt cedar tends to colonize more rapidly in streams impacted by flow regulations (Reclamation 1998).

B. Factors Affecting Species and Critical Habitat within the Action Area

1. Migrational Barriers

The construction and operation of migrational barriers described in the previous section (East Park, Stony Gorge, Black Butte, and North Diversion Dams, and the TCC and GCID irrigation diversions) has greatly impacted listed salmonids and their critical habitat within Stony Creek. By blocking migration to the upper reaches of Stony Creek, these dams have caused the complete extirpation of all spawning populations of spring-run Chinook salmon, and have severely diminished the potential for steelhead to spawn and survive in Stony Creek. One of the primary constituent elements of critical habitat for spring-run Chinook salmon and steelhead is suitable migration corridors. By blocking migration to the upper reaches of Stony Creek, these dams have completely destroyed the suitability of this PCE in lower Stony Creek, as it can no longer act as a migration corridor to the spawning habitat in the upper watershed.

2. Substrate/Spawning Habitat

The lack of quality spawning substrates described above has reduced the spawning potential for steelhead and Chinook salmon in lower Stony Creek. Many stretches of the upper reach, below Black Butte Dam, are completely devoid of suitable spawning gravels and the high proportion of sand and other small sediments in the lower sections of the creek is likely to cause pre-emergent mortality in a high percentage of the eggs that are deposited in the creek.

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3. Hydrologic Conditions

Low spring and summer flows on lower Stony Creek contribute to warm water temperatures and cause the entire creek to be uninhabitable by salmonids. Even as water temperatures cool in the fall, the flow releases are often maintained at such low levels that no flowing water makes it to the Sacramento River, precluding any fish from migrating into the creek to spawn. During the winter and spring flood control season rapid fluctuations and high peak flows can mobilize creek sediments, causing redds to be washed away or be buried under deposits from upstream. Extreme high flow events of greater than 10,000 cfs or 15,000 cfs occurred in 38 and 17 percent, respectively, of the 24 years of record examined (1965 – 1988). While recent adjustments to the Corps' flood management operations have reduced the severity of these impacts, there is still the potential for these operational flow changes to result in the death of eggs and pre-emergent fry. This circumstance is particularly evident for steelhead which spawn January – March, the principal high-flow period.

4. Water Temperature

Due to high summer water temperatures in lower Stony Creek, spring-run Chinook salmon can not complete their full life cycles in the creek, as both require cooler summer temperatures for adult holding and/or spawning and egg incubation. With regards to steelhead, current water temperature conditions in lower Stony Creek are at best marginal, but generally provide the necessary temperatures to allow successful steelhead reproduction in most years. Water temperatures are optimal (<55 °F) throughout the primary steelhead spawning period (December through March) although temperatures can rise quickly in the spring, leaving the potential for late spawned redds and fry to be lost to lethal temperature conditions. Summertime water temperatures are also well above the lethal level for steelhead, precluding the possibility for juveniles to rear in Stony Creek over the summer. Instead, they would be forced to migrate downstream to the mouth of the creek and into the Sacramento River, where temperatures generally remain suitable for steelhead rearing throughout the year. This type of behavior has been documented in other intermittent tributaries to larger rivers. Everest (1973) found that steelhead spawned in January and February in Sam's and Kane Creeks (intermittent tributaries to the Rogue River in southern Oregon) emerged in April and May, and migrated downstream into the Rogue River as water temperatures surpassed 70 °C, often only a few days before the creeks became intermittent. Similar life history strategies are evident in numerous intermittent tributaries in the upper Sacramento River in the Redding area, where steelhead spawn in the small tributaries and their offspring migrate out to the Sacramento River in the spring before the tributaries go dry. Despite the occurrence of marginally suitable water temperatures for steelhead reproduction, recent monitoring has not detected any successful steelhead reproduction in Stony Creek. High water temperatures are considered to be a significant factor in this lack of a healthy steelhead population in the creek (Reclamation 2001).

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5. Riparian Habitat/Instream Structural Diversity

The sparse riparian vegetation and high proportion of invasive giant reed and salt cedar along lower Stony Creek reduce the quality of the critical habitat for rearing salmonids. The lack of dense overhead cover and shade increases water temperatures, reduces the input of food from terrestrial insects and reduces the ability of juvenile salmonids to find shelter from predators. The lack of large woody debris in the creek further impacts the PCE's for rearing and migrating by reducing the instream structural diversity necessary for juvenile feeding and sheltering. The lack of deeply rooted vegetation along the stream banks also allows for accelerated erosion and sediment influx into the stream.

6. Mining

Since 1977, DFG has not allowed instream pit mining in Stony Creek. However, mid-channel gravel-bar skimming remains the typical mining technique used in lower Stony Creek, and excavation below the level of seasonally replenished aggregate has occurred in the area east and west of the Highway 32 bridge (Glenn County 1997). The mines in this area had permitted extraction rates of 300,000-750,000 CY/y in 1990. These rates are 2 to 6 times the natural pre-dam sediment supply from the upper watershed, and 11 to 29 times the current sediment supply provided by upstream bank erosion (Swanson and Kondolf 1991). These tremendous extraction rates have directly lowered the channel bed within the boundaries of the gravel mines and induced channel incision immediately upstream and downstream. Kondolf and Swanson (1993) state: "Even if extraction were to cease today, the channel will continue to adjust to this catastrophic removal of sediment, probably for decades." In areas where gravel mining activities have created a disturbance threshold that exceeds the maintenance and regeneration capabilities of the native riparian vegetation, invasive weeds such as the Giant reed have become established.

These instream gravel mining activities directly impact salmonids and redds by elevating turbidity levels within and downstream of the extraction zones, and by direct disturbance of fish and eggs present within the extraction zone during instream work. Instream gravel mining also depletes the supply of suitable spawning substrates within the creek, an element that is severely limiting in lower Stony Creek.

7. Bank Stabilization/Agricultural and Residential Land Use

Bank stabilization and riprapping associated with land use activities such as agriculture and home building have altered streambank and channel morphology on lower Stony Creek. These practices have led to reductions in downstream recruitment of gravel and large woody debris which has reduced the quality and quantity of the PCEs of spawning and rearing habitat. It is suspected that groundwater pumping may lower the water table which causes Stony Creek water to absorb into the surrounding alluvium and prolongs the period of time that the creek remains disconnected from the Sacramento River during dry periods. However, groundwater hydrographs show that groundwater levels in, and near, the Orland Project actually rise as evidenced by spring and fall groundwater

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measurements (www.ca.water.gov). DWR hydrographs also show an increase in groundwater levels in proximity to the TCC and in related service areas since the mid-1980's. In addition, small unscreened water diversions for agriculture use result in direct entrainment of emigrating salmonids.

8. Species Interactions

In addition to salmonids, lower Stony Creek supports a wide variety of native non-salmonid migratory and resident species, and numerous introduced non-salmonid species. These species may compete with Chinook salmon and steelhead for food and/or suitable habitat, and several may prey upon salmonid fry and juveniles. Population estimates of these species and potential for adverse impacts to salmonids are unknown at this time. Adult Sacramento pikeminnow are known to be abundant in Stony Creek during the spring (the species' spawning period) and are known to prey on salmonid fry. Table 4 shows all fish species reported from various past studies of Stony Creek. The table gives the species names, status as to being exotic or native to the creek, and the area in which they were found.

Table 4
Fish Species Reported In The Stony Creek Watershed

Common Name	Scientific Name	Native / Exotic (N/E)	Above Black Butte Dam	Below Black Butte Dam	Source
Chinook Salmon	*Oncorhynchus tshawytscha*	N		X	a,c,d
Steelhead Trout	*Oncorhynchus mykiss mykiss*	N		X	d
Rainbow Trout	*Oncorhynchus mykiss*	N	X		a,b,c
Sacramento Sucker	*Catostomus occidentalis*	N		X	a,b
Common Carp	*Cyprinus carpio*	E	X	X	a,b,c
Sacramento Squawfish	*Ptychocheilus grandis*	N		X	a,b
California Roach	*Hesperoleucus symmetricus*	N		X	a.b
Speckled Dace	*Rhinichthys osculus*	N		X	a,b
Brown Bullhead	*Ameiurus nebulosus*	E		X	a
Mosquito fish	*Gambusia affinis*	E		X	a,b
Largemouth Bass	*Micropterus salmoides*	E	X	X	a,b,c
Green Sunfish	*Lepomis cyanellus*	E	X	X	a,b,c
Bluegill Sunfish	*Lepomis macrochirus*	E	X	X	a,b,c
Threespine Stickleback	*Gasterosteus aculeatus*	N		X	a,b

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Bigscale Logperch	*Percina macrolepida*	E		X	b
Riffle Sculpin	*Cottus gulosus*	N		X	b
Prickley Sculpin	*Cottus asper*	N		X	b
Hitch	*Lavinia exilicauda*	N		X	b
Golden Shiner	*Notemigonus crysoleucas*	E		X	b
Hardhead	*Mylopharodon conocephalus*	N	X	X	b,c
White Crappie	*Pomoxis annularis*	E	X	X	b,c
Black Crappie	*Pomoxis nigromaculatus*	E	X		c
Striped Bass	*Morone saxatilis*	E	X		c
Smallmouth Bass	*Micropterus dolomieu*	E	X	X	b,c
Channel Catfish	*Ictalurus punctatus*	E	X	X	b,c
White Catfish	*Ameiurus catus*	E	X	X	b,c
Black Bullhead	*Ameiurus melas*	E		X	b
Tule Perch	*Hysterocarpus traski*	N		X	b
Warmouth	*Lepomis gulosus*	E		X	b
Threadfin Shad	*Dorosoma petenese*	E	X	X	b,c
Redear Sunfish	*Lepomis microlophus*	E	X		c
Lamprey	*Lampetra spp.*	N		X	b

Sources:
a. Puckett, 1969
b. M. Brown, 1995
c. DFG (unpublished files Region II)
d. Maslin and McKinney, 1994

C. Likelihood of Species Survival and Recovery in the Action Area

Under baseline conditions, there is zero likelihood of survival and/or recovery of naturally reproducing populations of winter-run Chinook salmon and spring-run Chinook salmon in lower Stony Creek. There is no evidence indicating that winter-run Chinook salmon ever spawned and reproduced in Stony Creek, and it is likely that winter-run use of the creek has always been, as it is today, as opportunistic non-natal rearing habitat.

Spring-run Chinook salmon have been cut off from their historic holding and spawning habitat by the dams on Stony Creek. This blockage of the historic migratory corridor makes it impossible for spring-run Chinook salmon to reproduce in Stony Creek. Spring-run Chinook salmon are now limited to using the creek as non-natal rearing habitat during those periods when water temperatures are suitable and the creek has a flowing connection to the Sacramento River.

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The majority, if not all, of the historic steelhead spawning habitat in Stony Creek has also been cut off by Black Butte Dam. Recent monitoring has not detected any adult or natal juvenile steelhead in lower Stony Creek, and there is no evidence to indicate that steelhead have used the creek as spawning habitat in recent years. However, habitat conditions during the winter spawning and incubation period remain marginally suitable for steelhead reproduction, and it is possible that with the GCID barrier removed from the mouth of the creek since 1999, and ongoing habitat restoration under way, steelhead could eventually recolonize the lower creek and establish a spawning population.

V. EFFECTS OF THE ACTION

For purposes of this analysis, water temperature and flow evaluations in lower Stony Creek are based on official records for the period 1979-1998 (Reclamation 1998, Reclamation and Corps 2001). Project operations and environmental conditions (*i.e.* instream flows, release schedules, water temperatures, etc.) have not changed significantly since this period. This data set is the most recent complete and comprehensive data available and constitutes the best scientific and commercial information available.

A. Approach to the Assessment

1. Information Available for the Assessment

To conduct this assessment, NMFS examined an extensive amount of evidence and information from a variety of sources. Detailed background information on the status of these species and the potential effects of this project on these species has been taken from a number of documents including project-specific environmental reports, peer reviewed scientific journals, primary reference materials, government and non-government reports, project meetings and personal communications.

2. Assumptions Underlying this Assessment

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.

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.

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Because the proposed project is essentially the continuation of water management operations as they have occurred in the recent past, the habitat conditions and the effects of the project that have been observed in the recent past (baseline conditions) are at times described in this section and used as a reasonable estimation of the habitat conditions that can be expected to result from the future effects of the proposed project (effects of the action).

B. Reservoirs Above Black Butte Dam

Under current (and future) operational procedures, storage in East Park and Stony Gorge Reservoirs is maintained as close to the maximum allowable storage levels as possible, unless irrigation demands necessitate releases. The 1964 Exchange Agreement allows Orland Project water held in the upper reservoirs to be exchanged with CVP water within Black Butte Lake. Releases of Orland Project water are then made from Black Butte Lake storage instead of from the upper reservoirs. Water left in the upper reservoir early in the season is available for release to the irrigation system later in the summer or early fall.

In the last 16 years (1991 through 2006), East Park Reservoir has been maintained close to the maximum storage for 13 of 16 years and has consistently re-filled in the winter/spring following the draw-down years. Stony Gorge Reservoir has been drawn down to some extent each fall, but only 6 of those 16 years saw significant draw downs below 32,000 acre-feet of storage (California Data Exchange Center, provisional data).

In years following these rare significant drawdowns, the upper reservoirs refill during the winter months, capturing runoff that would otherwise flow downstream to the lower basin. By capturing this runoff, the refilling of the upper reservoirs delays the filling of Black Butte Lake and may prolong the period of minimum flow releases into lower Stony Creek and therefore extend the period when lower Stony Creek remains dry at its mouth and is hydrologically disconnected from the Sacramento River. When Stony Creek flows fail to reach the Sacramento River this prevents adult steelhead from entering the creek to spawn. The lack of access to Stony Creek in the fall and early winter also prevents fall-run Chinook salmon from spawning in the creek which eliminates an important source of nutrition (*i.e.*, salmon eggs and invertebrates that feed on salmon carcasses) for adult and juvenile steelhead and juvenile winter- and spring-run Chinook salmon. The loss of this important source of nutrients can reduce fitness levels and survival rates of juvenile salmonids rearing in Stony Creek.

C. Black Butte Dam and Lake

The construction of Black Butte Dam on the main stem of Stony Creek in 1963 blocked access by anadromous salmonids to the remainder of their historic spawning habitat within the Stony Creek watershed, including all tributaries to Stony Creek, above Black Butte Dam. The only reach left accessible to these fish is the lower 24.6 miles of creek which runs along the valley floor between the base of Black Butte Dam and the confluence with the Sacramento River. Historical conditions within this reach provided

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very poor if any suitable habitat for salmonid spawning and rearing. High temperatures and low flows created lethal conditions during most summer and early fall months, while high flashy flows carrying heavy sediment loads likely made winter conditions less than optimal for spawning. While the controlled release of stored water from the bottom of Black Butte Lake has likely provided some improvements to habitat conditions such as cooler water later into the spring, more consistent flows and less severe flood conditions, there are still many obstacles to the re-establishment of successful steelhead spawning populations in Stony Creek. These same obstacles prevent the establishment of a significant fall-run Chinook salmon population in Stony Creek, which in turn prevents the influx of important marine based nutrients to the system, impacting the fitness and survival of listed salmonids rearing in Stony Creek.

Black Butte Dam impacts the PCE's of critical habitat in Stony Creek by altering the timing and magnitude of flows as well as sediment transport to lower Stony Creek. Prior to construction of the dam, the channel was a high-gradient, bedload-dominated system with sharp fluctuations in discharge, where the channel carrying the main flow shifted periodically. Post-dam, the flood peaks have been attenuated, and storm runoff is stored for planned releases. Channel width and sediment transport have been reduced in the upper reaches and significant channel realignment has occurred. The sources of most bedload and suspended sediments have been eliminated by the dam. High volume flood control releases can produce accelerated bank erosion, which is the only source for recruitment of coarse bedload within this lower reach. Long-term impacts to PCEs associated with reservoir operations include the decreased recruitment of steelhead and fall-run Chinook spawning gravels, reduced recruitment of woody debris, and encroachment of non-endemic vegetation into spawning and rearing areas resulting in reduced habitat quality (NMFS 1996).

1. Temperature

Lower Stony Creek stream temperatures are directly influenced by ambient air temperature, solar radiation, shading, channel geometry, the temperature and volume of water released from Black Butte Lake. Releases made from Black Butte Lake are made from an outlet located at the bottom of the reservoir, ensuring the coldest temperatures possible. Black Butte Lake often stays relatively shallow during the summer months. Vertical temperature profiles indicate that the lake remains thermally unstable or weakly stratified and is easily mixed vertically by winds and diurnal heating and cooling. The waters are warm throughout the depths during the summer (Corps 1987). Reclamation's analysis of daily mean temperatures from four monitoring locations on lower Stony Creek from July 1995 to December 1997, indicate that winter temperatures are fairly consistent from year to year. Generally, stream temperatures begin to increase in the spring and exceed optimal rearing temperatures (>66 °F) between late April and August. Stream temperatures begin decreasing in September, generally reaching optimal spawning temperatures again in November.

Water temperatures warming up early in the spring can have several adverse effects on listed juvenile salmonids rearing in lower Stony Creek. Elevated temperatures can

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increase susceptibility to diseases, reduce growth rates and increase mortality in salmonids rearing in the creek. High water temperatures can also force juveniles out of the creek into the Sacramento River where rearing habitat is less appropriate for small salmonids than in smaller creeks.

When warm water temperatures are maintained into the fall they can prevent fall-run Chinook salmon from spawning in the creek, thereby eliminating an important source of nutrients for rearing juveniles.

2. Flood Control Operations

The recently revised ramping criteria for flood control releases from Black Butte Lake are described in the Environmental Baseline section of this document. While these revised criteria provide more gradual flow fluctuations during flood control operations than did the old criteria, the flashy nature of Stony Creek still creates situations where it is necessary for releases from Black Butte Dam to increase and decrease rapidly to prevent catastrophic flooding and insure the safety and structural integrity of Black Butte Dam. Stranding of Chinook salmon and steelhead may occur when water levels drop quickly and fish are either left totally exposed in dewatered areas or isolated in wetted areas that are no longer connected to the creek. Incubating eggs are even more susceptible to stranding due to their immobility and the tendency of salmonids to build their redds in shallow riffles. If no additional high flow events follow within a short period of time, isolated fish and eggs are likely to be lost to predation, lethal water temperatures, or desiccation.

The recently revised criteria for management of the bottom 5 to 7 percent of the flood pool in Black Butte Lake (described in the Environmental Baseline section of this document) generally has been successful in maintaining minimum flows of 100 to 200 cfs during the winter and spring flood control periods since late 2003 when the operating agreement was initiated. While no scientific studies have been conducted to analyze the effectiveness of these minimum flows in maintaining suitable steelhead spawning habitat PCEs, they have been found to maintain a flowing connection to the Sacramento River, provide suitable water temperatures for both spawning and rearing, and create a general bank-full condition that maintains connectivity throughout the lower creek, which reduces the potential for stranding and allows free movement through the area (Richard Corwin, Reclamation, pers. comm., May 2005). This recent success in maintaining 100 to 200 cfs minimum flows has occurred during relatively wet years and it is not yet known how successful these new protocols will be in maintaining adequate flows in drier years.

3. Black Butte Dam Powerplant

The Black Butte Dam Powerplant is operated opportunistically to take advantage of releases which are otherwise required for flood control or diversions. Flows releases are not controlled or regulated for hydropower generation. The intake for the powerplant takes water from the base of the dam and therefore provides the coldest water available

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from the reservoir. The powerplant uses only the force of the water to turn the turbines and generate hydropower, and water that is used is subsequently released to lower Stony Creek below Black Butte Dam. Temperature measurements taken at the powerplant tailwaters before release downstream indicate the powerplant does not significantly increase water temperatures downstream. Due to the eventual return of all water used at the powerplant to the creek and the method of power generation, powerplant operations do not affect the amount of flow released into lower Stony Creek from Black Butte Dam and have a negligible effect on the temperatures of flow releases. Therefore, powerplant operations are not likely to impact salmonids in lower Stony Creek.

D. South Diversion Intake and South Canal

The South Diversion Intake and South Canal divert water from an area directly below Black Butte Dam where there is no access for anadromous fish and therefore, no opportunity for listed fish to become entrained in the diversion facility.

South Canal diversions result solely from irrigation demand on the Orland Project south side operations. The Exchange Agreement requires Orland Project irrigation deliveries be provided from Black Butte storage, if available, which allows the upper reservoirs to maintain higher storage while reducing impacts on overall annual system storage since Black Butte flood control procedures require the annual evacuation of Black Butte Reservoir prior to the flood control season (late fall). However, the diversion of this stored water precludes its release into lower Stony Creek where it could otherwise improve the PCEs of critical habitat and improve survival of listed salmonids. If water was not released from Black Butte reservoir for Oreland Project diversions, there would be a greater volume of water left in Black Butte reservoir available for release down Stony Creek in the late fall when the Corps evacuates the reservoir for flood control purposes. Release of higher volumes of water during the late fall period would open up Stony Creek to the Sacramento River, improve habitat conditions in the creek, and allow earlier access to the creek for steelhead and fall-run Chinook salmon. Additionally, in some years, lower reservoir storage may result in higher release temperatures during late spring which could adversely affect listed salmonids incubating or rearing (natal or non-natal) within lower Stony Creek. Elevated temperatures can increase susceptibility to diseases, reduce growth rates and increase mortality in salmonids rearing in the creek. High water temperatures can also force juveniles out of the creek into the Sacramento River where rearing habitat is less appropriate for small salmonids than in smaller creeks. Due to a lack of temperature and habitat modeling for this system, the magnitude of potential impacts to habitat quality resulting from the diversion of this water has not been determined.

E. Northside Diversion Dam and North Canal

North Canal diversions will typically occur during the months of March to November although diversions may occur in any month of the year dependent on water demands and weather patterns. Maximum diversion rates are limited to 130 cfs and there is generally a minimum 30 cfs bypass to lower Stony Creek.

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As with the South Diversion, diversions occurring at the North Diversion Dam result from irrigation demand on Orland Project north side operations. The Exchange Agreement requires Orland Project irrigation deliveries be provided from Black Butte storage, if available, which allows the upper reservoirs to maintain higher storage while reducing impacts on overall annual system storage since Black Butte flood control procedures require the annual evacuation of Black Butte Reservoir prior to the flood control season (late fall).

The release of water for diversion at NDD provides relatively high, stable flows in the upper reach of lower Stony Creek, but the diversion of this water at NDD prevents its continuation down the creek where it could otherwise improve the flow and temperature based PCEs of critical habitat. If water was not released from Black Butte reservoir for Oreland Project diversions, there would be a greater volume of water left in Black Butte reservoir available for release down Stony Creek in the late fall when the Corps evacuates the reservoir for flood control purposes. Release of higher volumes of water during the late fall period would open up Stony Creek to the Sacramento River, improve habitat conditions in the creek, and allow earlier access to the creek for steelhead and fall-run Chinook salmon. Additionally, in some years, lower reservoir storage may result in higher release temperatures during late spring which could affect salmonids incubating or rearing (natal or non-natal) within lower Stony Creek. Elevated temperatures can increase susceptibility to diseases, reduce growth rates and increase mortality in salmonids rearing in the creek. High water temperatures can also force juveniles out of the creek and into the Sacramento River where rearing habitat is less appropriate for small salmonids than in smaller creeks. Due to a lack of temperature and habitat modeling for this system, the magnitude of potential impacts to habitat quality resulting from the diversion of this water has not been determined.

1. Adult Migration, Spawning, and Egg Incubation

In most years, November is the month when water temperatures in Stony Creek cool to the level of preferred temperatures for migrating steelhead adults. Upstream migration and spawning is limited to the reach of Stony Creek below Black Butte Dam due to the impassable nature of this facility. In most years, diversions at NDD have ceased by mid-November, prior to the initiation of the steelhead spawning migration in the Central Valley, and do not resume until late March, after the upstream migration period has ended (DFG 1993). During periods of non-diversion at NDD, the flashboards are removed from the crest of the dam and a large drum gate on the east side of the dam is often raised to allow creek flows to pass through this section of the dam.

A recent barrier analysis conducted by Reclamation (Corwin 2003) found that upstream passage at NDD is completely blocked during periods when the flash boards are installed and that even when the flash boards are removed (*i.e.*, typically from November through March, when most adult Central Valley steelhead migrate), the dam is impassable to average length steelhead at all flow levels. Only steelhead 640 mm and over, or the upper 10 percent of steelhead measured at RBDD should be able to jump over the lowest

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measured crest height, measured at 4,744 cfs. It also was concluded that steelhead measuring 785 mm and above or 0.4 percent of steelhead measured at RBDD would be capable of jumping the dam at any flow levels examined. This study also found that average sized Chinook salmon from the Sacramento River would be capable of passing NDD at all flows above 1,400 cfs and possibly even lower flows down to 165 cfs (Corwin 2003). While the ability to pass NDD would not be expected to benefit winter- or spring-run Chinook salmon, the ability of fall-run Chinook salmon to pass NDD would allow the influx of important nutrients to the system which could benefit rearing juveniles of all runs of Chinook salmon and steelhead in lower Stony Creek. There has been no monitoring for adult salmonids above NDD and juvenile monitoring in the North Diversion Canal during the irrigation season has not detected any juvenile salmonids.

Installation and removal of NDD flashboards requires that releases from Black Butte be brought to 30 cfs for 24 hours prior to, and for the 4 to 5 hours during, the manipulation of the boards. Installation typically occurs in March when irrigation demands begin (average monthly releases from Black Butte Lake range from approximately 90 cfs to 1,750 cfs) and removal typically occurs in November when irrigation demands subside (average monthly releases from Black Butte Lake range from 33 cfs to 224 cfs). Flow fluctuations during installation and removal of the flashboards have the potential to impede passage, strand adult and juvenile fish and dewater sections of spawning gravel containing incubating eggs and newly hatched fry. Depending on weather conditions at the time of flashboard installation and removal, the required low flow level may temporarily increase water temperatures in the creek. Stranding, dewatering, and water temperature increases are expected to result in physiological stress and possibly mortality of individuals exposed to these conditions. Once the flashboards are in place, NDD becomes a total barrier to upstream passage.

2. Fry, Juveniles, and Smolts

If any adult steelhead are able to traverse NDD and successfully spawn in the reach above the dam, the operation of NDD and North Canal is likely to adversely affect juveniles hatched above the structure. Throughout much of the irrigation season the majority of the water (70 to 80 percent) coming down lower Stony Creek is diverted into the unscreened North Canal. Therefore, downstream migrants which attempt to pass NDD after diversions have begun will have a good chance of being diverted into North Canal where they would not survive.

Steelhead spawned and reared above NDD would have to disperse out of Stony Creek as young-of-the-year instead of smolts since lethal summer temperatures (>75 °F occurring as early as June and continuing to October) make it impossible for a year-round population of steelhead juveniles to survive above NDD. Dispersal triggered by temperatures increasing above 65 °F may occur from late April to mid-June. Since the North Canal typically is operated during this time, steelhead migrating downstream from above NDD would likely to be entrained into the North Canal. Juvenile spring-run and winter-run Chinook salmon are not expected to rear above NDD and would not be subjected to entrainment into North Canal.

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Reclamation conducted a monitoring program in the North Canal from 2001 through 2004 in which they operated a fyke net in the upper end of the canal during the early summer diversion period (generally April through June) of each year (Corwin and Grant 2004). The fyke net sampled approximately 15 percent of the total flow in the canal during the sampling period and captured nearly 6,000 fish. None of these fish were salmonids. Continued monitoring through 2006 has likewise failed to detect any salmonids in the North Canal (Reclamation 2006). This data, along with the poor passage conditions at NDD and the poor quality of spawning habitat in the creek above NDD all indicate that there is no successful salmonid spawning occurring above NDD, primarily due to the adverse impacts of the proposed project.

F. Constant Head Orifice Rediversion

The CHO is operated based on demands from April 1 through May 15 and from September 15 through October 29, up to a maximum of 38,293 acre-feet per year. Diversions at the CHO may result in reductions of Black Butte Lake storage. The diversion of this stored water provides increased flows down Stony Creek to the CHO but precludes its continuation down the creek below the CHO where it would otherwise be available to manage for improved salmonid critical habitat PCEs. Additionally, in some years, lower reservoir storage may result in higher release temperatures during late spring through early fall which potentially would affect salmonids incubating or rearing (natal or non-natal) within lower Stony Creek. Due to a lack of temperature and habitat modeling for this system, the magnitude of potential impacts to habitat quality resulting from the diversion of this water has not been determined.

1. Adult Migration, Spawning, and Incubation

CHO operations in the spring can occur during the tail end of the upstream spawning migration period of steelhead. However, very few steelhead are anticipated to be migrating at this time into Stony Creek since April is the very end of the spawning period for steelhead (DFG 1993) and fish are likely to have migrated to their spawning grounds earlier in the spring. Additionally, if any steelhead were to spawn in lower Stony Creek in April or May, their eggs would not be likely to survive as water temperatures in this area generally rise above the level that is lethal to incubating steelhead eggs (58 °F) by mid-April (Reclamation and Corps 2001). Therefore, the operation of the CHO is not likely to adversely affect adult Central Valley steelhead migration and spawning.

2. Fry, Juveniles, and Smolts

Steelhead juveniles spawned and reared in lower Stony Creek likely would disperse out of the creek as young-of-the-year instead of age 1+ because high water temperatures make it impossible for juveniles to survive through the summer in lower Stony Creek. Dispersal may be triggered by increasing water temperatures which can exceed 65 °F beginning as early as late April. Since the unscreened CHO may be operated during this time, any steelhead migrating downstream from above the CHO prior to May 15 may be

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entrained into the TCC and would not be expected to survive. In addition, any non-natal rearing winter- and spring-run Chinook salmon and steelhead juveniles located above the CHO likely would disperse out of the creek according to these same temperature triggers and be subject to the same adverse effects. In order to minimize downstream passage problems at the CHO, culverts are placed within the temporary berm to facilitate passage. Also, adverse effects to juveniles are reduced through implementing conditions of the SWRCB permit (*e.g.*, maintaining bypass flows of 40 cfs below the CHO, slowly ramping down flows, and providing a fish distribution flow of 100 cfs prior to rediversion).

Reclamation conducted monitoring of entrainment into the TCC at the CHO in the springs of 2001, 2002, 2004, and 2005 (Corwin and Grant 2004, Reclamation 2005b, Reclamation 2006). No CHO diversions occurred in 2003 or 2006. The first year of sampling (2001) was basically a pilot year in which sampling strategies and protocols were tested and refined. A single fyke net was deployed for approximately 96 hours over a 15-day period. Only five fish and no salmonids were captured in 2001. In 2002 and 2004, two fyke nets were deployed side-by-side throughout most of the diversion period and several thousand fish, mostly Sacramento suckers (*Catostomus occidentalis),* were captured each year. In 2002, a total of 43 juvenile Chinook salmon were captured in the 2 fyke nets, and the expanded estimate of the total number of Chinook salmon entrained into the TCC that year was 328. In 2004, a total of 20 juvenile Chinook salmon were captured in the 2 fyke nets, and the expanded estimate of the total number of Chinook salmon entrained into the TCC that year was 92. In 2005 there was only a short, four-day diversion period (April 22 – 25). The fyke nets were deployed for a total of 69 hours sampling a total of approximately 175 acre feet of water. Only two fish were captured during this sampling effort, neither of which were salmonids. No steelhead were captured during any of the sampling in the TCC.

It is impossible to positively identify which ESU a wild Chinook salmon belongs to without genetic analysis. However, a length criteria analysis developed for juvenile Chinook salmon on the Sacramento River (Green 1992) indicates that all of the salmon captured (43 individuals) in 2002 were in the fall-and late fall-run Chinook salmon category. This same length criteria analysis indicates that in 2004, approximately 65 percent of the Chinook salmon captured were in the fall- and late fall-run category (resulting in an expanded estimate of 60 individuals entrained), and 35 percent were in the spring-run category (resulting in an expanded estimate of 31 individuals entrained). It should also be noted that the length-at-date criteria model for the Sacramento River (Green 1992) is not necessarily a good indicator for determining ESU classifications of Chinook salmon in tributaries of the Sacramento River. Moore (1997) found that Chinook salmon in Blue Tent Creek grew faster and had a higher condition factor than those in the mainstem Sacramento River, and Maslin *et al.* (1997) stated, "Individuals of the correct size to be members of each of the four Sacramento Chinook races were observed (in Sacramento River tributaries) but rapid growth makes race assignment based on size questionable."

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VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Non-Federal actions that may affect lower Stony Creek include agricultural practices, water withdrawals/diversions, gravel mining, and State or privately sponsored habitat restoration and bank stabilization activities.

A. Agricultural Practices

Agricultural practices in the lower Stony Creek watershed are expected to continue into the future at similar acreages and crop types as are found today. Agriculture is the dominant land use in the area with a variety of crops and practices employed. The dominant perennial crops include both permanent pastures and orchards, and annual crops including wheat, hay, field corn, sugar beets, beans, and Sudan grass. A substantial area within the lower watershed is also used for grazing. Most of the grazed land occurs between Black Butte Dam and the TCC (Reclamation 1998).

Grazing along Stony Creek could increase erosion, reduce riparian vegetation and increase the nutrient load into the creek. The application of chemicals and fertilizers to crops along the creek also could increase the level of contaminants entering the creek. Agricultural water use will also impact the condition of PCEs on lower Stony Creek. Groundwater pumping can lower the water table and cause Stony Creek water to absorb into the surrounding alluvium which could prolong the period of time that the creek remains disconnected from the Sacramento River during dry periods, however Orland Project surface irrigation has been shown increases groundwater levels in the project area.

B. Gravel Mining

As of 1998, six instream gravel extraction operations existed along lower Stony Creek, occupying a total of 1,179 acres, and several new gravel mining operations are proposed for development along lower Stony Creek in the near future (Reclamation 1998). According to the draft Stony Creek Watershed Assessment Existing Conditions Report (Harvey and Associates 2006), gravel extraction rates for these mining operations were not publicly available because the data were considered proprietary. However, Swanson and Kondolf (1991) compiled the permitted extractions for the mines active on Stony Creek at the time of their study. The mining operations immediately upstream and downstream from Hwy 32 had combined permitted extraction rates of 300,000-750,000 CY/y in 1990. These rates are 2 to 6 times the natural pre-dam sediment input from the upper watershed, and 11 to 29 times the sediment supply currently provided by upstream bank erosion. Kondolf and Swanson (1993) state: "Even if extraction were to cease today, the channel will continue to adjust to this catastrophic removal of sediment, probably for decades." Gravel mining activities are expected to continue to directly

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impact salmonids and critical habitat by elevating turbidity levels within and downstream of the extraction zones, and by direct disturbance of any fish and eggs present within the extraction zone during instream work. Instream gravel mining will also continue to deplete the supply of suitable spawning substrates within the creek. These spawning gravels are a PCE of critical habitat that is severely limiting in lower Stony Creek, and their continued extraction, with no significant replenishment, will eventually make the creek completely unsuitable for salmonid spawning. Assuming the above mentioned rates of extraction will continue into the future, it is likely that the associated adverse impacts to critical habitat will continue and likely intensify.

C. Invasive Weed Control and Bank Stabilization

In 2000 the Glenn County Planning Department conducted a scoping process to determine the goals for the lower Stony Creek watershed. The goals that landowners identified were invasive species eradication, reduction of erosion, and modification of the release schedule from Black Butte Dam, also to reduce erosion. The Glenn County Resource Conservation District (GCRCD) is in the process of acquiring and coordinating funding, technical assistance, and permits in order to address the issues and concerns identified by the lower Stony Creek landowners.

Currently, the GCRCD proposes to provide technical, funding, and permitting assistance to private landowners on lower Stony Creek to implement the Lower Stony Creek Non-Native Invasive Species Eradication Project. The purpose of the project is to facilitate the eradication of Giant Reed (*Arundo donax)* and Salt Cedar (*Tamarix)*, revegetate the creek banks with native plants, install vegetative and structural bank stabilization features, and coordinate the permitting process. The GCRCD proposes to coordinate projects on private land using standardized and accepted methods and practices of weed management and bank stabilization in such a way that will not endanger, but improve, public and private natural resources and the environment. The GCRCD will then monitor project effectiveness and completeness using a Quality Assurance Project Plan developed by the GCRCD in conjunction with a technical advisory committee.

This project is likely to create some long-term benefits to salmonids and critical habitat PCEs in lower Stony Creek by improving riparian habitat and reducing fine sediment influx into the creek. There also are likely to be some short-term adverse impacts from instream construction of bank stabilization features and pesticide inflow from weed control. There is likely to be a long-term reduction in spawning gravel recruitment into the creek as lateral bank erosion, which is currently the only source of recruitment of new gravels into the creek, will be reduced.

VII. INTEGRATION AND SYNTHESIS

The greatest adverse effect associated with Stony Creek water management operations is the complete blockage of access by anadromous species to their historical spawning and rearing habitat above Black Butte Dam. Because this historic habitat is no longer

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accessible, Chinook salmon and steelhead are relegated to a small reach of the creek containing only marginal habitat that was not historically used to any great extent by these species. This makes these fish particularly vulnerable to the adverse effects of water management operations of the Corps and Reclamation. These Federal agencies, through the storage, release, and rediversion of flows, control the quantity and quality of the small amount of remaining habitat on Stony Creek.

The alteration of the natural hydrologic cycle due to upstream dam operations on Stony Creek has the potential to adversely affect all life stages of steelhead, as well as non-natal juvenile spring-run and winter-run Chinook salmon. Reservoir operations resulting in large scale flow fluctuations could cause adverse effects such as redd scouring or juvenile stranding. Extended periods of low flow releases can result in increased temperatures and reduced habitat availability.

NDD is a significant barrier to anadromous salmonids, and if any adults manage to pass above the dam and successfully spawn, entrainment of juveniles may occur within the North Canal (though no such passage or entrainment has been detected in 4 years of monitoring (Corwin and Grant 2004)). Juvenile steelhead, spring-run and winter-run Chinook salmon rearing in Stony Creek may also be entrained in the CHO Diversion. The diversion of water out of Stony Creek for consumptive purposes reduces flows below those diversions which can result in increased water temperatures and reduced quality and quantity of critical habitat.

The blockage of spawning gravels by Black Butte Dam, along with gravel extraction at the many mining operations along the creek have created a severe shortage of suitable spawning habitat in lower Stony Creek, with the upper end deeply incised down to bare rock and hardpan, and the lower end heavily dominated by fine sediments that can smother salmonid redds and reduce reproductive success. The continuation of these problems along with a new drive to stabilize the banks of the creek and thus eliminate the last source of gravel recruitment into the creek (*i.e.,* lateral erosion which recaptures old gravel deposits from the historic floodplain) will eventually make the creek completely devoid of suitable spawning habitat.

Impacts on Species Survival and Potential for Recovery

In examining the potential impacts of Stony Creek water management operations on the survival and potential for recovery of listed salmonids, one must determine whether or not those impacts are likely to reduce the numbers, reproduction, or distribution of these fish in such a way that their likelihood of recovery and survival within the action area is appreciably diminished, and if so, how those local reductions are likely to affect the overall populations throughout the Central Valley.

1. Winter- and Spring-run Chinook Salmon

With regards to winter-run and spring-run Chinook salmon, it is clear that project impacts on Stony Creek are unlikely to affect either reproduction or distribution of these ESUs as

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there are no spawning populations of either ESU in Stony Creek. The fact that non-natal juvenile winter-and spring-run Chinook salmon have been documented rearing in Stony Creek means that certain impacts of the water management operations such as sustained low flows, flow fluctuations, and unscreened water diversions could cause a reduction in the numbers of fish that use Stony Creek as rearing habitat. However, the majority of juvenile salmon collected in Stony Creek have been found within the lower two miles of the creek (Maslin and McKinney 1994, Corwin and Grant 2004) where they are not exposed to water diversions and they are likely to have the ability to escape to the Sacramento River when conditions in Stony Creek become unfavorable. Therefore, it is likely that very few of the fish that use Stony Creek as a rearing area actually are harmed or killed by the adverse effects associated with water management operations.

In estimating the effect of the loss of a small proportion of Stony Creek juveniles on the broader Central Valley populations of these ESUs, it is important to note that the poor habitat conditions found in Stony Creek (fluctuating flows, high temperatures, low instream habitat diversity, and poor SRA habitat) make it unlikely that this creek is used as non-natal rearing habitat by a significant proportion of the juvenile populations of these ESUs. On the other hand, were the creek managed in a more favorable manner to improve rearing conditions for juvenile salmonids, this large tributary with a long stretch of accessible, low-gradient habitat could serve as high-quality rearing habitat for a larger number of juvenile winter- and spring-run Chinook salmon. Under current conditions, the injury and death of the small number of juvenile Chinook salmon impacted by Federal water management operations is unlikely to result in detectable reductions in the number, reproduction, or distribution of winter- and spring-run Chinook salmon given the large fluctuations in juvenile survival rates experienced by the populations annually. As a result, NMFS finds that it is not reasonable to expect that these juvenile losses will reduce the likelihood of survival and recovery of the Sacramento River winter-run Chinook salmon or the Central Valley spring-run Chinook salmon.

2. Central Valley steelhead

Although steelhead spawning has not been documented in Stony Creek in recent years, there is access to marginally suitable spawning habitat for steelhead in the creek, and it is reasonable to assume that water management operations can and will have an effect on steelhead numbers, reproduction and distribution within Stony Creek. The severity of the adverse impacts produced by current operations will vary from year to year and season to season dependent on hydrologic conditions, irrigation demands and flood control requirements. It is likely that in years when operations produce extreme flow fluctuations, blockage or delay in migration, extended low-flow periods, and other such impacts, steelhead numbers, reproductive success, and distribution will be reduced. If these severe conditions occur on a regular basis, the likelihood of survival and recovery of any local steelhead population would be appreciably reduced.

The determination that the proposed project has the potential to appreciably reduce the likelihood of survival and recovery of the local steelhead population in lower Stony Creek requires that we must next determine the importance of this population to the

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viability of the overall Central Valley DPS. This importance can be measured by the level of contribution that the Stony Creek population makes to the numbers, genetic diversity, and resilience of the greater DPS.

It is likely that prior to the permanent removal of the GCID crossing, favorable conditions for steelhead spawning and fry survival only occurred on an occasional basis and it is unlikely that a significant sustained population could have been established. The longstanding access problem caused by the GCID canal crossing, along with all of the other effects of current water management operations on Stony Creek make it very unlikely that any current population of steelhead on Stony Creek is large enough or genetically distinct enough to contribute significantly to the Central Valley DPS. Based on the likely low value of the Stony Creek population to the overall diversity and resilience of the Central Valley steelhead DPS, NMFS finds that it is not reasonable to expect that reductions in the likelihood of survival and recovery of the local population will result in reductions in the likelihood of survival and recovery of the DPS.

3. Critical Habitat

Habitat conditions in lower Stony Creek below Black Butte Dam always have been marginal in terms of the ability to support spawning populations of Chinook salmon and steelhead. The location on the valley floor and natural hydrologic conditions created an environment that was likely too hot and dry to serve as anything other than a migratory corridor for these fish to access the more suitable habitat found in the upper reaches of the watershed. The controlled release of relatively cool water out of Black Butte Dam has improved the potential for this reach to serve as spawning and rearing habitat, although that improvement is relatively limited and the habitat remains marginal.

While the proposed water management operations to be conducted on lower Stony Creek do not allow the accessible habitat within the creek to meet the full potential to support and conserve listed salmonids, the small amount of habitat available in lower Stony Creek and the incremental level of degradation likely to result from future operations do not appear to significantly degrade the functions for which the habitat is currently being used (primarily as non-natal rearing habitat during cold water periods). Proposed operations are expected to maintain the currently medium conservation value (NMFS 2005) of the habitat and are not expected to diminish the current levels or types of habitat use by salmonids. As a result, NMFS expects that the proposed operations are not likely to diminish the value of critical habitat in lower Stony Creek for the survival and recovery of spring-run Chinook salmon and steelhead, or diminish the value of critical habitat within the overall designation. Lower Stony Creek water management operations are not expected to impact critical habitat for Sacramento River winter-run Chinook salmon, which has not been designated within the creek.

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VIII. CONCLUSION

After reviewing the current status of endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, and critical habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead, the environmental baseline for the action area, the effects of proposed lower Stony Creek water operations, and all other cumulative effects, it is NMFS' biological opinion that lower Stony Creek water operations are not likely to jeopardize the continued existence of these species, and are not likely to destroy or adversely modify designated critical habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by Reclamation and the Corps (the Agencies) so that they become binding conditions of any permits issued or project descriptions, as appropriate, for the exemption in section 7(o)(2) to apply. The Agencies have a continuing duty to regulate the activities covered by this incidental take statement. If the Agencies fail to assume and implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Agencies must report the progress of the action and its impact on the species to NMFS as specified in this incidental take statement (50 C.F.R. §402.14(i)(3)).

A. Amount or Extent of Take

There are several aspects of the proposed action which have the potential to take listed species. The actual numbers of individuals likely to be taken can be estimated for certain aspects of the project while for others it cannot. With regards to the entrainment of fish into the irrigation canals, data is available from which to derive an estimate of take likely to occur from these activities. Data collected during Reclamation's studies and sampling efforts in lower Stony Creek (Corwin and Grant 2004, Reclamation 2005) has been

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analyzed to create an estimate of the level of entrainment that might occur due to future irrigation diversions on lower Stony Creek.

Although biologists who conducted the fish monitoring study are of the opinion that all Chinook salmon caught near the CHO were most likely members of the fall-run ESU, it is impossible to positively determine which ESU the juvenile Chinook salmon captured or entrained in Stony Creek might belong to. Therefore, a conservative approach will be taken in assuming that all entrained juvenile Chinook salmon are listed species (*i.e.,* either Central Valley spring-run or Sacramento River winter-run Chinook salmon) to insure that adequate accounting of potential take is provided should future ESU identification reveal that some or all these fish are in fact members of the listed ESUs. The highest estimate of Chinook salmon entrainment occurred in 2002 with 328 Chinook salmon entrained. Although Reclamation's monitoring efforts have not detected entrainment of Central Valley steelhead at the TCC diversion or the North Diversion, a small amount of steelhead take will be assumed to insure that any potential future take of steelhead will be accounted for, and thereby avoid jeopardizing Reclamation's future operation of these facilities due to "unauthorized take". Therefore we will assume that the maximum level of take expected at the agricultural diversions on Stony Creek will be 328 juvenile winter-run and/or spring-run Chinook salmon and 20 juvenile steelhead.

The entrainment monitoring and salvage system that is currently being used on the TCC diversion is assumed to capture a large proportion of the fish entrained into the diversion (wing-nets on the fyke traps now span the entire canal and are operated throughout the diversion period; conditions permitting). Every effort is made to insure that all fish captured in these traps are kept in good condition and are released back into the creek, below the diversion, following data collection. Through analysis of past capture and mortality rates, debris loads in the fike traps, and frequent fluctuations in diversion flows at the CHO, Reclamation has estimated that the level of lethal take for salmonids captured within the fyke traps will be approximately 49 fish during each annual monitoring/salvage period.

There are several other aspects of the proposed water management operations which can cause the incidental take of listed species through extreme flow fluctuations, insufficient releases which do not maintain suitable habitat conditions within lower Stony Creek, and the installation, operation and maintenance of diversion structures. The take associated with these activities is likely to occur in the form of dewatered redds, scoured redds, delayed or blocked migration due to low flows and/or structural impediments (diversion structures), isolation and stranding of fish due to flow fluctuations, and reduced survival and fecundity due to unfavorable habitat conditions. It is impossible to estimate the number of listed fish likely to be taken as a result of these impacts due to many unpredictable variables such as population size and timing of use by the various life stages of the listed species in Stony Creek and weather conditions/precipitation levels which will influence the frequency, timing, and magnitude of flow fluctuations as well as water temperatures and habitat availability and quality.

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Because of the unpredictable nature of the annual level of take likely to be caused by these aspects of Stony Creek water management operations, NMFS has designated specific project related ecological surrogates to represent the extent of take anticipated to be caused by Stony Creek water management operations, so that we will be able to monitor those surrogates to determine the level of take that is occurring. The three most appropriate ecological surrogates for the extent of take caused by Stony Creek water management operations are: 1) the timing and duration of rediversion activities at the TCC; 2) the minimum bypass flows that will be maintained below specific diversion points on Stony Creek; and 3) the flood control/ramping rate operations that will be implemented by the Corps.

1. Ecological Surrogates

- The analysis of the effects of the proposed project anticipates that the diversion structure for the TCC will not be installed prior to April 1 of each year and a minimum 40 cfs bypass flow will be maintained at all times while the diversion structure is in place. Additionally, a fish distribution flow of not less than 100 cfs will be released below NDD for a period of 24 hours prior to the commencement of spring time diversions at the TCC.

- The analysis of the effects of the proposed project anticipates that a minimum of 30 cfs flow will be maintained below the lowest point of diversion not withstanding the above 40cfs requirement below the active TCC diversion.

- The analysis of the effects of the proposed project anticipates that the Corps will follow the flood control/ramping rate guidelines described on pages 33 and 34 of this document.

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

B. Effect of the Take

In this biological opinion, NMFS has determined that the level of anticipated take is not likely to jeopardize the continued existence of listed Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead or result in the destruction or adverse modification of critical habitat.

C. Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize take of Sacramento winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead:

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1. Reclamation shall seek to minimize the impacts to listed species associated with the diversion of water from Stony Creek by continuing to capture and count salmonids that may become entrained into the CHO, and release them below the CHO.

2. The Corps shall implement flood release protocols to minimize the adverse effects of low flows and flow fluctuations on incubating eggs as well as juvenile and adult anadromous salmonids in Stony Creek.

3. The Corps shall develop and implement a long-term gravel augmentation program to improve the quality and quantity of salmonid spawning habitat throughout lower Stony Creek.

4. Reclamation and the Corps shall meet with NMFS each spring to determine minimum instream flows in lower Stony Creek during the spring cold-water period. The provision of increased minimum instream flows will be determined using water storage levels in the three reservoirs and projected inflow into Black Butte Reservoir on or after April 1 of each year.

D. Terms and Conditions

Reclamation and the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures listed above. These terms and conditions are non-discretionary.

1. Reclamation shall seek to minimize the impacts to listed species associated with the diversion of water from Stony Creek by continuing to capture and count salmonids that may become entrained into the CHO, and to release them below the CHO.

    A) Reclamation shall continue to implement the fish monitoring/salvage operations at the CHO during all periods that water is being diverted into the TCC during the spring diversion season (April 1-May 15). The trapping facilities shall be designed so as to sample the entire flow of the diversion by extending wing nets from the edges of the traps out to the banks of the channel. This can safely be done with flows up to 200 cfs. Wing nets or similar devices should also be employed between the two traps to insure that fish are not able to pass between the traps without being captured. When flows are above 200 cfs, Reclamation shall sample as much of the flow as can be safely sampled, with a minimum of 40% of the channel being sampled.

    B) Reclamation shall provide an annual report on the number, species, and disposition of all salmonids captured during the monitoring/salvage operations at the CHO. This report shall be provided within four months of the completion of monitoring/salvage operations each year. Take may

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not exceed 328 Chinook salmon and 20 steelhead. Lethal take for salmonids may not exceed 49 individuals during the annual monitoring/salvage operations.

The above mentioned report required by term and condition 1-B shall be submitted to:

Office Supervisor
Sacramento Area Office
National Marine Fisheries Service
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814
FAX: (916) 930-3629
Phone: (916) 930-3604

2. The Corps shall implement flood release protocols to minimize the adverse effects of flow fluctuations on incubating eggs as well as juvenile and adult anadromous salmonids in Stony Creek.

A) The Corps shall implement, to the extent possible, the ramping rate criteria provided in Table 5 for flood releases[1] from Black Butte Lake when storage elevations are encroached into the prescribed flood control space required at any particular time as determined from the updated Flood Control Diagram.

The rates of change for increasing flood releases of minimum flow to 1,000 cfs shall be as follows:

i. When storage encroaches 0 percent to 25 percent of the required flood control space, releases will be increased by no more than 250 cfs/hour.

ii. When storage encroaches 25 percent to 50 percent of the required flood control space, releases will be increased by no more than 500 cfs/hour.

iii. When storage encroaches 50 percent or more of the required flood control space, releases will be increased by no more than 1,000 cfs/hour.

When flood releases are above 1,000 cfs, releases shall be increased by no more than 1,000 cfs/hour. Exceptions to this requirement shall be allowed to insure the

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[1] *All releases are expected to be within +/- 5 percent of those targeted.*

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structural integrity of the Corps' facilities and in emergency situations, to protect human lives and property from downstream flood damages.

The rate of change for decreasing releases shall be as follows:

i When flood release is 15,000 cfs to 5,000 cfs, releases will be decreased by no more than 500 cfs/hour.

ii When flood release is 5,000 cfs to 500 cfs, releases will be decreased by no more than 250 cfs/hour.

iii. When flood release is 500 cfs to 100 cfs, releases will be decreased by no more than 250 cfs/day at a rate not greater than 30 cfs/hr.

iv. When flood release is at or below 100 cfs, releases will be decreased in approximately 10 cfs/hour increments.

Table 5. Corps Ramping Rates[1]

When Increasing Flood Releases from Minimum Flow to 1,000 cfs:	
0 % to 25 % encroachment	250 cfs/hr or less
25 % to 50 % encroachment	500 cfs/hr. or less
Above 50 % encroachment	1,000 cfs/hr or less
When Increasing Flood Releases Above 1,000 cfs[2]:	
Any encroachment	1,000 cfs/hr. or less
When Decreasing Flood Releases:	
Flood releases 15,000 to 5,000 cfs	500 cfs/hr. or less
Flood releases 5,000 to 500 cfs	250 cfs/hr. or less
Flood releases 500 to 100 cfs	250 cfs/day at a rate not greater than 30 cfs/hr
Flood releases 100 cfs or less	10 cfs/hr

[1]*All releases are expected to be within + /- 5 of percent those targeted.*

[2]*Operating experience has shown that when upward release changes are required within the range of 4,000 cfs to 6,500 cfs (depending on reservoir storage) the gates should be operated in such a way as to force a hydraulic jump below the outlet portal by temporarily increasing the release by approximately 2,000 cfs. Once the hydraulic jump is established, the 1,000 cfs per hour (or less) rate of release would resume.*

B) The Corps shall continue to implement the recently developed flood release protocols for the last 5 to 7 percent of floodwater encroachment in Black Butte Lake. The intent is to release this last increment of flood water in a manner that will maintain minimum releases of 100 cfs or

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greater for as long as possible during flood control operations. On an annual basis in the fall of each year, the Corps, NMFS, and Reclamation shall meet to develop guidelines for release patterns for the upcoming winter with the intent of providing consistently suitable conditions for successful spawning and survival of anadromous salmonids. Those alternative release patterns shall not impair the Corps' flood control abilities through Black Butte Dam. In the event that flood releases are being made when irrigation water is requested, the total release from Black Butte Dam will be irrigation demands plus the desired instream flow needed for promoting successful spawning and survival of anadromous salmonids.

3. The Corps shall develop and implement a long-term gravel augmentation program to improve the quality and quantity of salmonid spawning habitat throughout lower Stony Creek.

   A) The Corps shall work with NMFS and other willing partners (GCRCD, Reclamation, local gravel mine operators, *etc*.) to develop and implement a spawning gravel augmentation program whereby an appropriate amount of suitably sized, clean spawning gravel will be placed into the upper end of lower Stony Creek on a regular basis to improve spawning habitat in those parts of the creek that have been deprived of adequate gravel recruitment due to the existence of Black Butte Dam. Implementation of this program shall commence within five (5) years of the issuance of this biological opinion

4. Reclamation and the Corps shall meet with NMFS each spring to determine minimum instream flows in lower Stony Creek during the spring cold-water period. The provision of increased minimum instream flows will be determined using water storage levels in the three reservoirs and projected inflow into Black Butte Reservoir on or after April 1 of each year.

   A) NMFS will initiate communications in early March of each year to establish early storage and inflow conditions and to set a meeting between Reclamation, the Corps and NMFS where the agencies will determine minimum instream flows in lower Stony Creek during the spring cold-water period.

   In those years when storage in Black Butte Lake is expected to exceed 104,654 acre feet on or after April 1, and the upstream reservoirs are full (Stony Gorge with 50,300 acre-feet, and East Park with 51,000 acre-feet), Reclamation shall increase minimum flows as much as possible with the intent of maintaining these flow levels throughout the cold-water period (see below). The target instream flow level shall be maintained below the lowest active diversion (or from Black Butte Dam if no diversions are occurring) during those periods when Reclamation has control over Black

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Butte releases (non-flood control periods). These minimum flow releases will be determined by consensus between NMFS, Reclamation, and the Corps using water storage levels and anticipated inflow to the three reservoirs on or after April 1 of each year as a guideline.

When implemented, the increased minimum instream flow will be maintained as long as possible or through May 31 of that year, or until average daily water temperatures at the release point for Black Butte Dam reach 70 °F for three consecutive days, whichever occurs first, or until the time when the total system storage is less than 32.5 TAF (sum of minimum pool storage in the three reservoirs).

Failure by either agency to implement the project as described in this BO or to implement the terms and conditions set forth in this incidental take statement may cause the level of incidental take anticipated in this BO to be exceeded. If such a situation arises, the Agencies must immediately notify NMFS to provide an explanation for the deviation from the proposed project description or non adherence to the terms and conditions and review with NMFS the need for reinitiation of consultation.

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on a listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Reclamation and the Corps should support and promote habitat restoration activities on lower Stony Creek, including the local landowner based efforts to restore healthy riparian habitat along the lower creek.

2. To improve habitat conditions and allow earlier access to Stony Creek for upstream migrating salmonids, Reclamation should use excess pumping capacity at the Red Bluff Pumping Plant (RBPP) to provide flows into the TCC which would be released into Stony Creek through the CHO in the fall. These releases should be a minimum of 75 cfs (the standard capacity of a single pump at the RBPP), should begin when water temperatures in the canal cool down to the point where they would provide suitable and attractive habitat for salmonids attempting to enter Stony Creek (below 68 °F), and should continue until natural instream flows in Stony Creek reach 100 cfs at the CHO.

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

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XI. REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the proposed lower Stony Creek Water Management Operations Plan. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take authorized in the accompanying incidental take statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in this opinion; (3) the action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

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Enclosure 2

Magnuson-Stevens Fishery Conservation and Management Act (MSA)

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS[1]
U.S. Bureau of Reclamation and U.S. Army Corps of Engineers Lower Stony Creek Water Management Operations

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The geographic extent of freshwater essential fish habitat (EFH) for the Pacific salmon fishery includes waters currently or historically accessible to salmon within specific U.S. Geological Survey hydrologic units (Pacific Fishery Management Council 1999). EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of EFH, "waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

The associated biological opinion (Enclosure 1) thoroughly addresses the species of Chinook salmon listed both under the Endangered Species Act (ESA) as well as the MSA which potentially will be affected by the proposed action. These include Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley spring-run Chinook salmon (*O. tshawytscha*). Therefore, this EFH consultation will concentrate primarily on the Central Valley fall/late fall-run Chinook salmon (*O. tshawytscha*) which is covered under the MSA, although not listed under the ESA.

The Sacramento, Feather, Yuba, American, Cosumnes, Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin Rivers, and many of their tributaries, support wild populations of Central Valley fall-/late fall-run (herein "fall-run") Chinook salmon. However, 40 to 50 percent of spawning and rearing habitats once used by these fish have been lost or degraded. Fall-run Chinook salmon once were found throughout the Sacramento and San Joaquin River drainages, but have suffered declines since the mid-

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

1900s as a result of several factors, including commercial fishing, blockage of spawning and rearing habitat, water flow fluctuations, unsuitable water temperatures, loss of fish in overflow basins, loss of genetic fitness and habitat competition due to straying hatchery fish, and a reduction in habitat quality.

Chinook salmon in the Sacramento/San Joaquin basin are genetically and physically distinguishable from coastal forms (Clark 1929). Additionally, San Joaquin River populations tend to mature at an earlier age and spawn later in the year than Sacramento River populations. These differences could have been phenotypic responses to the generally warmer temperature and lower flow conditions found in the San Joaquin River basin relative to the Sacramento River basin. There is no apparent difference in the distribution of marine coded wire tag (CWT) recoveries from Sacramento and San Joaquin River hatchery populations, nor are there genetic differences between Sacramento and San Joaquin River fall-run populations (based on DNA and allozyme analysis) of a similar magnitude to that used in distinguishing other Evolutionarily Significant Units (ESUs). This apparent lack of distinguishing life-history and genetic characteristics may be due, in part, to large-scale transfers of Sacramento River fall-run Chinook salmon into the San Joaquin River basin.

The historical abundance of fall-run Chinook salmon is poorly documented (Myers *et al.* 1998) and complete estimates are not available until 1953 (U.S. Fish and Wildlife Service [FWS] 1995). From the late 1930s to the late 1950s estimates for mainstem Sacramento River fall-run fish were obtained from spawning surveys and ladder counts at the Anderson-Cottonwood Irrigation Dam. Although surveys were not consistent or complete, they did yield population estimates for fall-run Chinook salmon in the Sacramento River ranging from 102,000 to 513,000 fish (Yoshiyama *et al.* 1998). Average escapement from 1953 to 1966 was 179,000 fish and from 1967 to 1991 was 77,000 (FWS 1995). From 1992 to 1997 the estimated fall-run population in the Sacramento River has ranged from 107,300 to 381,000 fish (Yoshiyama *et al.* 1998). Over the last 6 years average escapement of fall-run spawners in the mainstem Sacramento River has been above 190,000; however, 20 to 40 percent of these natural spawners have been of hatchery origin. The increase in salmon runs in the Sacramento River since 1990 may be attributable to several factors including, increased water supplies following the 1987-1992 drought, stricter ocean harvest regulations, and fisheries restoration actions throughout the Central Valley. However, it is unclear if natural populations are self-sustaining or if the appearance of a healthy population is due to high hatchery production. Concern remains over impacts from high hatchery production and harvest levels, although ocean and freshwater harvest rates have been recently reduced.

Although little information has been documented on fall/late-fall run Chinook salmon spawning in Stony Creek since the construction of Black Butte Dam, there has been sporadic documentation of spawning and juvenile rearing within the creek. Spawning surveys conducted by the California Department of Fish and Game (DFG) in the winter of 1981-82 estimated 384 adult fall-run Chinook salmon spawning in Stony Creek (Reavis 1983). A survey conducted by DFG during the fall and winter of 2000-01

documented successful Chinook salmon spawning in Stony Creek during a very dry year. Although no adult salmon were actually seen during this highly limited survey, redds were located and newly emergent fry were collected at several locations throughout the lower 15 miles of the creek (Charles Brown, DFG, pers. comm., March 5, 2001).

Corwin and Grant (2004) conducted limited surveys for adult Chinook salmon and redds during the fall-run spawning season from 2001 through 2004. While high stream flows and a lack of private land access limited these surveys to a very small area of the creek over short periods of time, the investigators found proof (in the form of live fish, carcasses, and/or redds) of adult escapement and spawning in each year of the study. In 2003, a groundwater monitoring study conducted by the California Department of Water Resources provided sufficient flows in lower Stony Creek to allow surface flows to reach the confluence of the Sacramento River during the early part of the fall-run Chinook salmon migration period. That fall's surveys showed the highest level of spawning activity of the 4-year study, with 27 live adults, 13 carcasses, and 18 redds documented before an increase in flows on December 10, 2003, made it impossible to conduct further surveys for the rest of the winter. The capture of newly-hatched fry Chinook salmon (30 to 40 mm fork-length) in each year of the study provided further evidence of consistently successful Chinook salmon spawning in lower Stony Creek during the study period (Corwin and Grant 2004).

A. Life History and Habitat Requirements

Central Valley fall-run Chinook salmon are "ocean-type," entering the Sacramento River from July through December, and spawning from October through January. Peak spawning occurs in October and November (Reynolds *et al.* 1993). Chinook salmon spawning generally occurs in swift, relatively shallow riffles or along the edges of fast runs at depths up to 15 feet. Preferred spawning substrate is clean loose gravel. Gravels are unsuitable for spawning when cemented with clay or fines, or when sediments settle out onto redds reducing intergravel percolation (NMFS 1997).

Egg incubation occurs from October through March, and juvenile rearing and smolt emigration occurs from January through June (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and estuary (Kjelson *et al.* 1982). The remainder of fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, tributary streams are used as rearing habitat. These non-natal rearing areas are highly productive micro-habitats providing abundant food and cover for juvenile Chinook salmon to grow to the smolt stage. Smolts are juvenile salmonids that are undergoing a physiological transformation that allows them to enter saltwater. These smolts generally spend a very short time in the Delta and estuary before entry into the ocean.

In contrast, the majority of fry carried downstream soon after emergence are believed to reside in the Delta and estuary for several months before entering the ocean (Healey 1980, 1982; Kjelson *et al.* 1982). Principal foods of Chinook salmon while rearing in freshwater and estuarine environments are larval and adult insects and zooplankton such as *Daphnia,* flies, gnats, mosquitoes or copepods (Kjelson *et al.* 1982), stonefly nymphs or beetle larvae (Chapman and Quistdorff 1938) as well as other estuarine and freshwater invertebrates. All outmigrant Central Valley fall-run Chinook salmon depend on passage through the Sacramento-San Joaquin Delta for access to the ocean. They remain off the California coast during their ocean residence and migration.

II. DESCRIPTION OF THE PROPOSED ACTION

The proposed action is described in the *Description of the Proposed Action* section of the associated biological opinion (Enclosure 1) for the endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, and threatened Central Valley steelhead ESUs.

III. EFFECTS OF THE ACTION

The greatest adverse effect on fall-run Chinook salmon EFH associated with Stony Creek water management operations is the complete blockage of access to a large portion their historical spawning and rearing habitat above Black Butte Dam. Because this historic habitat is no longer accessible, Chinook salmon are relegated to a small reach of the creek containing only marginal habitat. This makes these fish particularly vulnerable to the water management operations of the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation (Reclamation). These Federal agencies, through the storage and release of flows, control the quantity and quality of the small amount of remaining habitat on Stony Creek. The alteration of the natural hydrologic cycle due to upstream dam operations on Stony Creek has the potential to adversely affect all life stages of fall-run Chinook salmon. The storage of fall and early winter rains in upstream reservoirs prevents the flows of lower Stony Creek from reaching the Sacramento River until December of most years, thereby excluding the vast majority of adult fall-run Chinook salmon from entering Stony Creek to spawn. Reservoir operations resulting in large scale flow fluctuations can cause adverse effects such as redd scouring or juvenile stranding. Extended periods of low flow releases can result in increased temperatures and reduced habitat availability.

Diversion of irrigation water into the Tehama Colusa Canal (TCC) through the constant head orifice (CHO) at Stony Creek is another major impact to EFH, and causes direct entrainment and loss of juvenile fall-run Chinook salmon. The diversion of water out of Stony Creek for consumptive purposes also reduces flows below those diversions which results in increased water temperatures and reduced quality and quantity of essential habitat.

As discussed above, EFH protections apply to all ESUs of Pacific Chinook salmon, so the adverse effects that impact the habitat occupied by winter- and spring-run Chinook salmon juveniles are also considered adverse effects on EFH. Those effects are thoroughly detailed in the biological opinion for the proposed project (Enclosure 1).

IV. CONCLUSION

Upon review of the effects of lower Stony Creek water management operations, NMFS believes that some project activities will adversely affect EFH of Pacific salmon protected under the MSA.

V. EFH CONSERVATION RECOMMENDATIONS

As the habitat requirements of Central Valley fall-run Chinook salmon within the action area are similar to those of the Federally-listed species addressed in the attached biological opinion, NMFS recommends that the ESA reasonable and prudent measures and conservation recommendations included in the biological opinion prepared for the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead ESUs, be adopted as EFH conservation recommendations.

Additionally, the following conservation recommendation should be implemented to improve migrational, holding, and spawning habitat for Chinook salmon within the action area.

- To improve habitat conditions and allow earlier access to Stony Creek for upstream migrating Chinook salmon, Reclamation should use available pumping capacity at the Red Bluff Pumping Plant to provide flows into the TCC which would be released into Stony Creek through the CHO in the fall. These releases should be a minimum of 75 cfs (the standard capacity of a single pump at the RBPP), should begin when water temperatures in the canal cool down to the point where they would provide suitable and attractive habitat for salmonids attempting to enter Stony Creek (below 68 °F), and should continue until natural instream flows in Stony Creek reach 100 cfs at the CHO.

VI. ACTION AGENCY STATUTORY REQUIREMENTS

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

recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(j)).

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SITES VALUE PLANNING ALTERNATIVES

JANUARY 15

Sites

Value Planning Alternatives

Sites

General

- Eliminate one diversion location (Delevan) and rely on existing diversions at Red Bluff and Hamilton City
- Reduced release back to river due to 1) reduced diversions and 2) assumed in lieu storage at release from Shasta Reservoir

Release to River	=	SOD Participant Demand	-	Release to Participants from Shasta

Need feedback from Reclamation

Sites

Draft_0001317

Alternative 1 – Reduce Reservoir to 1.5 MAF, change bridge to multi-span bridge, substitute a release only canal for the single Delevan pipeline from Colusa Basin Drain to TRR near TCC - $5.2B

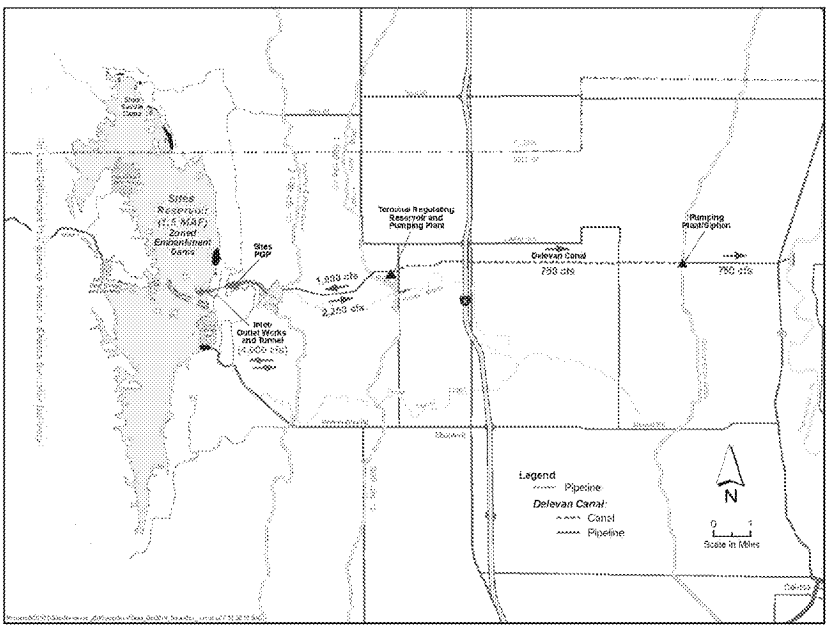


Figure 1

Alternative 2 – Similar to Alternative 1 but uses the southern road alignment to Lodoga in place of the bridge - $4.0B

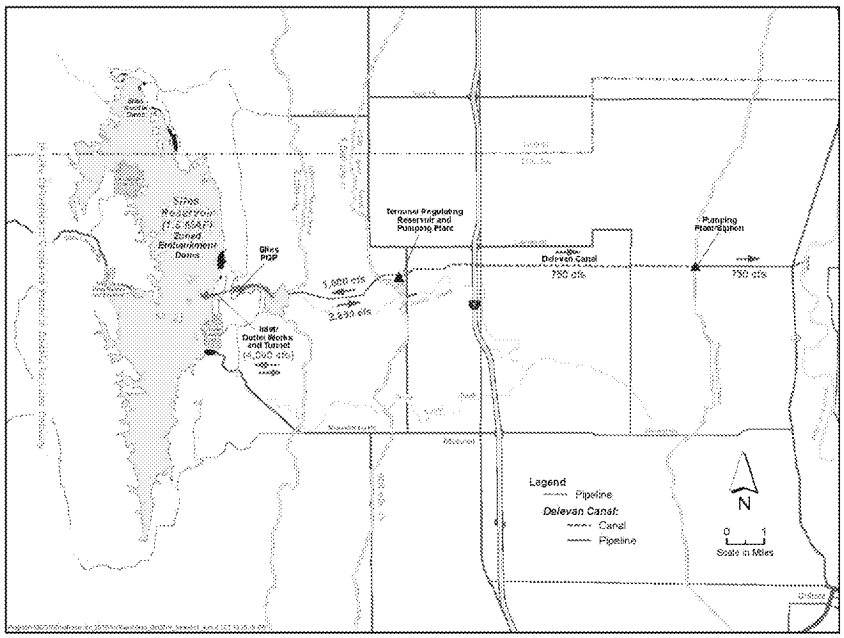


Figure 2

Alternative 3 – Similar to Alternative 1, but replaces Sites PGP with the Tehama-Colusa Regulating Reservoir and PGP and modified TRR PGP - $3.9B

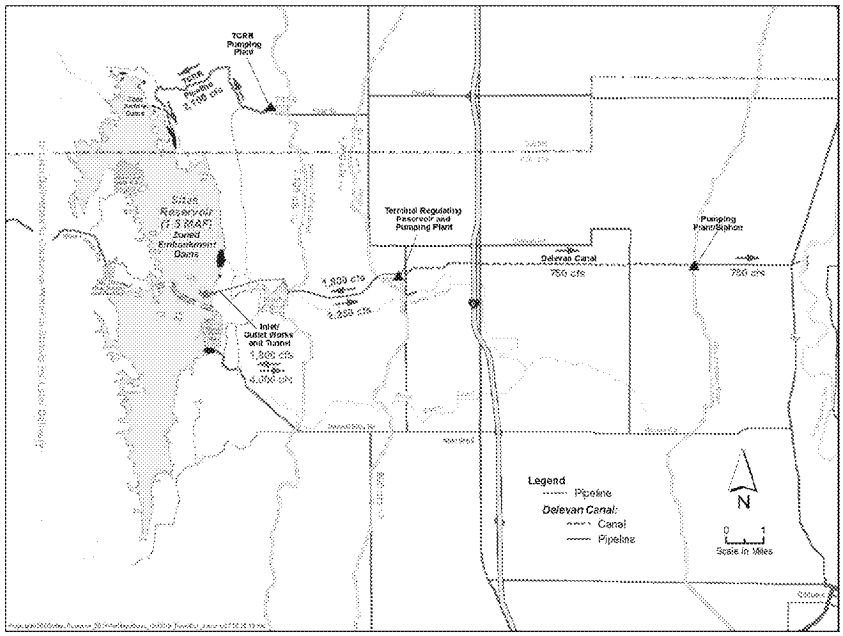


Figure 3

Alternative 4a – Same as Alternative 1 but replaces the zoned rockfill embankment dam with an earthfill dam – $3.8B

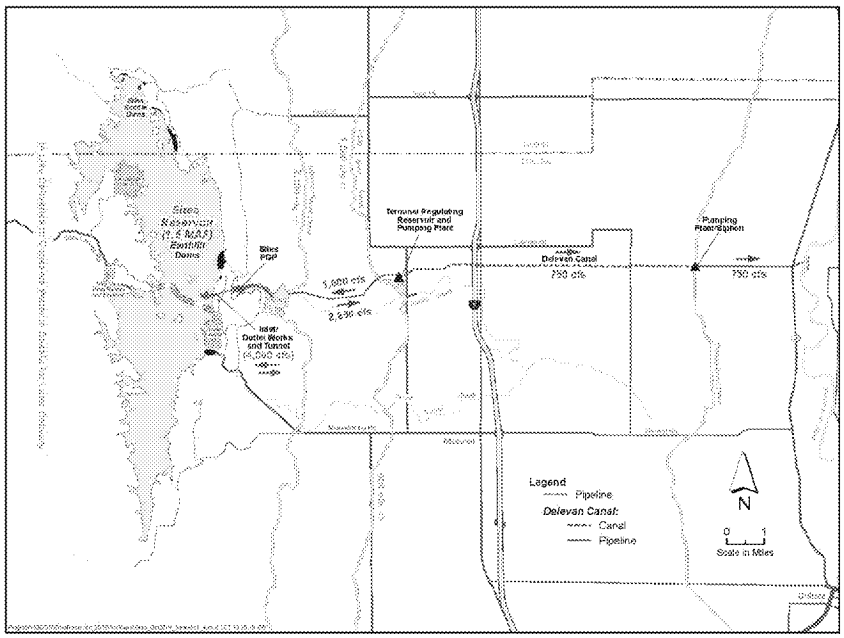


Figure 4a

Alternative 4b – Same as Alternative 1 but replaces the zoned rockfill embankment dam with a hardfill dam – $3.9B

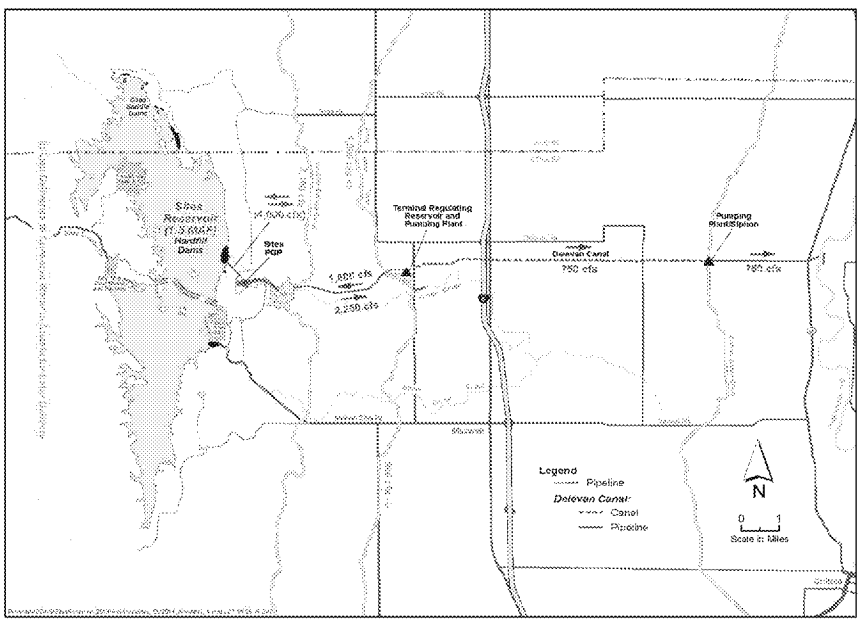


Figure 4b

Alternative 5a –Replaces Delevan Canal/ Pipeline with Canal from the T-C Canal to the CBD - $3.5B

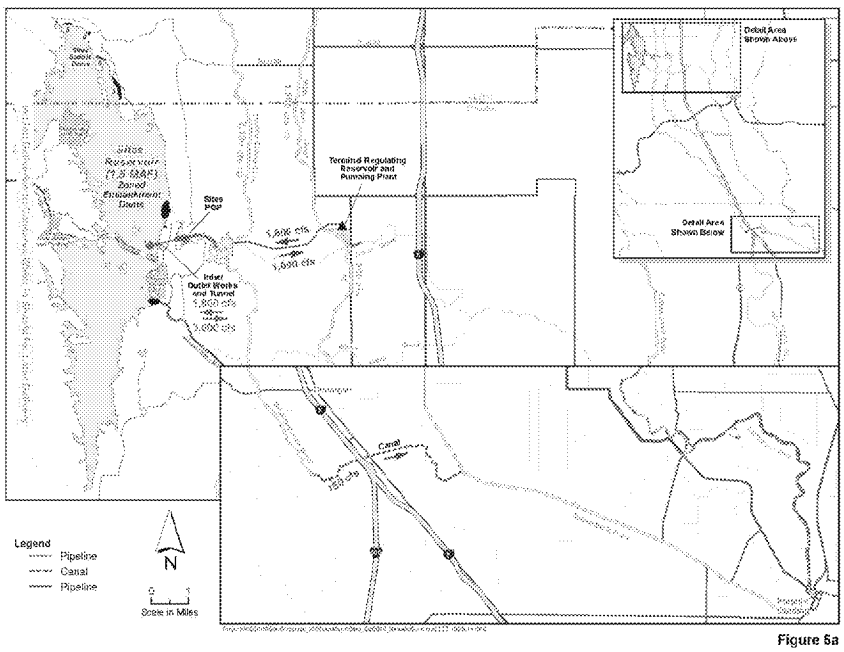


Figure 5a

Alternative 5b - Similar to Alternative 5a but Extension of Release to the Sacramento River via Siphon and Pumping plant - $3.9B

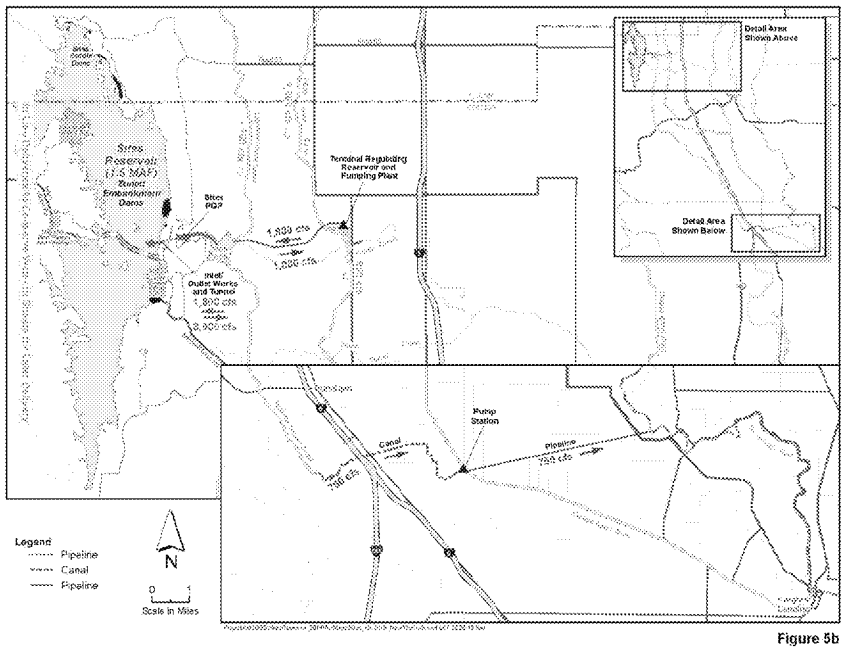


Figure 5b

Alternative 6a – Combination of Alt 3, 4 and 5a – replace Sites PGP with 2 smaller facilities, Dunnigan release to the CBD, and an Earthfill Dam - $3.4B

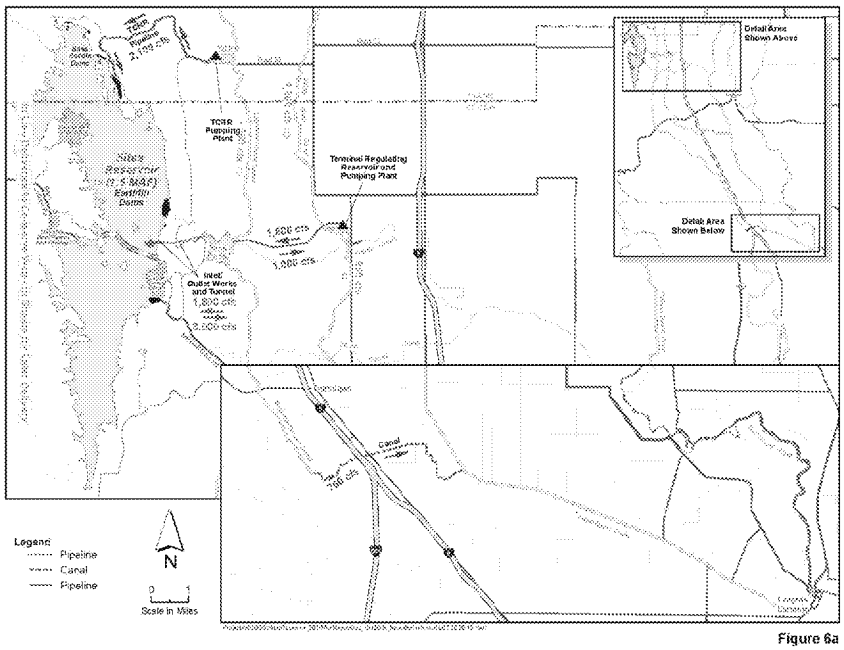


Figure 6a

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Alternative 6b –Reduces Reservoir to 1.3MAF and releases water from the Dunnigan Canal to the Sacramento River - $3.6B

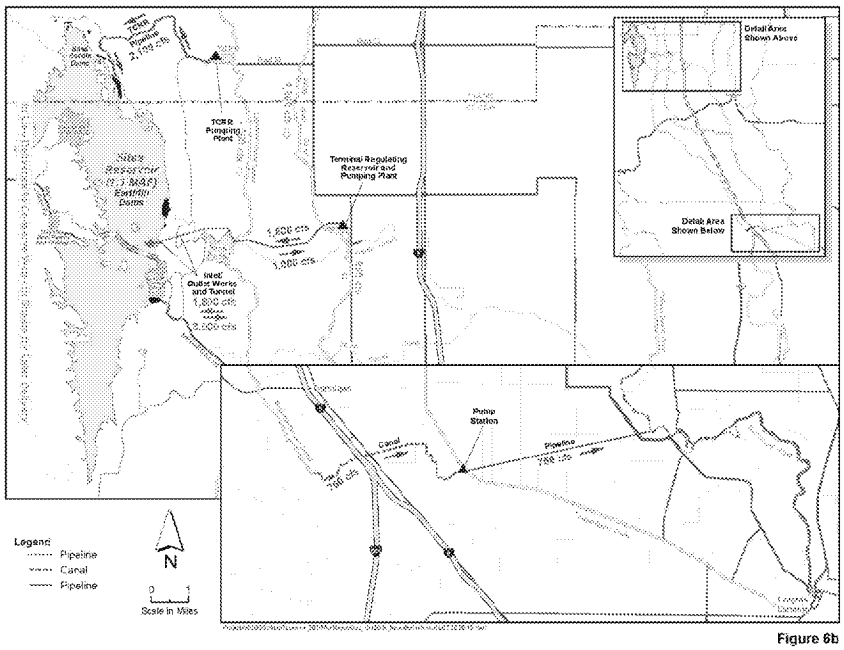


Figure 6b

Draft_0001326

From: Frederiksen, Lee E. [Lee.Frederiksen@hdrinc.com]
Sent: 1/22/2020 10:17:20 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]; Laurie Warner Herson (laurie.warner.herson@phenixenv.com) [laurie.warner.herson@phenixenv.com]; Spranza, John [John.Spranza@hdrinc.com]; Arsenijevic, Jelica [Jelica.Arsenijevic@hdrinc.com]
Subject: FW: Colusa County Map of Sites Roads Alternatives
Attachments: Sites Reservoir Water Line Boundary with Road Alternatives Optimized.pdf

fyi

Lee Frederiksen, PE
D 916.817.4883 M 916.213.0569

hdrinc.com/follow-us

From: Rob Kunde [mailto:rkunde@wrmwsd.com]
Sent: Saturday, January 18, 2020 11:33 AM
To: Frederiksen, Lee E. <Lee.Frederiksen@hdrinc.com>; Herrin, Jeff <jeff.herrin@aecom.com>
Subject: Colusa County Map of Sites Roads Alternatives

Lee and Jeff:

On Tuesday Jan 14 at the Value Planning lunch, Gary Evans indicated a "non-starter". This means that having public traffic intermingle with construction traffic during Sites construction was unacceptable to him. Gary was not locked in on a specific post-construction road alternative other than to note the two roads south of Maxwell to property owners and a radio tower were necessary, but gravel roads might be acceptable (unless the south road becomes the main road from Maxwell to Lodoga). Further dialogue with Gary is needed after you consider the attachment and these comments.

See map below provided by Mike Azevedo. Lee has this map in paper format.

Robert J. Kunde, P.E.
Retired Annuitant
Wheeler Ridge-Maricopa Water Storage District
12109 Highway 166, Bakersfield, CA 93313
cell: 661-345-3719 email: rkunde@wrmwsd.com

From: Michael Azevedo <mjazevedo@countyofcolusa.com>
Sent: Friday, January 17, 2020 7:40 AM
To: Rob Kunde
Cc: Gary Evans
Subject: 1/17/20 discussion

Rob,

Here is an exhibit that I believe represents some of the topics Supervisor Evans would like to discuss.

See you in Maxwell.

Michael J Azevedo
Assistant Director

Colusa County Public Works
www.countyofcolusa.org
530.458.0466

Sites Reservoir Feasibility Study
Technical Memorandum

Mitigation Measure Evaluation and Cost Estimate

October 2016

Prepared for

Sites Project Authority

Prepared by

AECOM

2020 L Street, Suite 400
Sacramento, CA 95811

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Attachments

Attachment 1 Site Plans for Alternatives A through D
Attachment 2 Sites Reservoir Mitigation Cost Summary
Attachment 3 High Cost Mitigation Measure Measures
Attachment 4 Detailed Cost Assumptions by Resource
Attachment 5 Anticipated Land Use Impacts (Alternative C)
Attachment 6 Vegetation Community and Habitat Impacts (Alternative C)
Attachment 7 Air Quality Impacts (Alternative C)

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1.0 ABSTRACT

For the Sites Project Authority (Authority), AECOM has developed a planning-level cost estimate for implementing measures necessary to mitigate anticipated environmental impacts resulting from the construction, operation, and maintenance of the Sites Reservoir Alternative C.

The cost estimate includes a summary of costs for relevant mitigation measures followed by detailed cost estimate worksheets with assumptions. To support the preparation of the l cost estimate, AECOM held a series of mitigation cost development workshops. In addition to cost development, AECOM evaluated mitigation-related schedule constraints and recommendations for modifying mitigation measures. This technical memorandum is comprised of the following:

- Study Objective
- Background
- Mitigation Costs
- Key Cost Assumptions
- Recommended Mitigation Measure Modifications
- Mitigation Related Schedule Constraints
- Recommendations and Next Steps

2.0 STUDY OBJECTIVE

The purpose of this assignment was to develop feasibility-level costs for mitigation measure implementation, identify any project schedule constraints related to implementing the mitigation measures, provide recommendations for changes to the mitigation measures, and identify next steps for mitigation planning. This assignment is intended to inform ongoing project planning and requests for grant funding.

3.0 BACKGROUND

In 2013, a planning-level cost estimate for implementation of the North-of-the-Delta-Offstream Storage (NODOS) Mitigation Monitoring Plan was prepared (DWR and Reclamation 2013). At the time these costs were developed, details regarding mitigation measures were limited. The purpose of this memorandum is to present a more detailed update to previous mitigation cost estimates to inform ongoing project planning and requests for grant funding. In May 2016, AECOM held a series of mitigation-related workshops with the Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) Team comprised of California Department of Water Resources (DWR), U.S. Bureau of Reclamation (Reclamation), and CH2M HILL staff.

During the workshops, a total of 155 mitigation measures from the NODOS Preliminary Administrative Draft EIR were reviewed (DWR 2013: Appendix 1A). Cost assumptions, potential

schedule impacts associated with implementing the mitigation measures, and recommended modifications to the measures that could potentially reduce project costs were discussed. The 2013 mitigation cost estimate was also reviewed. Assumptions developed during the workshops were used to update the mitigation costs.

4.0 MITIGATION COSTS

Mitigation costs for Alternative C are based on the environmental impact analysis and implementing the mitigation measures from the NODOS Preliminary Administrative Draft Environmental Impact Report (DWR 2013). These costs can be readily scaled to Alternative A or B and will inform the development of costs for Alternative D currently under development by the Authority. Conceptual site plans for each of these Alternatives are provided as Attachment 1. Alternative C is comprised of a 1.81 million acre-feet reservoir formed by two large dams and nine saddle dams. It includes two hydropower pumping and generating facilities, a forebay/afterbay reservoir adjacent to the existing Tehama-Colusa Canal, a terminal regulating reservoir adjacent to the Glenn-Colusa Canal, large diameter pipelines (TRR and Delevan), power transmission lines, a fish-screened intake/discharge facility on the Sacramento River and three designated recreation areas. The project components associated with Alternative C are the most comparable to the Authority-preferred alternative (Alternative D) that is currently being developed.

Wherever possible, AECOM followed the estimating instructions contained in Reclamation's Cost Estimating Handbook (Reclamation, 1989) and Reclamation's Manual, Directives and Standards, FAC 09-01, FAC 09-02, and FAC 09-03.

The allowances and contingencies by component applied to mitigation cost estimates are presented in Table 1. The mobilization/demobilization allowance and design and construction contingencies were applied to develop the field cost. The non-contract cost allowance was then applied to the field cost to arrive at the construction cost.

Escalation of construction costs to a Notice to Proceed date has not been included in the estimate. This was done to avoid confusion and double counting, because escalation is a factor included in the benefit-cost feasibility analysis of the project following several possible design and construction scheduling options.

This analysis is limited to implementing mitigation measures not already included in the costs associated with the design, construction, and operations and maintenance (O&M) activities for Alternative C.

Table 1. Cost Estimate Allowances and Contingencies for Mitigation Costs

Component	Value	Basis for Assigned Allowance or Contingency
Mobilization/Demobilization	2%	Approximately 65% of the mitigation costs are associated with real estate actions, 19% of the costs with environmental and cultural resources monitoring, and the remaining 16% for restoration. Mobilization/demobilization for monitoring largely consists of the mobilization and demobilization of environmental monitoring staff with pickup trucks and infrequent short-term monitoring by watercraft. In this case mobilization/demobilization costs are likely to be in the range of 1% to 2%.
Design Contingency	12%	Covers minor unlisted items, minor design and scope changes, and cost estimating refinements. This is the area of greatest uncertainty prior to the negotiation of permits. We recommend increasing the design contingency from 10% to 12%.
Procurement Strategy	1%	The most significant effort will be associated with procuring mitigation credits. The construction contractors selected for facility construction will perform the bulk of the restoration and construction related tasks. There will be a real estate contractor and one or two environmental monitoring contracts. There may be some small landscaping contracts. Most of the oversight throughout will likely be performed by the environmental contractor who will work for the Authority.
Escalation to Notice to Proceed	—	This will be addressed in the Basis of Estimate Report consistent with the overall project cost estimate.
Construction Contingency	2%	Only 16% of the total mitigation is anticipated to include construction costs related to restoration. The construction contingency for real estate and monitoring should be very low.
Non-Contract Costs	4%	Approximately $52 million in monitoring costs is already included in the mitigation estimates. We do not anticipate another layer of construction management. There will be some design, but the design will be highly constrained by the permits.

Source: Data compiled by AECOM in 2016

Table 2 presents a summary of estimated construction phase mitigation costs by category. A detailed cost breakdown by mitigation category and measure is presented Attachment 2.

Table 2. Construction Phase Mitigation Costs for Alternative C

Mitigation Category	Estimated Cost
Vegetation Communities/Botanical Resources	$91,800,000
Wetlands/Surface Waters	$83,000,000
Aquatic Resources	$56,000,000
Wildlife Habitat	$53,000,000
Cultural/Historic/Paleontological Resources	$35,000,000
Land and Agriculture	$31,000,000
Air Quality	$200,000
Total	**$350,000,000**

Notes:

Source: Data compiled by AECOM in 2016

Table 3 presents a summary of O&M phase mitigation costs.

Table 3. O&M Phase Mitigation Costs for Alternative C

Mitigation Category	Estimated Annual Cost[1]
Vegetation Communities/Botanical Resources	$85,000
Wetlands/Surface Waters/Groundwater	$275,000[2]
Aquatic Resources	$775,000[3]
Wildlife Habitat	12,400[4]
Cultural/Historic/Paleontological Resources	$9,000
Land and Agriculture	-----[5]
Air Quality	$5,000[6]
Flood Control and Management	$4,320,000[7]
Total	**$5,481,400**

Notes:

1. Costs include mobilization, contingency and escalation
2. Costs include for *Mitigation Measure GWRES-2* ($25,000) and *Mitigation Measure SWQual-1a* ($250,000).
3. Costs include an annual contingency for Mitigation Measure *Fish-1b ($500,000 per year)* and annual on-site restoration land management for Mitigation Measure *Fish-1e ($275,000 per year)*.
4. Estimated costs are associated with on-site restoration land management for Mitigation Measure *Wild-3c* and *Bot-1a* (10 acres); and *Wet-1a* (21 acres) for a total of 31 acres of on-site restoration monitoring.
5. No ongoing costs are assumed for agricultural and conservation easements
6. Estimated annual cost is associated with stationary source permitting fees anticipated for using the emergency back-up generators at the pumping plants
7. Estimated annual cost associated with maintaining stream flow of 10 cfs between Oct-May in Funks and Stone Corral creeks as specified in Mitigation Measure *Flood-1;* Cost assumes average of 30 days per month; $450 per acre-feet of water (AF); 1 cfs provides 2 AF/day

Source: Data compiled by AECOM in 2016

Attachment 3 presents a summary of the mitigation measures that have the highest cost. Detailed assumptions for mitigation categories presented in Table 1 are included in Attachment 4. Quantities for estimating project costs are derived from the impact analysis in the NODOS Preliminary Administrative Draft Environmental Impact Report for Alternative C (DWR 2013). To simplify documentation, quantity tables used in the analysis are presented as Attachments 5 and 6.

The total estimated costs associated with impacts on vegetation communities, wetlands and special-status species habitat were developed by first calculating the land mitigation requirements using applicable mitigation ratios and estimated land impacts presented on a per-acre basis.

The range of mitigation ratios used for cost estimating were derived from mitigation ratios used in previously implemented projects, including the CALFED Programmatic EIR/EIS, Shasta Lake Water Resources Investigation EIR/EIS, and Los Vaqueros Expansion Investigation EIR/EIS.

On-site mitigation through land acquisition and restoration was assumed for all temporary and permanent impacts to streams, aquatic habitat as prescribed in Mitigation Measures *Fish 1-e, Wild-3c, Bot-1a;* and *Wet-1a*. All other permanent impacts to natural community and terrestrial special-status species habitat are assumed to be mitigated off-site through the purchase of credits from a mitigation bank.

To estimate costs for off-site mitigation, the mitigation land acreages were then multiplied by a mitigation bank cost range to obtain cost ranges for mitigation of effects on natural communities and special-status species habitat. A detailed breakdown of the mitigation land needs and associated costs for each natural community and focus special-status species is provided in Attachment 6.

On-site mitigation costs for restoration prescribed in Mitigation Measures *Fish 1-e, Wild-3c, Bot-1a;* and *Wet-1a*, it was assumed that assumed that two acres of land for every mitigation acre would be needed for restoration. This conservative approach does not take into account the existing habitat function acquired land. If land acquired is of high habitat value, then less acres of land may be needed for on-site restoration. Annual mitigation land management and monitoring costs for on-site restoration were assumed to be $400 per acre.

5.0 AIR QUALITY MITIGATION

Air quality in California is regulated at the Federal, state, and local levels. The pollutants of greatest concern in the project area of Glenn and Colusa counties are:

- Ozone
- Ozone precursors (Nitrogen oxides (NOx) and Reactive Organic Gases (ROG))
- Particulate matter (PM_{10}) from vehicle and equipment exhaust
- Particulate matter (PM_{10}) from soil disturbance and wind erosion (fugitive dust)
- PM10 precursors (NOx, ROG, and Sulphur oxides (SOx)).

Table 4 compares the proposed Sites Reservoir project with the Folsom Dam Safety Improvement project. Both projects are located in the Sacramento Valley Air Basin but are regulated by different air pollution control districts. Unlike the Folsom Dam project, the proposed Sites Reservoir project would be located in federally-designated attainment zones for ozone and PM_{10}. Therefore, no federal General Conformity de minimis standards would be applicable since all National Ambient Air Quality Standards (NAAQS) established by the U.S. Environmental Protection Agency (EPA) would be met. However, the project would be located in a state-designated nonattainment zone for PM_{10} similar to the Folsom Dam project.

Table 4. Comparison with Folsom Dam Safety Improvements Project

	Folsom Dam Safety Improvements	Sites Reservoir1
Project Location	Sacramento, Placer, and El Dorado counties	Glenn and Colusa counties
Air Basin	Lower Sacramento Valley	Upper Sacramento Valley
Air District	Sacramento Metro AQMD	Glenn County APCD and Colusa County APCD
Federal Attainment Status (NAAQS)[2]		
Ozone	Non-attainment, serious for 8-hour average	Unclassified/Attainment
NOx	Attainment	Unclassified/Attainment
ROG	Not applicable	Not applicable
PM_{10}	Non-attainment, moderate	Unclassified
$PM_{2.5}$	Attainment	Unclassified/Attainment
CO	Attainment/Maintenance	Unclassified/Attainment
SOx	Attainment	Unclassified
State Attainment Status (CAAQS)[2]		
Ozone	Non-attainment	Attainment
NOx	Attainment	Attainment
ROG	Not applicable	Not applicable
PM_{10}	Non-attainment	Non-attainment
$PM_{2.5}$	Attainment	Attainment
CO	Attainment	Unclassified
SOx	Attainment	Attainment
Local AQMD/APCD Construction-Related Significance Threshold[2]		
PM_{10}	50 µg per cubic meter	Level B > 25 lbs per day Level C > 137 lbs per day[3]
NOx	85 lbs per day	Level B > 80 lbs per day Level C > 137 lbs per day[3]
ROG	Sacramento County - none; El Dorado and Placer counties – 82 lbs. per day	Level B > 25 lbs per day Level C > 137 lbs per day[3]
Local Fees for Exceeding Threshold	If mitigated NOx emissions still exceed 85 lbs per day, SMAQMD's policy is to charge a mitigation fee of $14,300 per ton excess (at time of construction) ($18,260 per ton excess as of July 2016)	See Table 5 for stationary emission sources only Glenn and Colusa counties currently do not have a program or mechanism to collect mitigation fees for CEQA project-related emissions beyond the New Source Review permitting programs for stationary sources

Notes for Table 4

[1] Status is as of December 2015

[2] $PM_{2.5}$ – Particulate matter less than or equal to a 2.5 microns

PM_{10} – Particulate matter less than or equal to a nominal 10 microns

NOx – Nitrogen oxides (ozone and PM_{10} precursor)

SOx – Sulphur oxides (PM_{10} precursor)

CO – Carbon monoxide

ROG – Reactive Organic Gases (ozone and PM_{10} precursor)

[3] Level C – If emissions from a project would exceed the Level C thresholds, mitigation measures (BAMMs and SMMs[4]), including off-site mitigation measures following the guidelines, may be required to reduce the overall air quality impacts of the project to a level of insignificance. (from Tehama County Air Pollution Control District; Glenn and Colusa counties expected to have similar requirements)

[4] BAMMS – Best Available Mitigation Measures

SMMs – Standard Mitigation Measures

Source: Folsom Dam Safety and Flood Damage Reduction Draft EIS/EIR Chapter 3 (Reclamation 2006) and Sites Reservoir - Preliminary Administrative Draft EIR Chapter 24 (DWR 2013)

New pollutant sources that meet the definition of a Stationary Source, such as on-site concrete and asphalt batch plants and operational aggregate quarries, will need to be permitted by the local air pollution control districts in Glenn and Colusa counties. Permit fees to allow construction of stationary sources (Authority to Construct permits) and annual permit fees to allow ongoing operation of stationary sources (Permits to Operate) are discussed in the Districts' air quality rules and regulations. These New Source Review (NSR) requirements in Glenn and Colusa counties only apply to sources that meet the definition of a stationary source. Table 5 summarizes the NSR permitting fee schedule for stationary sources. Glenn County has a similar fee schedule.

Table 5. Colusa County Fee Schedule for Permitting Stationary Sources[1]

Permit	Fee Schedule
Authority to Construct Permit	$228.00 (fee covers the review of the project emissions, air quality impacts, and the preparation of an air quality summary analysis report)
Annual Operating Permit	$110 plus the following:
For sources up to 1 ton per year	$238
For sources 1 to 5 tons per year	$279
For sources 5 to 10 tons per year	$380
For sources 10 to 15 tons per year	$465
For sources 15 to 20 tons per year	$549
For sources 20 to 25 tons per year	$744 plus $39 for every ton or fraction of ton over 25 tons

Source: Email communication from Casey Ryan, Air Pollution Standards Officer II, Colusa County APCD (March 22, 2016)

For CEQA, construction-related emissions for all project-related sources (i.e., mobile, area, fugitive, and stationary sources) must be estimated. Table 6 defines the Levels of Significance for the pollutants of concern. Attachment 7 includes tables extracted from the Preliminary Administrative Draft EIR that summarize the preliminary CEQA analysis. These tables are further summarized in Table 7.

Table 6. Thresholds of Significance for Pollutants of Concern

Pollutant	Level A	Level B	Level C
NOx	Less than or equal to 25 lbs/day	Greater than 25 lbs per day	Greater than 137 lbs per day
ROG	Less than or equal to 25 lbs/day	Greater than 25 lbs per day	Greater than 137 lbs per day
PM_{10}	Less than or equal to 25 lbs/day	Greater than 80 lbs per day	Greater than 137 lbs per day
Level of Significance	Potentially Significant Impacts	Potentially Significant Impacts	Significant Impacts
Required CEQA Document	Mitigated Negative Declaration (MND) or Negative Declaration	MND or Environmental Impact Report (EIR)	EIR
Mitigation		Mitigation measures, Best Available Mitigation Measures (BAMMs) and Standard Mitigation Measures (SMMs), including off-site mitigation measures following the guidelines, may be required to reduce the overall air quality impacts of the project to a level of insignificance.	

Source: Tehama County Air Pollution Control District Air Quality Planning & Permitting Handbook (April 2015)

Based on a preliminary impact analysis of the construction, operation, and maintenance of project facilities, the project will have significant impacts to air quality before mitigation. Glenn and Colusa counties currently do not have a program or mechanism to collect mitigation fees for CEQA project-related emissions beyond the NSR permitting programs for stationary sources.

Table 7. Summary of Preliminary CEQA Impact Analysis (from Attachment 7 tables)

Pollutant	Level A Significance Threshold Exceeded	Level B Significance Threshold Exceeded	Level C Significance Threshold Exceeded
NOx	Construction – Yes O&M – Yes	Construction – Yes O&M – Yes	Construction – Yes O&M – No
ROG	Construction – Yes O&M – Yes	Construction – Yes O&M – Yes	Construction – Yes O&M – No
PM_{10}	Construction – Yes O&M – No	Construction – Yes O&M – No	Construction – Yes O&M – No

The following mitigation measures are proposed to be implemented:

- Air Qual-1a: Develop a Fugitive Dust Control Plan
- Air Qual-1b: Implement Measures to Reduce Equipment and Vehicle Exhaust Emissions.

Descriptions of the mitigation measures and cost estimate cost assumptions are described in Appendix 4I. The mitigation implementation costs are included in Tables 2 and 3.

Because engineering studies indicate that anticipated construction materials can sourced within the same air basin as the project, additional mitigation costs associated with the transport of materials through areas with more stringent air emissions regulations would be avoided.

The concrete batch plants and quarry operations activities during construction are considered stationary emission sources and would require a permit to construct/operate from the local air district.

Table 8. Summary of Air Quality Mitigation Measures

Impact	Project Facilities	Level of Significance before Mitigation	Mitigation Measure	Level of Significance After Mitigation
Air Qual-1 Conflict with an applicable Air Quality Plan, contribute substantially to an Air Quality Violation, and/or Result in a Cumulative Considerably Net Increase of Nonattainment Pollutants	All Primary Area Project Facilities (construction)	Significant	Air Qual-1a Develop a Fugitive Duct Control Plan	Significant and unavoidable for emissions of PM_{10}
			Air Qual-1b Implement measures to reduce equipment and vehicle exhaust emissions	Significant and unavoidable for emissions of NOx, PM_{10}, and ROG
				Less than Significant for emissions of SOx, CO, and $PM_{2.5}$
	All Primary Area Project Facilities (O&M)	Significant	Air Qual-1a Develop a Fugitive Duct Control Plan	Less than Significant
			Air Qual-1b Implement measures to reduce equipment and vehicle exhaust emissions	Less than Significant
GHG-1: Generation of Cumulative GHG Emissions	CVP Operational Emissions	Potentially Significant	No Feasible Mitigation	Potentially Significant and Unavoidable

Source: Preliminary Administrative Draft EIR Chapter 24 Air Quality Table 24-14 and Chapter 25 Climate Change and Greenhouse Gas Emissions Table 25-15 (DWR, 2013)

6.0 KEY COST ASSUMPTIONS

The following presents a summary of the key assumptions for developing costs presented in Tables 2 and 3. Detailed assumptions specific to each mitigation measure can be found in Attachment 4.

- Natural community and special-status species habitat impacts identified for Alternative C are assumed to be of high quality and suitable to support special-status species. A detailed evaluation of existing habitat may identify some land of degraded habitat value or highly disturbed. For that reason, the mitigation requirements and associated costs may be less for some areas and lower than estimated in Table 1.
- No overlap in land needed for mitigation for natural communities and special-status species except for agricultural land types and ponds is assumed for this cost estimate. A more detailed habitat assessment and land evaluation will eventually be needed to identify more precise impacts from the selected alternative on natural communities and special-status species habitats. Agency coordination would also be required to determine land types necessary to meet mitigation requirements.
- With the exception of Bald and Golden Eagle, giant garter snake, California red-legged frog, western pond turtle and burrowing owl, this cost estimate assumes that habitat requirements for other special-status species that may be affected by the project are met by compensation for the different natural community type effects. Mitigation requirements for valley elderberry longhorn beetle are assumed to be met as part of on-site restoration prescribed in Mitigation Measure *Fish-1e*.
- Specialized pre-construction surveys (e.g., for rare plants) were assumed to be performed at the same pace as protocol-level surveys for consistency; however, specialized preconstruction surveys would likely be performed much faster than protocol-level surveys. For that reason, the survey costs may be less than estimated.
- The majority of costs estimated for cultural and paleontological resources are contingency-related in the event of discovery of unidentified resources and/or human remains during construction activities. These estimates are based on known site conditions and experience on similar projects.
- Except for permitting and associated fees related to air quality, the mitigation costs do not include costs associated with any other permits needed for the project including preparation of permit applications or coordination with regulatory agencies for approvals.

7.0 RECOMMENDED MITIGATION MEASURE MODIFICATIONS

During review of the proposed mitigation measures, it was noted that several mitigation measures may require further evaluation or modification. Such modifications would also assist with refining the estimated range of costs associated with mitigation measure implementation. These measures include the following:

- **Mitigation Measure *Fish-1a***: Increase stocking frequency of coldwater fish species. Further evaluation is needed to confirm potential effects to coldwater fish species and how stocking frequency would reduce these effects.
- **Mitigation Measure *Fish 1b***: Mitigation monitoring and reporting plan for potential reduced flows into Yolo Bypass. Further evaluation of anticipated project operations and associated changes in Yolo Bypass flows is needed. Future analyses may indicate that this is a benefit and not an impact.
- **Mitigation Measure *Fish-1e***: Implement Habitat Restoration Actions. This mitigation measure specifies on-site restoration requirements associated with Stone Corral and Funks creeks. It is recommended that these requirements be further developed and incorporated into the project description so that secondary (indirect) impacts associated with proposed restoration are evaluated as part of the EIR/EIS.
- **Mitigation Measure *Flood-1***: Maintain permanent low flow releases into Stone Corral and Funks Creeks Downstream of Sites and Golden Gate Dams. This mitigation measure specifies a downstream flow performance standard of 10 cubic feet per second (cfs). Confirmation of the 10 cfs flow performance standard should be performed prior to finalization of project operations costs.
- **Mitigation Measure *Rec-4a***: Extend the Existing Dinosaur Point Boat Ramp at San Luis Reservoir. The need for this mitigation measure to address changes in San Luis Reservoir from project operations and feasibility of implementation needs to be further evaluated.
- **Mitigation Measure *Rec-4b***: Extend the Basalt Campground Water Intake at San Luis Reservoir. The need for this mitigation measure to address changes in San Luis Reservoir from project operations and feasibility of implementation needs to be further evaluated.

8.0 MITIGATION RELATED SCHEDULE CONSTRAINTS

Schedule constraints as a result of implementing mitigation measures include the following:

- Mitigation Measure *Wild-2d* requires the development of various planning documents and performance of Golden Eagle telemetry studies for 3 to 5 years prior to construction and then 3 to 5 years post construction. This mitigation measure impacts when construction of the project can begin.
- Several watershed hydrological studies are required as mitigation to inform or provide guidance regarding how to avoid and/or minimize impacts to natural springs, swales and wetland areas. These studies are to be performed prior to the finalization of project designs.
- Various mitigation measures specify construction work window constraints, including the following:

- All in-water work activities will be limited to July through September (Mitigation Measure *Fish-1f*).
- Demolition and structure removal work activities are to be avoided during bat maternity season from mid-April through August 31, and outside of the winter months when bats could be hibernating (Mitigation Measure *Wild-1b*).
- Construction activities within 0.5 mile of nesting Golden Eagles must be avoided between March 1 and August 15 (Mitigation Measure *Wild-2d*).
- Construction activities for the Delevan Pipeline Intake/Discharge Facility in vicinity of giant garter snake habitat will be limited from May 1 through October 1 (Mitigation Measure *Wild-2e*).
- Construction activity in the vicinity of burrows occupied by nesting burrowing owls must be avoided from February 1 through August 31; the peak nesting season occurs from April 15 through July 15 (Mitigation Measure *Wild-2g*).
- Construction activity for the Delevan Pipeline Intake/Discharge Facility in vicinity of riparian and orchard vegetation must be avoided between mid-June through August (Mitigation Measure *Wild-2i*).

9.0 RECOMMENDATIONS AND NEXT STEPS

The recommended next steps to address mitigation requirements are as follows:

- Several mitigation measures require the avoidance and/or minimization of impacts to sensitive habitats. It is recommended that during finalization of project designs further evaluation of possible avoidance or minimization be performed to reduce mitigation requirements and costs, and impacts to project schedule. These avoidance measures may include adjusting facility footprints, determining alternative routes, or modifications to construction methods.
- Mitigation requirements for Golden Eagle include up to five years of telemetry surveys prior to construction. These studies would assist with identifying nesting and foraging locations of Golden Eagle in the project area as well as suitable areas to implement habitat mitigation for Golden Eagle. It is recommended that preparation of these monitoring plans be initiated in consultation with regulatory agencies in the near-term in order to minimize impact to the construction schedule.
- Mitigation requirements for implementation of Habitat Restoration Actions (Mitigation Measure *Fish-1e*) specify on-site restoration requirements associated with Stone Corral and Funks creeks. It is recommended that these requirements be further developed and incorporated into the project description of the EIR/EIS. Restoration strategies that target habitats for multiple species could significantly reduce the overall area of land needed for off-site mitigation by simultaneously meeting the requirements of natural communities and of one or more special-status species on the same area of land. The final approach

for onsite restoration should also consider the feasibility of meeting off-site mitigation requirements.

- The feasibility of using mitigation banks for meeting off-site mitigation requirements for the loss of habitat and agriculture should be further evaluated. It is recommended that anticipated mitigation requirements be further discussed with mitigation banks within the project area (e.g., Westervelt) and county staff. In the event that off-site mitigation requirements cannot be fully achieved, additional on-site mitigation may need to be considered.
- Further discussion with the Glenn and Colusa County Air Pollution Control Districts is planned by the EIS/EIR team (CH2M Hill) to confirm if additional air quality mitigation would be required for constructing and operating the proposed project.

10.0 REFERENCES

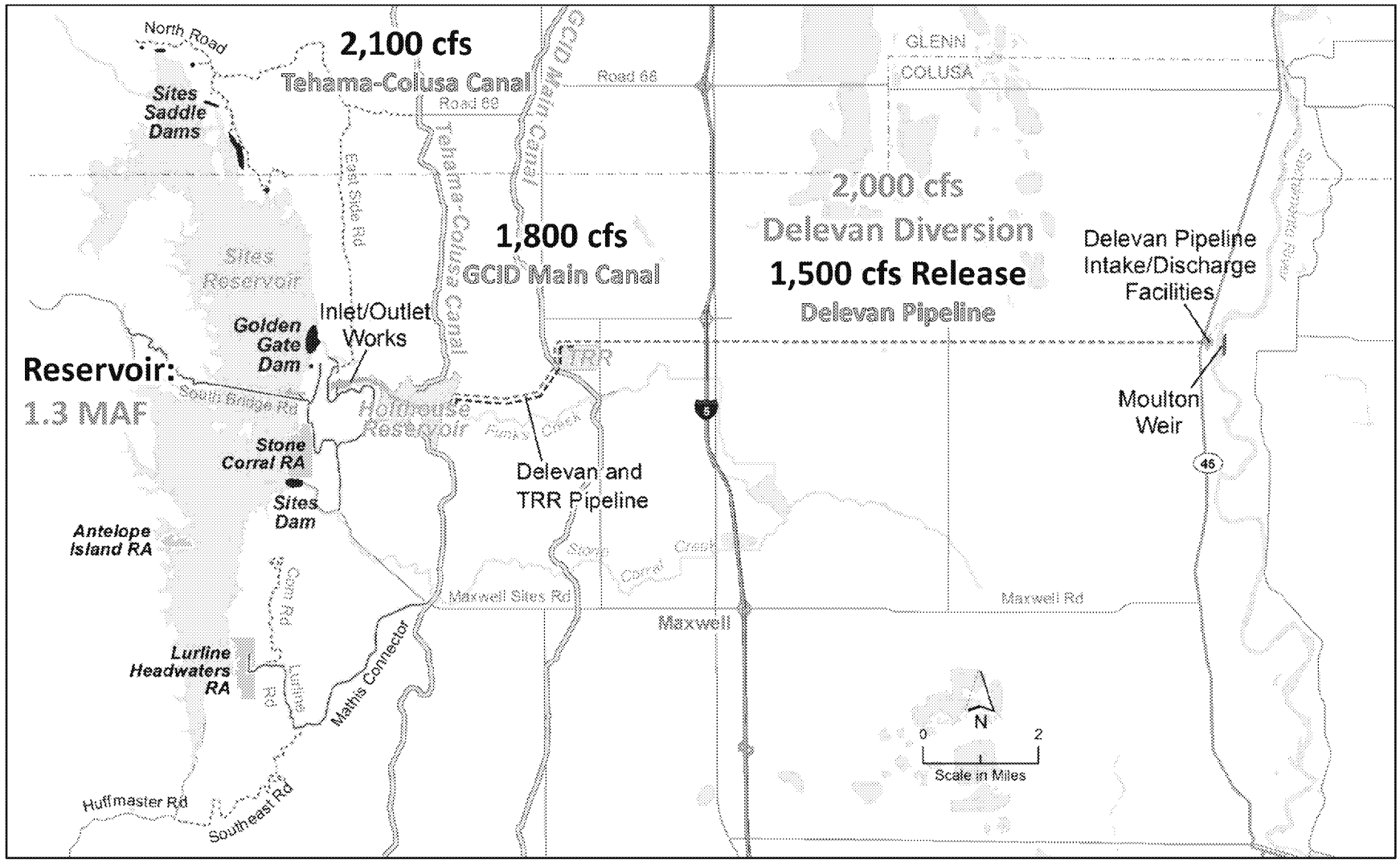
DWR and Reclamation 2013. *Mitigation Monitoring Plan Costs for North-of-the-Delta Off stream Storage.* Prepared for the California Department of Water Resource and United States Department of Interior, Bureau of Reclamation. Sacramento, CA. November.

DWR 2013. *NODOS Preliminary Administrative Draft Environmental Impact Report.* Sacramento, CA. December. Available online: http://www.water.ca.gov/storage/northdelta/prelim_admin_draft_eir_index.cfm

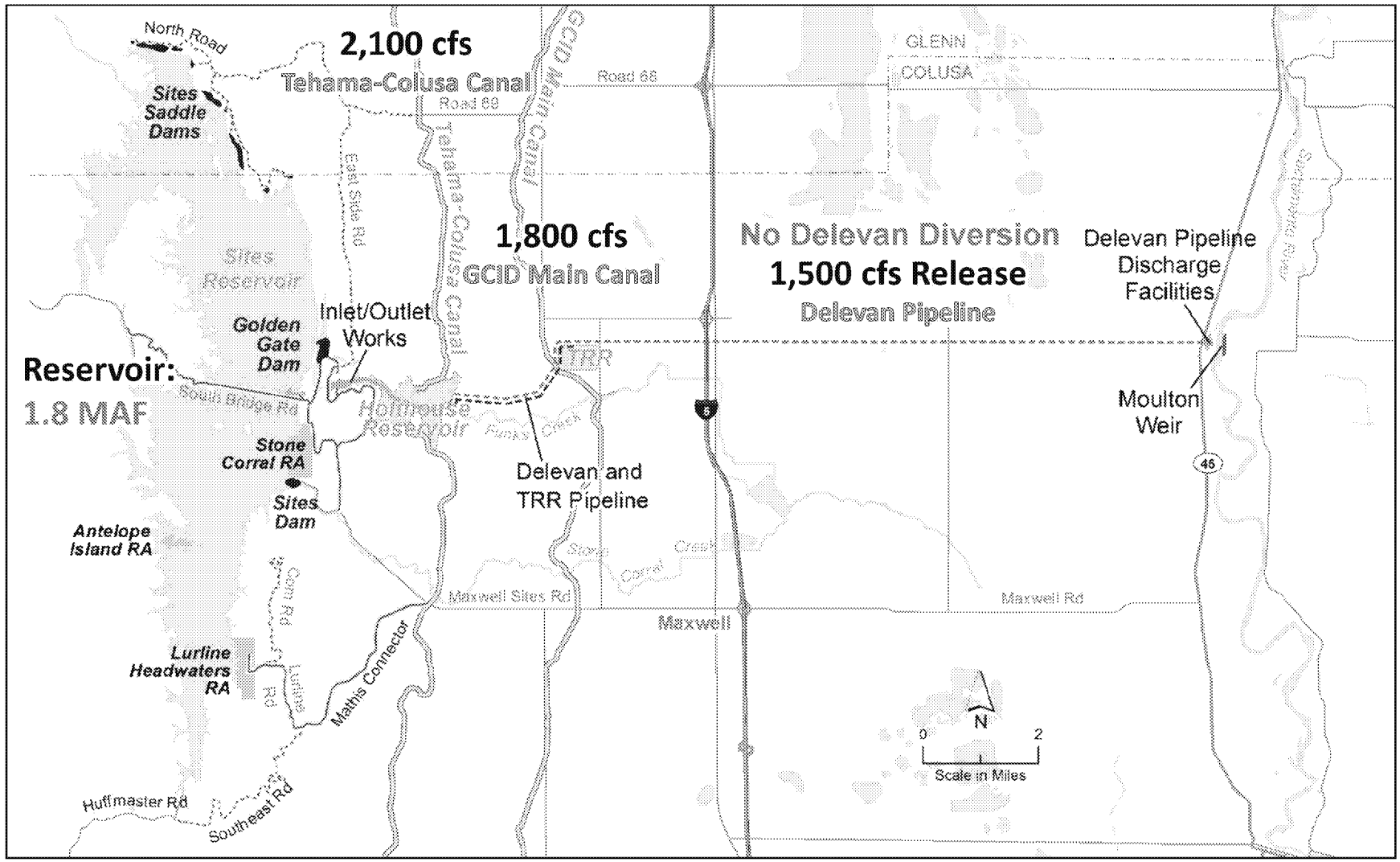
Reclamation 2006. Folsom Dam Safety and Flood Damage Reduction Draft Environmental Impact Statement/Environmental Impact Report. Folsom, CA. December. Available online. http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=1808

ATTACHMENT 1

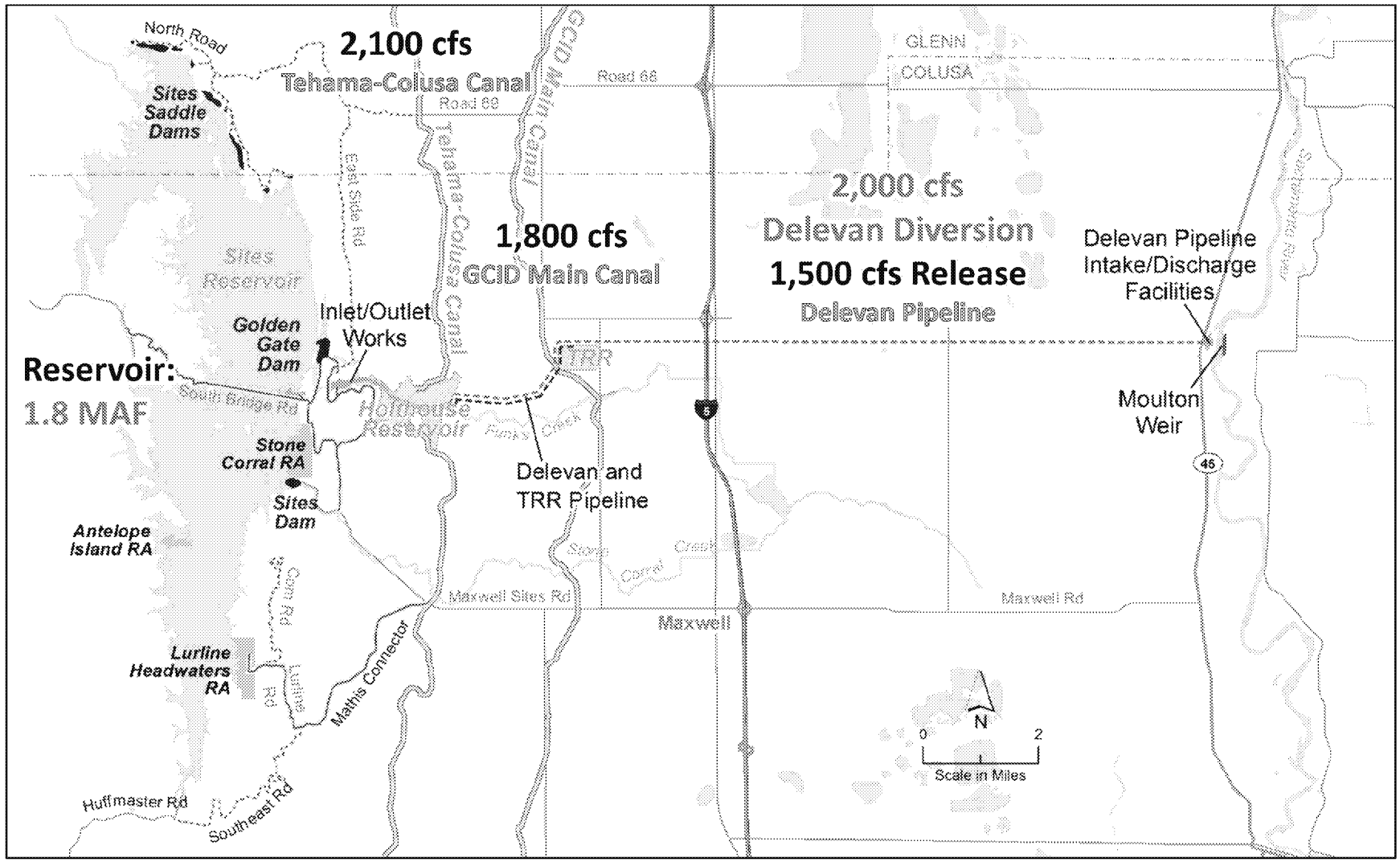
Site Plans for Alternatives A through D



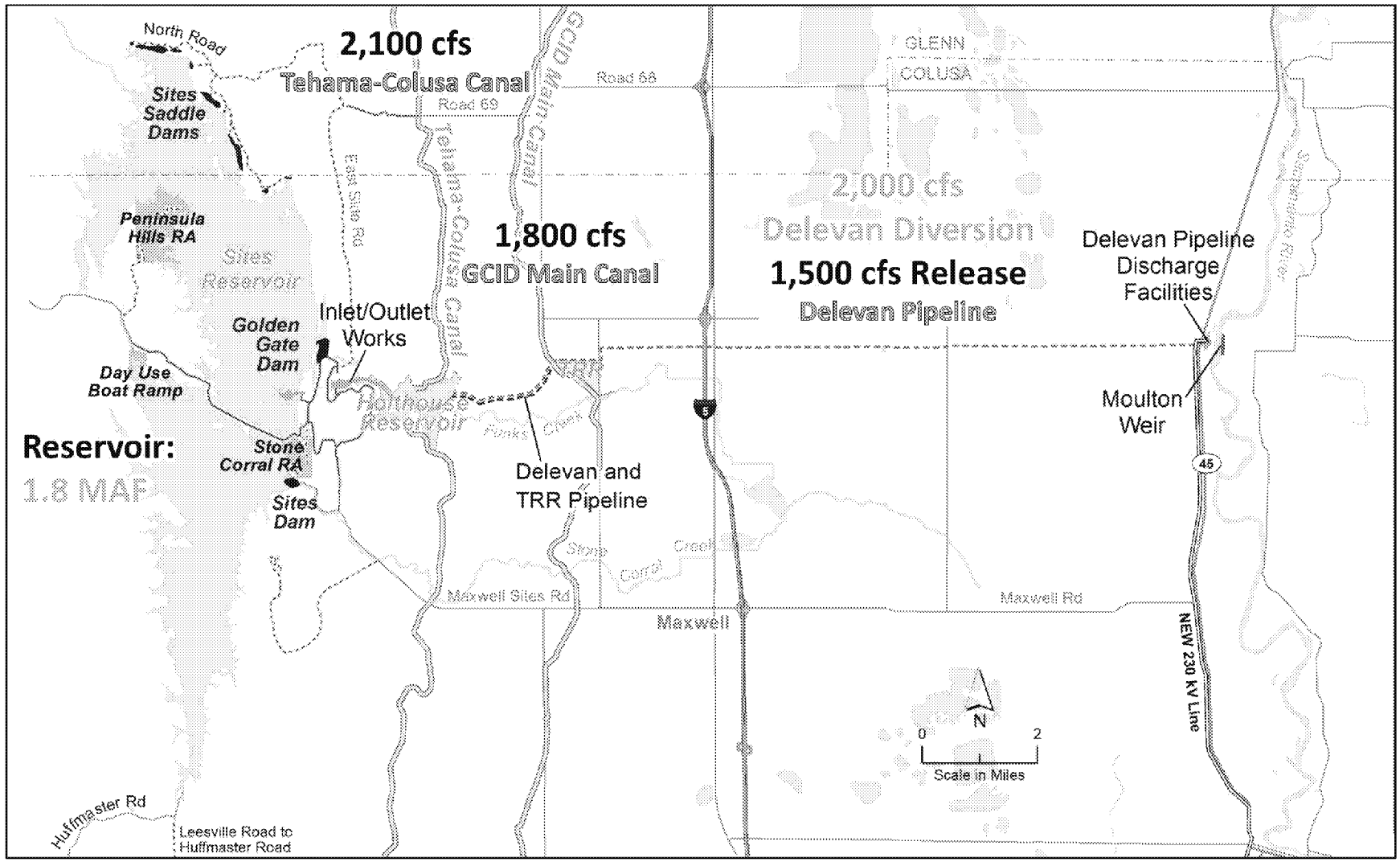
ALTERNATIVE A SITE PLAN



ALTERNATIVE B SITE PLAN



ALTERNATIVE C SITE PLAN



ALTERNATIVE D SITE PLAN

ATTACHMENT 2

Sites Reservoir Mitigation Cost Summary

SITES RESERVOIR JOINT POWERS AUTHORITY — **ESTIMATE WORKSHEET** — SHEET 01 OF 10

FEATURE:
NODOS Project
Project Mitigation and Monitoring Plan
Resource Category Cost Estimates

Summary Sheet

PROJECT: NODOS Alternative C

WOID: | **ESTIMATE LEVEL:** Planning
REGION: | **UNIT PRICE LEVEL:** 2016
FILE: #N/A

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Surface Water Quality					$1,510,108.10
		Aquatic Resources					$46,487,500.00
		Botanical Resources					$75,033,200.00
		Wildlife Habitat					$43,753,900.00
		Wetlands Habitat					$66,540,000.00
		Cultural Resources					$27,690,000.00
		Land Use					$25,789,375.00
		Paleontology					$1,210,000.00
		Air Quality					$150,000.00
		Subtotal					**$288,164,083.10**
		Mobilization	2%	+/-			$5,800,000.00
		Subtotal with Mobilization					**$293,964,083.10**
		Contract Cost Allowances (Sum of):	13%	+/-			$36,035,916.90
		Design Contingencies, 12 % (+/-)					
		APS, 1 % (+/-). Type of procurement: Full and open sealed bid competition					
		CONTRACT COST					**$330,000,000.00**
		Construction Contingencies	2%	+/-			$10,000,000.00
		FIELD COST					**$340,000,000.00**
		Non-Contract Costs	4%	+/-			$10,000,000.00
		CONSTRUCTION COST (Unit Price Level Oct 2015)					**$350,000,000.00**
		Escalation to Notice to Proceed (NTP) *(separate calculation not included here)*					
		at		per year for		years	
		CONSTRUCTION COST (with Escalation to NTP)					**$350,000,000.00**
		Ref.: For appropriate use and terminology, see Reclamation Manual, Directives and Standards FAC; 09-01, 09-02 and 09-03.					

QUANTITIES		PRICES	
BY Loren Murray	CHECKED Anthony Quintrall	BY Loren Murray	CHECKED Joseph Barnes
DATE PREPARED 5/26/2016	PEER REVIEW / DATE	DATE PREPARED 05/26/16	PEER REVIEW / DATE

SITES RESERVOIR JOINT POWERS AUTHORITY **ESTIMATE WORKSHEET** SHEET 02 OF 10

FEATURE:
NODOS Project
Project Mitigation and Monitoring Plan
Resource Category Cost Estimates
Surface Water Quality

PROJECT:
NODOS Alternative C

WOID: | **ESTIMATE LEVEL:** Planning
REGION: | **UNIT PRICE LEVEL:** 2016
FILE: #N/A

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Surface Water Quality					
	1	*SWQual-1a*	SWQ	1.0	ea	$1,500,000.00	$1,500,000.00
		SWQual-1b	SWQ				
	2	Clear & Grub		1.0	ea	$5,000.00	$5,000.00
	3	Earthwork - excavate around springs (est. 3 springs)		50.0	yd3	$3.27	$163.50
	4	Grout Injection (est. 3.33 yd3 per spring)		10.0	yd3	$100.00	$1,000.00
	5	Concrete Transit Trucking		60.0	yd3	$22.71	$1,362.60
	6	Backfill, Concrete site capping		50.0	yd3	$50.00	$2,500.00
	7	Spreading/compaction - excavated materials		100.0	yd3	$0.82	$82.00
		SUBTOTAL THIS SHEET					**$1,510,108.10**

QUANTITIES		PRICES	
BY Loren Murray	CHECKED Anthony Quintrall	BY Loren Murray	CHECKED Joseph Barnes
DATE PREPARED 05/26/16	PEER REVIEW / DATE	DATE PREPARED 05/26/16	PEER REVIEW / DATE

SITES RESERVOIR JOINT POWERS AUTHORITY **ESTIMATE WORKSHEET** SHEET 03 OF 10

FEATURE:
NODOS Project
Project Mitigation and Monitoring Plan
Resource Category Cost Estimates
Aquatic Resources

PROJECT:
NODOS Alternative C

WOID:	**ESTIMATE LEVEL:** Planning
REGION:	**UNIT PRICE LEVEL:** 2016
FILE: #N/A	

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Aquatic Resources					
		Fish-1e	AR				
	1	Land Acquisition - Fee Title	AR	681.0	acre	$2,500.00	$1,702,500.00
	2	Riparian Restoration	AR	681.0	acre	$65,000.00	$44,265,000.00
		Fish-1h					
	3	Fish salvage and rescue plan	AR	1.0	ea	$20,000.00	$20,000.00
	4	Fish salvage and rescue implementation	AR	1.0	ea.	$500,000.00	$500,000.00

SITES RESERVOIR JOINT POWERS AUTHORITY **ESTIMATE WORKSHEET** SHEET 04 OF 10

FEATURE:
NODOS Project
Project Mitigation and Monitoring Plan
Resource Category Cost Estimates
Botanical Resources

PROJECT:
NODOS Alternative C

WOID: | **ESTIMATE LEVEL:** Planning
REGION: | **UNIT PRICE LEVEL:** 2016
FILE: #N/A

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Vegetation Communities					
		Bot-1[x]; Bot-2[x]; Bot-3[x]					
	1	Annual grasslands, permanent (2:1)		27,391.4	acre	$2,500.00	$68,478,500.00
	2	Blue oak woodlands, permanent (1:1)		478.6	acre	$3,000.00	$1,435,800.00
	3	Blue oak mixed chaparral, perm. (1:1)		33.40	acre	$3,000.00	$100,200.00
	4	Canal, permanent (1:1)		1.0	acre	$20,000.00	$20,000.00
	5	Valley oak woodland, permanent (3:1)		10.5	acre	$3,000.00	$31,500.00
	6	*Bot-1b*					
		Watershed Hydrological Studies (alkaline wetlands)		1.0	LS	$300,000.00	$300,000.00
		Bot-1d					
		Watershed Hydrological Studies (groundwater pressure		1.0	LS	$300,000.00	$300,000.00
		Bot-2a					
		Sidalcea keckii and Amsinckia lunaris Surveys		2250.0	days	$1,600.00	$3,600,000.00
		Bot-2c					
		Rare Alkaline Wetland Species Surveys		7.0	days	$1,600.00	$11,200.00
		Bot-2d					
		Special-Status Plant Species Surveys		472.5	days	$1,600.00	$756,000.00
		SUBTOTAL THIS SHEET					**$75,033,200.00**

QUANTITIES		**PRICES**	
BY Loren Murray	**CHECKED** Anthony Quintrall	**BY** Loren Murray	**CHECKED** Joseph Barnes
DATE PREPARED 05/26/16	**PEER REVIEW / DATE**	**DATE PREPARED** 05/26/16	**PEER REVIEW / DATE**

SITES RESERVOIR JOINT POWERS AUTHORITY — **ESTIMATE WORKSHEET** — SHEET 05 OF 10

FEATURE:
NODOS Project
Project Mitigation and Monitoring Plan
Resource Category Cost Estimates
Wildlife Habitat

PROJECT:
NODOS Alternative C

WOID:
REGION:
FILE: #N/A

ESTIMATE LEVEL: Planning
UNIT PRICE LEVEL: 2016

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Wild-1[x]; Wild-2[x]					
	1	Blue oak woodland (GE; SH; WSF)(4:1)	Wild-2	3550.0	acre	$3,000.00	$10,650,000.00
	2	Deciduous orchard (GGS)	Wild-2c	46.2	acre	$4,500.00	$207,900.00
	3	Dryland grain and seed crops (SH)(0.5:1)	Wild-1a	166.6	acre	$2,000.00	$333,200.00
	4	Irrigated row and field crops (SH)(0.5:1)	Wild-1a	77.8	acre	$2,500.00	$194,500.00
	5	Pasture (GSC; FH; BO; WTK)(1:1)		72.7	acre	$4,500.00	$327,150.00
	6	Rice (GGS)(3:1 perm ac./ 1:1 temp ac.)	Wild-2c	1752.7	acre	$4,500.00	$7,887,150.00
	7	Valley foothill riparian (3:1) (GGS; VELB		334.6	acre	$3,000.00	$1,003,800.00
		CTS; BE; SH; WYBC; VRI; WPT; RT)					
	8	Blue Oak woodland/mixed (*Bot-[x]*)	Bot-2a	52.0	acre	$3,000.00	$156,000.00
		Wild-1b					
	9	Implement bat exclusion measures	Wild-1b	18.0	days	$1,600.00	$28,800.00
		Wild-2b					
	9	Bald eagle nest removal	Wild-2b	3.0	Nest	$11,960.00	$35,880.00
		Wild-2d					
	10	Golden eagle pre-/post-construction	Wild-2d	7.0	Years	$290,000.00	$2,030,000.00
		satellite telemetry studies					
	11	Golden Eagle Monitoring Plan	Wild-2d	1.0	LS	$150,000.00	$150,000.00
	12	Golden eagle Protection Plan	Wild-2d	1.0	LS	$150,000.00	$150,000.00
	13	Independent Expert (Pete Bloom)	Wild-2d	1.0	LS	$120,000.00	$120,000.00
	14	Helicopter survey - nesting population	Wild-2d	4.0	Survey	$10,800.00	$43,200.00
	15	Helicopter detraction actions	Wild-2d	3.0	Nest	$17,940.00	$53,820.00
		Wild-2g					
	16	Pre-constr survey western burrowing owls	Wild-2g	16500.0	acre	$200.00	$3,300,000.00
		Wild-2h					
	17	Pre-constr survey western pond turtle	Wild-2h	1712.5	acre	$200.00	$342,500.00
		Wild-4					
	18	Awareness training (human disturbance)	Wild-4	1.0	LS	$100,000.00	$100,000.00
	19	Pre-constr surveys /monitoring during	Wild-4	10.0	Year	$1,664,000.00	$16,640,000.00
		construction					
		SUBTOTAL THIS SHEET					**$43,753,900.00**

QUANTITIES		PRICES	
BY Loren Murray	CHECKED Anthony Quintrall	BY Loren Murray	CHECKED Joseph Barnes
DATE PREPARED 05/26/16	PEER REVIEW / DATE	DATE PREPARED 05/26/16	PEER REVIEW / DATE

SITES RESERVOIR JOINT POWERS AUTHORITY **ESTIMATE WORKSHEET** SHEET 06 OF 10

FEATURE:
NODOS Project
Project Mitigation and Monitoring Plan
Resource Category Cost Estimates
Wetlands Habitat

PROJECT:
NODOS Alternative C

WOID:	**ESTIMATE LEVEL:** Planning
REGION:	**UNIT PRICE LEVEL:** 2016
FILE: #N/A	

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Wet-1[x]					
	1	Alkaline wetlands (2:1; onsite)		74.0	acre	$150,000.00	$11,100,000.00
	2	Emergent wetlands (3:1; offsite)		7.2	acre	$100,000.00	$720,000.00
	3	Seasonal wetlands (3:1)		547.2	acre	$100,000.00	$54,720,000.00
		SUBTOTAL THIS SHEET					$66,540,000.00

QUANTITIES		PRICES	
BY Loren Murray	CHECKED Anthony Quintrall	BY Loren Murray	CHECKED Joseph Barnes
DATE PREPARED 05/26/16	PEER REVIEW / DATE	DATE PREPARED 05/26/16	PEER REVIEW / DATE

SITES RESERVOIR JOINT POWERS AUTHORITY **ESTIMATE WORKSHEET** SHEET 07 OF 10

FEATURE:
NODOS Project
Project Mitigation and Monitoring Plan
Resource Category Cost Estimates
Cultural Resources

PROJECT:
NODOS Alternative C

WOID: | **ESTIMATE LEVEL:** Planning
REGION: | **UNIT PRICE LEVEL:** 2016
FILE: #N/A

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Cultural Resources					
		Cul-1a					
	1	Remaining surveys for avoidance	Cul-1a	1000.0	acre	$40.00	$40,000.00
		Complete desktop evaluations	Cul-1a	1.0	LS	$100,000.00	$100,000.00
		Cul-1b					
		Conduct Archeological Recovery	Cul-1b				
	2	Ethnographic Studies/Inventory	Cul-1b	1.0	LS	$250,000.00	$250,000.00
	3	Evaluation of NRHP/CRHR eligib	Cul-1b	10.0	sites	$250,000.00	$2,500,000.00
	4	Test Pitting, excavation and exam.	Cul-1b	1.0	LS	$100,000.00	$100,000.00
	5	Preparation and Curation	Cul-1b	1000.0	boxes	$5,000.00	$5,000,000.00
		Cul-1c					
	6	Resources discovery during Construction	Cul-1c	10.0	ea.	$400,000.00	$4,000,000.00
		Cul-1e					
	7	Future Operational Impacts Agmts	Cul-1e	1.0	LS	$200,000.00	$200,000.00
		Cul-2a					
	8	Properties/Resources Treatment	Cul-2a	1.0	LS	$1,000,000.00	$1,000,000.00
		Cul-2b					
	9	HABS/HAER Documentation	Cul-2b	1.0	LS	$1,000,000.00	$1,000,000.00
		Cul-3					
	10	Tribal Consultation for impacts to TCPs	Cul-3	4.0	Tribes	$500,000.00	$2,000,000.00
		Cul-4a					
	11	Relocations of known cemeteries	Cul-4a	250.0	Persons	$4,000.00	$1,000,000.00
	12	Midden grave site (unofficial cemetery)	Cul-4a	1.0	LS	$10,000,000.00	$10,000,000.00
		Cul-4b					
	13	Human remains discovery/treatment	Cul-4b	100.0	Persons	$5,000.00	$500,000.00
		SUBTOTAL THIS SHEET					**$27,690,000.00**

QUANTITIES		**PRICES**	
BY Loren Murray	CHECKED Anthony Quintrall	BY Loren Murray	CHECKED Joseph Barnes
DATE PREPARED 05/26/16	PEER REVIEW / DATE	DATE PREPARED 05/26/16	PEER REVIEW / DATE

SITES RESERVOIR JOINT POWERS AUTHORITY **ESTIMATE WORKSHEET** SHEET 08 OF 10

FEATURE:
NODOS Project
Project Mitigation and Monitoring Plan
Resource Category Cost Estimates
Land and Agriculture

PROJECT:
NODOS Alternative C

WOID: | **ESTIMATE LEVEL:** Planning
REGION: | **UNIT PRICE LEVEL:** 2016
FILE: #N/A

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Land and Agriculture					
		Land-2a					
	1	Glenn County Coordination		1.0	LS	$50,000.00	$50,000.00
		Land-2b					
	2	Wetlands easement cancellation and		21.0	acre	$150,000.00	$3,150,000.00
		compensatory mitigation (3:1)					
		Land-3b					
	3	Maxwell Irrigation District Agreements		1.0	LS	$50,000.00	$50,000.00
		Land-4a					
	4	Agricultural conservations easements		1.0	LS	$5,000,000.00	$5,000,000.00
		FMMP Mitigation (1:1)		2,500.0	acre	$5,000.00	$12,500,000.00
		(in Glenn and Colusa County)					
		Land-5c					
	5	Williamson Act contracts rescinded		16,126.0	acre	$312.50	$5,039,375.00
		(12.5% of value; value avg. at $2500/ac.)					
		SUBTOTAL THIS SHEET					**$25,789,375.00**

QUANTITIES		PRICES	
BY Loren Murray	CHECKED Anthony Saltrail	BY Loren Murray	CHECKED Joseph Barnes
DATE PREPARED 05/26/16	PEER REVIEW / DATE	DATE PREPARED 05/26/16	PEER REVIEW / DATE

SITES RESERVOIR JOINT POWERS AUTHORITY — **ESTIMATE WORKSHEET** — SHEET 09 OF 10

FEATURE:
NODOS Project
Project Mitigation and Monitoring Plan
Resource Category Cost Estimates
Paleontology

PROJECT: NODOS Alternative C

WOID: | **ESTIMATE LEVEL:** Planning
REGION: | **UNIT PRICE LEVEL:** 2016
FILE: #N/A

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Paleontology					
		Paleo-1b					
	1	Paleontological Resource Specialist		1.0	LS	$350,000.00	$350,000.00
		pre-construction consultation					
		Paleo-1c					
	2	Implement Paleontological Resources		1.0	LS	$200,000.00	$200,000.00
		Monitoring/Mitigation Plan					
		Paleo-1d					
	3	Paleontological Resources Awareness		1.0	LS	$100,000.00	$100,000.00
		Training					
		Paleo-1e					
	4	Monitoring during Construction and		8.0	Year	$50,000.00	$400,000.00
		monthly reporting					
		Paleo-1f					
	5	Ensure Monitoring & Mitigation		8.0	Year	$20,000.00	$160,000.00
		implementation plan					
		SUBTOTAL THIS SHEET					**$1,210,000.00**

QUANTITIES		PRICES	
BY Loren Murray	CHECKED Anthony Quintal	BY Loren Murray	CHECKED Joseph Barnes
DATE PREPARED 05/26/16	PEER REVIEW / DATE	DATE PREPARED 05/26/16	PEER REVIEW / DATE

SITES RESERVOIR JOINT POWERS AUTHORITY **ESTIMATE WORKSHEET** SHEET 10 OF 10

FEATURE: NODOS Project Project Mitigation and Monitoring Plan Air Quality	**PROJECT:** NODOS Alternative C
WOID:	**ESTIMATE LEVEL:** Planning
REGION:	**UNIT PRICE LEVEL:** 2016
FILE: #N/A	

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Air Quality Impacts					
		Air Qual - 1a					
	1	Fugitive Dust Control Plan		1.0	LS	$100,000.00	$100,000.00
		Air Qual - 1b					
	2	Equipment/Vehicle Emmissions Reduction		10.0	year	$5,000.00	$50,000.00
		SUBTOTAL THIS SHEET					**$150,000.00**

QUANTITIES		**PRICES**	
BY Loren Murray	CHECKED Anthony Quintrall	BY Loren Murray	CHECKED Joseph Barnes
DATE PREPARED 05/26/16	PEER REVIEW / DATE	DATE PREPARED 05/26/16	PEER REVIEW / DATE

ATTACHMENT 3

High Cost Mitigation Measures

Attachment 3. High Cost Mitigation Components

Mitigation Measure	High Cost Component/Activity	Estimated Costs[1] ($million)
Bot-1a; Bot-2e Wild 1a; Wild 2b	Mitigation for loss of annual grasslands	68.5
Bot-1a; Wet-2a; Wild 1a	Mitigation for loss of seasonal wetlands	54.7
Bot-1a; Wet-1a; Fish-1e; Wild-3c	Riparian/Stream restoration	44.3
Bot-1a; Wet-2b	Mitigation for loss of alkaline wetlands	11.1
Bot-1a; Wild 1a	Mitigation for loss of Blue Oak woodland	10.7
Cul-4a	Native American (Midden) grave repatriation	10.0
Cul-1b	Archeological resources recovery	7.9
Bot-1a; Wild 1a; Wild 2c; Land-4a	Mitigation for loss of rice fields, giant garter snake habitat and prime farmland	7.9
Land 4a	Ag lands conservation easements for loss of prime farmland	12.5
Land 5c	Williamson Act contract cancellation fees	5.0

Notes:

[1] Estimated costs include mobilization, contingency, and escalation

Source: Data compiled by AECOM in 2016

ATTACHMENT 4

Detailed Cost Assumptions by Resource

Botanical Resources

Wetland and other Waters of the U.S.

Terrestrial Biological Resources

Aquatic Resources

Surface Water Quality

Cultural Resources

Paleontological Resources

Land Use

Air Quality

Attachment 4A. Botanical Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Bot-1a: Implement Vegetation Community Mitigation Measures Recommended by USFWS	A Habitat Evaluation Procedures (HEP) assessment of the Primary Study Area was conducted under the lead of USFWS. A determination of appropriate mitigation measures for the habitat types that would be adversely affected within the Primary Study Area shall be made using the results of the HEP assessment, as well as through consultation with USFWS pursuant to the Fish and Wildlife Coordination Act. Mitigation measures could include but not be limited to protection, enhancement, restoration, or conservation easement.	Refer to vegetation community impacts spreadsheet – Attachment 6.
Bot-1b: Conduct Watershed Hydrological Studies	DWR and Reclamation shall conduct hydrological studies to determine how much of the grassy upland acts as a watershed for the alkaline wetland swale that feeds the downstream alkaline marsh. The studies shall provide guidance regarding how to avoid impacts to the grasslands that direct water to the marsh.	Costs to be included in project construction and O&M costs. Cost to include study only. **$300,000 to $700,000 (studies)** O&M monitoring and reporting for wetlands. **$20,000 per year**
Bot-1c: Avoid/Minimize Loss or Disturbance of Vegetation by Refining the Siting of Facilities and Implementing BMPs	DWR and Reclamation shall implement BMPs, protective measures such as fencing and erosion, sedimentation, and dust control, and where possible refine the siting of facilities to minimize construction disturbance to sensitive vegetation communities.	Costs for protective measures to be included in project construction and O&M costs.
Bot-1d: Conduct Groundwater Hydrological Studies	DWR and Reclamation shall conduct hydrological studies to determine the effects of groundwater pressure on the alkaline habitat quality of the swale and the marsh. Measures may include protection of nearby similar vegetation communities, or USFWS may determine the effects are unavoidable and there may be no means of mitigation if there are no equivalent nearby vegetation communities that are feasible to protect or enhance.	Cost to include groundwater hydrology studies focused on impacts to alkaline habitat only. **$300,000 to $700,000 (studies)** O&M for groundwater and alkaline habitat monitoring. **$25,000 per year**

Attachment 4A. Botanical Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Bot-1e: Minimize Impacts by Siting Facilities Away from Drainage Swales and Implementing BMPs	DWR and Reclamation shall implement measures that mitigate impacts within the Holthouse Reservoir Complex to alkaline wetland vegetation in the on-site swale to avoid sedimentation of the swale during Project construction, according to recommendations received during consultation with USFWS.	Costs to be included in project construction and O&M costs.
Bot-1f: Implement BMPs to Avoid Disturbance of Marsh Vegetation in Adjacent Delevan National Wildlife Refuge	DWR and Reclamation shall set back all construction activities and equipment at least 20 feet away from the strip of marshy vegetation along the south end of the Delevan Pipeline construction disturbance area bordering the north edge of Delevan NWR. In addition, construction workers shall be prohibited from entering the NWR. BMPs, including signage on existing fencing, shall also be used to minimize erosion, sedimentation, and dust.	Costs to be included in project construction and O&M costs. Avoidance will be included into designs. No additional costs associated. Engineers to evaluate tunneling construction methods to avoid impacts.
Bot-2a: Conduct Pre-Construction Surveys for *Sidalcea keckii* and *Amsinckia lunaris*; if Found, Compensate According to USFWS Guidelines	If either plant species is found during the Project pre-construction surveys, DWR and Reclamation shall immediately report the location and size of occurrences to CDFG and USFWS. If found, DWR and Reclamation shall compensate for the loss or temporary disturbance of either species according to USFWS guidelines, which could include protection of known occurrences in nearby habitat.	Assume total acreage to be surveyed is 4,000 to 5,000 acres. Assume survey 6 acres per day for protocol level studies at $100 per hour. Assume 2 staff and 3 surveys. **$3,200,000 to $4,000,000 (surveys)**
Bot-2b: Avoid Occurrences of CNPS List 1B and State- or Federally-Listed Plant Species	DWR and Reclamation shall avoid occurrences of *Sidalcea keckii, Amsinckia lunaris*, and *Lotus rubriflorus* by refining the siting of facilities where feasible, and minimizing construction impacts with protection measures and BMPs, such as fencing and erosion, dust, and sedimentation control.	Costs to be included in project construction and O&M costs. Avoidance will be included into designs. No additional costs associated. Engineers to evaluate tunneling construction methods to avoid impacts.

Attachment 4A. Botanical Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Bot-2c: Conduct Pre-Construction Surveys for Rare Alkaline Wetland Species in the Managed Alkaline Wetland Parcel of the Delevan Pipeline	DWR and Reclamation shall conduct pre-construction surveys to determine if rare alkaline wetland species are present. If determined to be present during the pre-construction surveys, DWR and Reclamation shall compensate for the loss and temporary disturbance of alkaline wetland species according to USFWS guidelines, which could include protection of known occurrences in nearby habitat.	Assume 14 acres to be surveyed. Assume 2 staff and 3 surveys. Assume 6 acres per day for protocol level studies at $100 per hour. **$11,200 (surveys)**
Bot-2d: Conduct Pre-Construction Surveys for Special-Status Plant Species	DWR and Reclamation shall conduct pre-construction surveys to determine if habitats that support special-status species are present.	Assume mitigation applies to unsurveyed grassland areas associated with the Delevan project components(13 miles long and 1,000 feet wide = 1,575 acres). Assume two staff and three surveys per year for 8 years. Assume: 10 acres per day for protocol level studies at $100 per hour. **$756,000 (surveys)**
Bot-2e: Compensate for Loss or Disturbance of CNPS List 4 Species According to CDFG Guidelines	DWR and Reclamation shall compensate for the loss of 13 occurrences CNPS List 4 species pursuant to consultation with DFG, which could include protection of known occurrences in nearby habitat. DWR and Reclamation shall also compensate for the temporary disturbance of four CNPS List 4 species pursuant to consultation with DFG, which could include preserving habitat available for recolonization by three of the four species by revegetating with local natives and using weed-free mulch to prevent post-construction takeover by weeds.	Refer to vegetation community impacts spreadsheet – Attachment 6.

Attachment 4A. Botanical Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Bot-3a: Implement Preventive Actions by Following Weed Control BMPs; Minimize Exposed Ground; Reduce Weed Seed by Removal of On-Site and Off-Site Weeds	DWR and Reclamation shall minimize the introduction of new weed seeds into the construction disturbance area or transport weed seeds between construction disturbance areas by following weed control BMPs (e.g., equipment washing). DWR and Reclamation shall minimize the exposed ground within the construction disturbance area that is available for weed colonization or spread by mulching with weed-free materials or planting the exposed ground with native cover crops local to the Project area. In addition, DWR and Reclamation shall reduce the weed seed that is available for invasion into the Project construction disturbance area by appropriate removal of on-site weeds and by implementing selective adjacent off-site weed removal.	Costs to be included in project construction and O&M costs. O&M for weed management. **$10,000/year**
Bot-3b: Implement Avoidance Measures in Areas Adjacent to the Delevan National Wildlife Refuge	During construction of the Delevan Pipeline and Power Transmission Line, DWR and Reclamation shall avoid the placement of large staging areas within the portion of the construction disturbance area that borders the Delevan NWR.	Costs to be included in project construction and O&M costs. Avoidance will be included into designs. No additional costs associated with mitigation measure. Engineers to evaluate jack and bore and/or tunneling construction methods to avoid impacts.
Bot-4: Implement Vegetation Monitoring in Coordination with USFWS	DWR and Reclamation, in coordination with USFWS, shall monitor the effects of human activities on the health of sensitive areas adjacent to Project facilities.	Timing after construction/during operation of recreation facilities. Assume monitoring at Stone Corral and Peninsula Hills Recreation Areas and assume costs will be rolled up into O&M costs for recreation facilities. O&M for vegetation monitoring **$25,000 per year**

Attachment 4B. Wetlands and Other Waters of the U.S.

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Wet-1a: Implement Compensatory Mitigation Measures for Streams pursuant to USACE Determination within the Watershed in which the Impacts	Compensatory mitigation for streams shall be provided for each significant impact identified by the USACE determination according to ratios determined by the USACE for the appropriate category and degree of severity of loss or impact. Mitigation shall occur within the watershed in which the impacts occur: • Sites Reservoir & Dams, Recreation Areas—Funks/Hunter/Antelope/Grapevine/Stone Corral Creek watersheds. • Delevan Pipeline Intake Facilities, Delevan Pipeline Discharge Facility—Sacramento River adjacent to facility location. • Road Relocations, Funks Reservoir, Holthouse Reservoir Complex, Sites Inlet/Outlet Structure and associated facilities, Field Office Maintenance Yard, Electrical Switchyard—Funks Creek watershed.	Refer to wetland impacts spreadsheet – Attachment 6.
Wet-1b: Reroute Canals to Ensure Continued Hydrological Connection, or Implement other Compensatory Mitigation Measures pursuant to USACE Determination	For impacts to canals, mitigation shall include re-routing the canals to ensure continued hydrological connection to traditional waters of the U.S. Loss of emergent wetland habitat from within canals shall be mitigated for in other ways, as recommended by the USACE.	Costs associated with avoidance measures, BMPs and to be included in project construction and O&M costs.
Wet-1c: Restore Ponds to Original Condition, or Implement other Compensatory Mitigation Measures pursuant to USACE Determination within the Same Hydrologic Unit in which the Ponds Occur	The pond located 3.5 miles west of the Sacramento River within the Delevan Pipeline construction disturbance area should be restored after construction is completed to its current condition as an agricultural pond. If restoration is not possible, compensatory mitigation measures, pursuant to USACE determination, shall be implemented within the Hunters Creek-Logan Creek watershed downstream of their confluence.	Refer to wetland impacts spreadsheet – Attachment 6.

Attachment 4B. Wetlands and Other Waters of the U.S.

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Wet-2a: Conserve, Enhance, Restore, or Create Seasonal Wetlands, or Implement other Compensatory Mitigation Measures pursuant to USACE Determination within the Watershed in which the Impacts Occur	For the seasonal wetlands located along the edge of Funks Reservoir, alter the extent of dredging so that the slope of the reservoir bottom is more tapered at this point	Refer to wetland impacts spreadsheet – Attachment 6.
Wet-2b: Conserve, Enhance, Restore, or Create Alkaline Wetlands, or Implement other Compensatory Mitigation Measures pursuant to USACE Determination within the Watershed in which the Impacts Occur	The local saline spring areas further upslope in same geological formation as the springs that feed Salt Lake shall be enhanced. These springs are located outside of the Sites Reservoir footprint but in the creases of the foothills due north of Salt Lake. Some of them may be able to be expanded, and could possibly be partially protected from grazing impacts with the installation of protective fencing. A conservation agreement shall be entered into with Reclamation to manage and protect the entire alkaline wetland area southeast of Holthouse Reservoir. Management shall include burning and grazing regimes similar to those used effectively on the Sacramento NWR. A purchase or conservation agreement shall be entered into with the utilities or other landowners to protect and manage other saline/alkaline wetland habitats in parcels east of the Tehama-Colusa (T-C) Canal, north of the Primary Study Area. Protected areas might include a potential alkaline wetland area southeast of the Colusa Generating Station located along the T-C Canal. For the Holthouse Reservoir alkaline wetlands, a hydrogeological study shall be conducted to determine the direction and sources of water supplying the seeps, swales, and main wetland area, to better inform evaluation of potential effects of placing the dam and reservoir in proximity of the wetland's west edge. The study shall include testing of the wetland area's water and soils, and may allow for development of minimization measures.	Refer to wetland impacts spreadsheet – Attachment 6.

Attachment 4B. Wetlands and Other Waters of the U.S.

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Wet-2c: Conserve, Enhance, Restore, or Create Vernal Pools Equivalent to the Type of Vernal Pools Adversely Impacted, or Implement other Compensatory Mitigation Measures pursuant to USACE Determination	For vernal pools, the type of vernal pools conserved elsewhere shall be equivalent to the type lost from the Primary Study Area – most likely, clay pan and alkaline vernal pools. Consultation with vernal pool experts shall occur to ensure ecological equivalence.	Refer to wetland impacts spreadsheet – Attachment 6.
Wet-2d: Conserve, Enhance, Restore, or Create Emergent Wetlands, or Implement other Compensatory Mitigation Measures pursuant to USACE Determination within the Watershed in which the Impacts Occur	[Text not included in previous draft of EIS/R]	Refer to wetland impacts spreadsheet – Attachment 6.
Wet-2e: Conserve, Enhance, Restore, or Create Comparable Riparian Wetlands in the Inner Coast Range Foothills, or Implement other Compensatory Mitigation Measures pursuant to USACE Determination	For the two-acre riparian wetland and waters of Funks Creek lost to Holthouse Reservoir, a comparable area in the inner coast range foothills shall be selected for restoration and conservation.	Refer to wetland impacts spreadsheet – Attachment 6.

Attachment 4C. Terrestrial Biological Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Wild-1a: Implement a Combination of Habitat Protection, Enhancement, Restoration, or Conservation Easement Measures, in Consultation with USFWS	For all three action alternatives, the acreage of permanent habitat loss within the Recreation Areas and the Road Relocations, as well as the temporary habitat disturbance within the construction disturbance areas for most facilities, was estimated. Because these acres are estimated, it may be possible to avoid impacts to certain habitat types. A Habitat Evaluation Procedures assessment of the Primary Study Area was conducted under the lead of USFWS. A determination of appropriate mitigation measures for the habitat types that would be adversely affected within the Primary Study Area shall be made using the results of the HEP assessment, as well as through consultation with USFWS pursuant to the Fish and Wildlife Coordination Act. Mitigation measures could include but not be limited to protection, enhancement, restoration, or conservation easement.	Refer to habitat impacts spreadsheet – Attachment 6.
Wild-1b: Implement Bat Exclusion Measures Prior to Demolition of Existing Structures	Prior to structure demolition, structures shall be inspected by a qualified biologist to determine if bats are present and if present, to determine if the structure is being used as a day, night, or maternity roost. If a roost is present, appropriate bat exclusion measures shall be implemented at least five to seven days prior to structure demolition outside of the maternity season, which can range from mid-April through August 31, and outside of the winter months when bats could be hibernating. Bat exclusion measures could include one-way devices such as polypropylene netting, plastic sheeting, or tube-type excluders that would be placed at all active entry points. If a roost is present in a structure located outside of a reservoir inundation area, possible avoidance measures could include retaining the structure.	Costs for bat exclusion measures to be included in project construction and O&M costs. Assume 89 structures to be surveyed. Trees that provide bat roosting habitat to be surveyed with other species surveys. Assume one-time survey. Assume five structures per day (18 days total) and two staff at $100 per hour. **$28,800 (surveys)**
Wild-2a: Obtain Permit for Bald Eagle Nest Tree Removal, Remove Nest Tree Outside of Breeding Season, and Create Suitable Habitat	A permit to remove or relocate an eagle nest shall be obtained from USFWS. The bald eagle nest tree shall be removed outside of the breeding season, which ranges from January through July, to avoid direct impacts. Dam construction activities shall not occur during the breeding season until the nest tree is removed. After construction is complete, the filling of Sites Reservoir and Holthouse Reservoir would create new fish-bearing lacustrine habitat in an area that is surrounded by suitable bald eagle nest trees. Following inundation, releases downstream of Golden Gate Dam would restore flows to Funks Creek to maintain fisheries and bald eagle habitat.	Costs to prepare a plan to remove nest included in Mitigation Measure *Wild-2d*.

Attachment 4C. Terrestrial Biological Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Wild-2b: Implement Protective Actions to Prevent Bank Swallows from Nesting in the Cut Banks of Project Construction Trenches	Construction of the pipelines shall begin in May due to giant garter snake restrictions. May falls within the bank swallow breeding season (ranging from mid-March through July). Protective action shall be taken to prevent bank swallows from attempting to nest within the cut banks of the pipeline trenches. Actions shall include the placement of a mesh net on all cut banks during the bank swallow nesting season, and implementation of Mitigation Measure Wild-3a to ensure that trenches are backfilled within 72 hours of pipeline installation.	Costs to be included in project construction and O&M costs.
Wild-2c: Conduct Pre-Construction Surveys for Giant Garter Snakes and Implement Protective Actions; Conduct Project Construction Activity Between May 1 and October 1 in Giant Garter Snake Habitat; Compensate for Temporary Disturbance of Habitat According to USFWS Guidelines	Protective actions shall be taken to avoid or minimize impacts to the giant garter snake. Protective actions and mitigation measures shall comply with the USFWS's Programmatic Biological Opinion (USFWS, 1997).	Costs associated with avoidance measures, BMPs and to be included in project construction and O&M costs. Assume GGS preconstruction survey and monitoring costs included in Mitigation Measure *Wild-4*.
Wild-2d: Implement Avoidance and Minimization Measures at Historic or Active Golden Eagle Nest Sites; Conduct Satellite Telemetry Studies Pre- and Post-Construction to Determine Territory Size; Prepare a Golden Eagle Protection Plan and a Golden Eagle Monitoring Plan; Mitigate for Loss of Annual Grassland Foraging Habitat	Construction activities shall be modified to ensure that nesting Golden Eagles are protected. To avoid impacts to nesting Golden Eagles at Peninsula Hills, construction of the recreation area would be deferred. To avoid or minimize possible impacts to nesting Golden Eagles in other construction areas, some or all of the following measures shall be implemented: • A bird detraction program shall be implemented near historic Golden Eagle nest sites to discourage eagles from returning to those sites. • Construction near recently active nest sites shall start outside the active nesting season. The nesting period for Golden Eagles is between March 1 and August 15. • If groundbreaking activities begin during the nesting period, a qualified biologist shall perform a pre-construction survey 14 to 30 days before the start of each new construction phase to search for Golden Eagle nest sites in appropriate habitat within 0.5 mile of proposed activities. If active nests	Nests located at three of the restoration areas and downstream of Site Dam. Located in Stone Corral and Peninsula Hills, Lurline Headwaters. Assume general pre-construction survey/clearance costs included in Mitigation Measure *Wild-4*. Telemetry Studies (assume 3 to 5 years prior to construction and then 3 to 5 years post construction). Assume $175 per hour for two staff. Assume 400 hours per year. **$840,000 to $1,400,000 ($140,000 per year)**

Attachment 4C. Terrestrial Biological Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
	are not identified, no further action is required and construction may proceed. • If active nests are identified, a minimum 0.5 mile buffer zone around active Golden Eagle nests shall be implemented. Buffer zones shall remain until young have fledged. For activities conducted with agency approval within this buffer zone, a qualified biologist shall monitor construction activities and the eagle nest(s) to monitor eagle reactions to activities. If activities are deemed to have a negative effect on nesting eagles, the biologist shall immediately inform the construction manager that work should be halted, and CDFG and USFWS will be consulted. • For Golden Eagles that begin nesting within the buffer zone after start of construction, the same avoidance and minimization measures as described for active eagle nests found before start of construction (0.5 mile buffer) shall be implemented. A buffer of less than 0.5 mile may be used if there is a visual barrier, such as a hill or dense trees, between the construction activity and the nest. To assess the impact of this loss of foraging habitat, the following measures shall be implemented prior to the start of Project construction: • A Golden Eagle Monitoring Plan shall be prepared. • Satellite telemetry studies shall be conducted for three to five years prior to the start of construction to establish the number of Golden Eagles and the size of their territories. • Surveys shall be conducted by permitted biologists. • A Golden Eagle Protection Plan shall be prepared.	Assume 10 sites for telemetry studies and equipment $15,000 per site. **$150,000** Helicopter Surveys – Four surveys for nesting population study (timing when vegetation is not on trees), helicopter costs – $950 per hour for 7 hours. **$26,600 ($6,600 per survey)** Expert assistance. **$120,000** Preparation of a Golden Eagle Protection Plan. **$150,000** Preparation of a Golden Eagle Monitoring Plan. **$150,000** Bird Detraction Program. **$300,000** Helicopter assist with implementation $2,750 per hour for 6 hours and two staff at $120 per hour for three nests. **$53,820** Avoidance and minimization measures (including 0.5 mile work exclusion around active nests) to be included in the construction and

Attachment 4C. Terrestrial Biological Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
		O&M costs. **Mitigation Measure *Wild-2d* total costs — $1,790,420 to $2,350,420**
Wild-2e: Implement Protective Actions to Minimize Impacts to the Ringtail, and Restore Connectivity of Riparian Corridor	The fully-protected ringtail was observed within the riparian habitat that would be removed during construction of the Delevan Pipeline Intake/Discharge Facilities. The removal of riparian habitat within the footprint of the facilities would further reduce connectivity of the riparian corridor at that location. Implementation of Mitigation Measure Wild-3c would restore that connectivity. To minimize potential direct impacts to the ringtail, riparian vegetation removal shall not occur during the early pup-rearing season, which ranges from May 1 through June 15. Efforts to restore riparian corridor connectivity could include other habitat enhancements, such as providing ringtail nesting cavities and planting food sources.	Assume mitigation costs to restore connectivity included in *Wild-3c*.

Attachment 4C. Terrestrial Biological Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Wild-2f: Implement Protective Actions to Avoid or Minimize Impacts to Elderberry Plants; Where Avoidance is not Possible, Transplant or Replace Plants, According to USFWS Guidelines	There are two elderberry shrubs located within the potential construction disturbance area for Sites Reservoir and Dams that could be completely avoided by establishing and maintaining a 100-foot-wide or wider buffer around them. Construction crews shall be briefed regarding the need to avoid these plants, and signs shall be posted during construction to avoid the buffer area. After Project construction is complete, this area would not be affected by Project operation or maintenance. The elderberry shrub immediately adjacent to the footprint of the Delevan Pipeline Intake/Discharge Facility is located on the edge of an irrigation canal that is situated along an existing access road. Because of its proximity to the road, it would not be possible to establish a 100-foot-wide buffer. It would also not be possible to establish a 100-foot-wide buffer for the shrubs located immediately adjacent to the existing Maxwell Sites Road. Consultation with USFWS would be initiated for possible approval to encroach on the buffer. Otherwise, appropriate mitigation measures shall be implemented. The elderberry shrubs within the footprint of Sites Reservoir, Sites Dam, and Golden Gate Dam, as well as the one shrub within the footprint of the Delevan Pipeline Intake/Discharge Facility, would not be avoided by Project construction, and therefore, shall be transplanted or replaced, depending on the likelihood of survival post-transplantation. Transplantation procedures shall comply with USFWS's 1999 Conservation Guidelines for the Elderberry Longhorn Beetle (USFWS, 1999). If transplantation is not feasible, USFWS general guidelines require replacement of elderberry plants in designated mitigation areas. Elderberry plants are typically replaced at a ratio of 2:1 for stems greater than one inch in diameter at ground level with no adult emergence holes, 3:1 for stems where emergence holes are documented in less than 50 percent of the shrubs, and 5:1 for stems greater than one inch in diameter with emergence holes. Mitigation measures already required for the loss of riparian habitat pursuant to the mitigation for loss of wildlife habitat types described above could potentially compensate for the native planting requirement for elderberry plant mitigation.	

Attachment 4C. Terrestrial Biological Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Wild-2g: Conduct Pre-Construction Surveys for Western Burrowing Owls; If Owls are Found, Implement Protective Actions	Pre-construction surveys shall be conducted in annual grasslands within the footprint of Sites Reservoir and within the construction disturbance area of the Road Relocations to determine if burrowing owls are present. These surveys shall be conducted within 30 days of ground-disturbing construction activities or the start of the filling of reservoir. Surveys shall be conducted by a qualified biologist in compliance with the Burrowing Owl Survey Protocol and Mitigation Guidelines (CBOC, 1993). If burrowing owl burrows are found, protective measures shall be implemented. Protective measures may include avoidance of occupied burrows during the nesting season, which is from February 1 through August 31, with the peak of the season occurring from April 15 through July 15. Any unoccupied burrows located within the immediate construction area shall be excavated using hand tools, and then filled to prevent reoccupation. If destruction of occupied burrows is unavoidable, such as within the footprint of Sites Reservoir, burrow entrances shall be altered, outside of the nesting season, to allow resident owls to exit but not re-enter the burrow. Owls shall be excluded from burrows by installing one-way doors in burrow entrances. One-way doors shall be left in place for at least 48 hours to ensure owls have left the burrow before the start of construction. Other possible mitigation could include the creation of artificial burrows in adjacent suitable habitat. Loss of annual grassland habitat shall be compensated for with implementation of the mitigation for loss of wildlife habitat types described above.	Assume 16,500 acres – one time survey 1 acre per hour two staff at $100 per hour. **$3,300,000 (surveys)**

Attachment 4C. Terrestrial Biological Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Wild-2h: Conduct Pre-Construction Surveys and Provide a Biological Monitor During Project Construction for the Western Pond Turtle; If Found, Turtles shall be Captured and Relocated by a Qualified Biologist	Before construction activities begin, a qualified biologist shall conduct western pond turtle surveys along creeks and other ponded areas within the footprint of Sites Reservoir, Sites Dam, and Holthouse Reservoir, as well as along the irrigation canals within the construction disturbance area of the Delevan Pipeline. Adjacent upland areas shall also be examined for evidence of nests or individual turtles. A Project biologist shall be responsible for conducting the survey and relocating any turtles found within footprints or construction disturbance areas. If a nest is observed, a biologist with appropriate permits and prior approval from CDFG shall move eggs to a suitable location or facility for incubation. However, some individuals may be undetected or enter sites after surveys are conducted, and could be subject to mortality. A biological monitor shall, therefore, be present during Project construction to minimize take.	Include Delevan pipeline area (1,575 acres) and canal (23.2 acres) and valley foothill riparian (VFR) habitat (114.3 acres) Assume one acre per hour, two staff, one time survey. **$342,500 (surveys)**
Wild-2i: Conduct Pre-Construction Surveys for the Western Yellow-Billed Cuckoo and Schedule Construction Activities to Avoid Impacts to Nest Sites	The yellow-billed cuckoo breeding season ranges from mid-June through August. To minimize direct impacts to this species, riparian and orchard vegetation removal within the footprint of the Delevan Pipeline Intake/Discharge Facility shall occur outside of these dates. If construction activities are scheduled to occur during the breeding season, preconstruction surveys shall be conducted in riparian and orchard habitat within the construction disturbance area of the Delevan Pipeline Intake/Discharge Facility to confirm that cuckoos are not actively nesting in or near the area. If active nests are identified, a minimum 500-foot construction buffer shall be established around any nest sites. All construction shall be avoided where active nests are discovered until the cuckoos have finished nesting. Loss of valley foothill riparian and deciduous orchard habitat shall be compensated for with implementation of the mitigation for loss of wildlife habitat types described above.	ACREAGE VFR at Intakes only – 13 acres. Assume one time survey, two staff, four acres per hour **$650 (survey)**
Wild-3a: During Project Construction, Backfill Trenches within 72 hours of Pipeline Installation and Provide an Escape Ramp for Trapped Wildlife	Pipeline trenches shall be backfilled within 72 hours of pipeline installation to prevent potential impacts to trapped wildlife. The trench shall be inspected for wildlife before it is filled. At the end of each day, a ramp shall be placed at the end of the trench at an approximate 45 degree slope to allow trapped wildlife to escape. In addition to a ramp, the trench shall be covered to prevent wildlife from falling in.	

Attachment 4C. Terrestrial Biological Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Wild-3b: Construct Transmission Lines and Associated Equipment Following Suggested Practices for Avian Protection on Power Lines	Transmission lines, poles, and associated equipment shall be properly fitted with wildlife protective devices to isolate and insulate structures to prevent injury or mortality to wildlife, especially avian species. Protective measures shall follow the guidelines provided in Suggested Practices for Avian Protection on Power Lines (APLIC, 2006), and shall include insulating hardware or conductors against simultaneous contact, using poles that minimize impacts to birds, and increasing the visibility of conductors or wires to prevent or minimize bird collisions	Costs to be included in project construction and O&M costs.
Wild-3c: Restore Riparian Habitat Connectivity	After the Delevan Pipeline Intake/Discharge Facilities are constructed, riparian habitat connectivity shall be restored to provide a travel corridor for terrestrial wildlife. The entire length of the land side of the new levee associated with the facilities shall be planted with riparian vegetation. Where the levee approaches SR 45, fencing shall be installed to protect wildlife from vehicles. Vegetation shall be monitored, and irrigated if necessary, to ensure survival.	Lands acquired for the Intake/Discharge facilities will be adequate to also accommodate incorporation of riparian connectivity mitigation.
Wild-4: Implement Avoidance and Minimization Measures	Measures to avoid or minimize human disturbance impacts associated with Project construction and maintenance activities.	Awareness Training. **$50,000 to $200,000** Preconstruction surveys/monitoring assume 8 full-time staff (FTE) for 10 years. Surveys + Monitoring **$1,660,000 per year ($16,600,000 surveys)** Project design avoidance measure costs to be included in project construction and O&M costs.

Attachment 4D. Aquatic Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Fish-1a: Increase stocking frequency of coldwater fish species	Text to be developed	No cost associated with this measure.
Fish-1b: Prepare and Implement a Mitigation Monitoring and Reporting Plan	DWR and Reclamation shall prepare and implement a Mitigation Monitoring and Reporting Plan to mitigate for expected significant reduced flows through the Yolo Bypass (all alternatives), which could include the following mitigation measure: • Modifications to the Fremont Weir to allow additional flow for inundation of the Yolo Bypass has been identified as a fisheries habitat improvement action by other projects or programs and may be implemented before the NODOS Project is authorized. If modifications occur before implementation of the NODOS Project, this impact would be reduced to less than significant and would not require mitigation. If the modifications are not yet implemented, mitigation measures for the NODOS Project could include modification of the weir to offset potentially reduced flows through the Yolo Bypass and associated habitat availability for splittail and other fish species of primary management concern.	Details related to mitigation need to be further evaluated as part of EIR/EIS revisions – measure may also include benefits.* O&M costs **$500,000/annually(contingency)**
Fish-1c: Prepare and Implement a Stormwater Pollution Prevention Plan (SWPPP) and an Erosion and Sediment Control Plan (ESCP) Prior to the Initiation of Construction Activities	DWR and Reclamation shall prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) and an Erosion and Sediment Control Plan (ESCP) prior to the initiation of construction activities.	Costs to be included in project construction and O&M costs.
Fish-1d: Prepare and Implement a Spill Prevention and Hazardous Materials Management Plan Prior to the Initiation of Construction Activities	DWR and Reclamation shall prepare a Spill Prevention and Hazardous Materials Management Plan (developed as part of the SWPPP) that would be designed to minimize the potential for chemical spills and seepage during construction, operation, and maintenance activities.	Costs to be included in project construction and O&M costs.

Attachment 4D. Aquatic Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Fish-1e: Implement Habitat Restoration Actions	To minimize disturbance to aquatic habitat, construction personnel shall participate in an environmental awareness training program provided by a qualified biologist. Construction personnel shall be informed about any sensitive biological resources associated with the proposed Project and that disturbance of sensitive habitat or special-status species would be a violation of the Endangered Species Act and the Clean Water Act.	Costs to include restoration at a ratio of 2:1 for linear stream miles inundated with the following project components: • Sites Reservoir Inundation Area and Sites Dams • Holthouse Reservoir Complex, the Sites Reservoir Inlet/Outlet Structure, and the Sites Pumping/Generating Plant • Delevan Pipeline Delevan Pipeline Intake Facilities and Delevan Pipeline Discharge Facility. Assume acquisition of 681 acres at $2,500 per acre. O&M cost for restoration land management —681 acres at $400 per acre. **$275,000**

Attachment 4D. Aquatic Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Fish-1f: Perform In-Water Pile Driving July Through September During Daylight Hours	In-water pile driving shall only occur during July through September during daylight hours. This time period takes into consideration the migratory patterns of salmonids; pile driving shall occur after the cessation of the outmigration of juvenile salmon and before the initiation of the upstream migration of adults returning to spawn. To avoid impacts to the majority of fish species of primary management concern, sheet pile installation and in-stream heavy equipment activity shall be coordinated with USFWS, USBR, CDFG, and NMFS to avoid and or minimize potential impacts. If feasible, a vibratory hammer shall be used, and pile driving shall commence at low energy levels and slowly build to impact force. In addition, underwater sound levels shall be monitored to ensure that pile driving activities do not create underwater sound levels that exceed NMFS' noise thresholds (i.e., accumulated sound exposure level of 183 dB and a peak pressure of 206 dB).	Costs to be included in project construction and O&M costs.
Fish-1g: Design Fish Screen in Compliance with NMFS and CDFG Criteria	Fish screen at the Delevan Pipeline Intake Facilities shall be designed to comply with NMFS and CDFG fish screening criteria. The Delevan Pipeline Intake Facilities or Discharge Facility shall be designed to minimize hydraulic and physical habitat that is suitable for non-native predatory fish species. The facility shall be designed in coordination with NMFS and CDFG to ensure incorporation of the best available scientific and engineering knowledge of fish screen design to minimize predation potential on fish species of primary management concern. These design criteria shall minimize or avoid increased habitat suitability for non-native predatory fish species. However, a monitoring and adaptive management program shall be implemented to ensure that losses resulting from predatory fish are minimized.	Costs to be included in project construction and O&M costs.

Attachment 4D. Aquatic Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Fish-1h: Prepare and Implement a Fish Salvage and Rescue Plan	The fish screen at the Delevan Pipeline Intake Facilities shall be designed to comply with NMFS and CDFG fish screening criteria. In addition, a Fish Salvage and Rescue Plan shall be developed and approved by NMFS and CDFG prior to initiation of construction activities, and could include the following measure: • A qualified biologist shall provide construction monitoring throughout all phases of the project. If spawning activities for sensitive fish species are encountered during construction activities, the monitoring biologist shall be authorized to stop construction activities until appropriate corrective measures are completed or it is determined that the fish would not be harmed. If possible, all fish species shall be allowed to independently move away from the area. Fish that become entrapped in any side channel where construction work is taking place shall be netted, transported to the river, and released according to the Fish Salvage and Release Plan.	Costs include preparation of a Fish Salvage and Rescue Plan and anticipated level of effort for fish salvage operations (contingency costs) **$520,000 (contingency)**

Attachment 4E. Surface Water Quality

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
SW Qual -1(a): Implement a Water Quality Monitoring, Modeling, and Operations Coordination Program to Protect Beneficial Uses	A comprehensive water monitoring program, including analysis of water quality conditions at the Project intake/discharge locations on the Sacramento River, as well as major Project conveyance and impoundment features, shall be implemented. This monitoring program shall include a network of automated real-time water monitoring locations at these locations, with data available to operators on the SCADA control system to allow real-time adaptive alteration in diversion amounts based on these conditions. This would allow operators to select the best quality waters to fill Sites Reservoir and potentially avoid importation of poor quality water that may affect the quality of Project water deliveries. This strategy could require additional modeling of Project water quality conditions to better understand the complex chemical interactions and physical and biological processes that affect contaminant levels. In addition, fish in Sites Reservoir shall be sampled and analyzed for mercury and other potential contaminants that may have deleterious effects to human and wildlife consumers. Results from these analyses shall be submitted to the Office of Environmental Health Hazard Assessment (OEHHA) for determination of the threats to consumers of fish in Sites Reservoir. Determination of adverse health effects to consumers would lead to educational postings at access points and public media to reduce exposure to contaminated fish.	Cost for infrastructure (monitoring devices, SCADA, etc.) and O&M of would be included in project construction and O&M costs. Water quality sampling necessary to determine how facilities should be operated is included in O&M costs. Supplemental mitigation cost **$1,500,000** O&M annual cost **$250,000**
SW Qual-1(b): Excavate and Remove, or Consolidate and Cap, Salt Lake	The Salt Lake site within the footprint of Sites Reservoir would be either excavated and removed or consolidated and capped by an impermeable cover to avoid dissolution of the salt deposit into the reservoir waters. Salt Lake is fed by upslope salt springs, is many decades old, and the salt pan has accumulated to an unknown thickness over this time by evaporation. After removal/capping of the salt pan, the salt spring inputs to a completed Sites Reservoir would be diluted by high quality Sacramento River imports to a level that would be less than significant to water quality.	Mitigation cost would include removal (clearing and grubbing) and removal of surface materials, jet grouting of concrete and capping of Salt Lake and site grading. **$10,000 to $15,000**
SW Qual-1(c) to SW-Qual-1(l)	Mitigation measures associated with implementation of SWPPP, BMPs and other related construction practices.	Mitigation costs would be included in project construction and O&M costs.

Attachment 4F. Cultural Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Cul-1a: Avoid Impacts to Historical Resources/Historic Properties	If feasible, impacts to identified historical resources/historic properties, including prehistoric and historic-era archaeological sites, buildings and structures, TCPs, and human remains shall be avoided. Methods of avoidance may include, but are not limited to, Project re-design, or, when appropriate, deeding the site into a permanent conservation easement; incorporation of sites into parks, greenspace, or other open space; and protection measures, such as fencing.	Assumption $40 per acre for remaining surveys and field documentation. **$32,500 to $50,000 (surveys)** Approximately 790 acres not yet survey. Additional areas to be defined – transmission line footprint and confirm pipeline alignments and Leesburg road. Costs should also include geo-archeology studies to determine the potential for buried resources. Timing of studies could be performed during construction. Assume **$100,000** prior to construction (timing of desktop evaluations – during EIR/EIS).

Attachment 4F. Cultural Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Cul-1b: Conduct Archaeological Data Recovery	If it is infeasible to avoid impacts to archaeological sites that have been determined to be eligible for listing on the CRHR or the NRHP, additional research including, but not necessarily limited to, archaeological excavation shall be conducted. This work shall be directed by a qualified archaeologist who meets the U.S. Secretary of Interior's professional standards, and shall include preparation of a research design; additional archival and historical research to supplement the research design, when appropriate; archaeological excavation; analysis of artifacts, features, and other attributes of the resource; and preparation of a technical report documenting the methods and results of the investigation in accordance with the California Office of Historic Preservation Guidelines for Archaeological Research Design (1991). The purpose of this work is to recover a sufficient quantity of data to compensate for damage to or destruction of a resource that is eligible for the CRHR pursuant to criterion 4 of CCR 4852(b) or the NRHP pursuant to 36 CFR 60.4(d). The procedures to be used in this data recovery program shall be determined in consultation with responsible agencies and interested parties such as Native American tribes, as appropriate, within the parameters of the PA.	Ethnographic Studies and Inventory with Evaluation. **$200,000 to $1,500,000** (Could be performed in phases – initial outreach **($200,000 to $500,000)** should occur during EIR/EIS). Costs for determining eligibility for sites in areas not yet surveyed and/or buried (Assume another 10 sites could be discovered.) **$2,500,000 to $5,000,000** Documentation costs. **$100,000** Curation costs – Assume $5,000 a box and 1,000 boxes. $**5,000,000 to $10,000,000** ***Cul-1b* total—$7,800,000 to $16,600,000**

Attachment 4F. Cultural Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Cul-1c: Immediately Halt Construction if Cultural Resources are Discovered and Implement an Accidental Discovery Plan	Not all cultural resources are visible on the ground surface. Protocols for addressing the accidental discovery of archaeological resources that are not visible on the ground surface during Project construction will be outlined in an Accidental Discovery Plan, as directed by the PA. If any cultural resources, such as structural features, unusual amounts of bone or shell, flaked or ground stone artifacts, historic-era artifacts, human remains, or architectural remains are encountered during any Project construction activities, work shall be suspended immediately at the location of the find and within an appropriate radius, with a minimum of 50 feet. A qualified archaeologist shall conduct a field investigation of the specific site and recommend mitigation deemed necessary for the protection or recovery of any cultural resource concluded by the archaeologist to represent a historical resource or unique archaeological resource. Mitigation measures shall be developed in consultation with responsible agencies and, as appropriate, interested parties such as Native American tribes. Implementation of the approved mitigation would be required before resuming construction activities at the archaeological site. All of the activities identified above shall be detailed in an Accidental Discovery Plan developed prior to construction so that all parties are aware of the actions required if buried archaeological resources are uncovered during Project construction. Discoveries of human remains shall be treated as described below for Mitigation Measure Cul-4b.	Assume contingency costs to address stop work to be included in project construction and O&M costs. Preparation of Accidental Discovery Plan. **$250,000 to $400,000** Field assessments after accidental discoveries are encountered during construction. Assume 10 to 20 accidental discoveries. **$4,000,000 to $8,000,000 (contingency)**
Cul-1d: Protection of Archaeological Sites by Capping	Capping archaeological sites that are considered historical resources with soil, gravels, rock, or specific kinds of vegetation can be a viable way to protect the deposits under some circumstances. For example, sites subject to inundation and water level fluctuations may be protected from erosion by applying a layer of gravel/rock (rip-rap), soil, cloth, or some combination of treatments. In such circumstances, regular monitoring would be required to evaluate the efficacy of the mitigation, and to identify if and when it is necessary to refresh the protection. A layer of soil, i.e., sterile fill, might also be placed over a site where construction of a building was planned, such that all construction disturbance would occur in the fill	Capping costs to be included in project construction and O&M costs. Assume monitoring to be included in construction and O&M costs.

Attachment 4F. Cultural Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Cul-1e: Develop Agreement Documents to Address Potential Future Operational Impacts to Cultural Resources	Protocols for addressing potential future operations impacts at Sites Reservoir and at existing facilities within the Extended Study Area shall be addressed in the PA. This may include preparation of Memoranda of Agreement for specific facilities and/or development of a Cultural Resources Management Plan, depending on the lead agency in charge of the facility. Management of historical resources/historic properties under such agreement documents might include standard measures for identification of historical resources/historic properties where needed, assessment of project impacts, and application of specific mitigation measures, as well as protocols for resource monitoring or stabilization techniques. Such agreement documents shall be developed in consultation with responsible agencies and interested parties, such as Native American tribes, as appropriate, within the parameters of the PA.	Preparation of MOA and PA and/or Cultural Resources Management Plan in consultation with responsible agencies and interested parties, such as Native American tribes, as appropriate. **$200,000 to $500,000**
Cul-2a: Follow the Secretary of the Interior's Standards for the Treatment of Historical Resources/Historic Properties	Because construction of Project facilities has the potential to modify buildings or structures that are considered historical resources/historic properties, any alterations, including relocation, to historic buildings or structures shall conform to the Secretary of the Interior's Standards for the Treatment of Historic Properties and Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings (1995).	Assume no built environment resources have been determined to be eligible; however, a railroad and quarry may be eligible. **$1,000,000 to $2,000,000**
Cul-2b: Record Built Environment Resources to Historic American Buildings Survey (HABS) and Historic American Engineering Record (HAER) Standards	If avoidance or relocation of a building or structure that is considered eligible for the CRHR or NRHP is not feasible, and the resource must be demolished, a qualified architectural historian who meets the U.S. Secretary of Interior's professional standards shall be retained to document the impacted historical architectural resource to Historic American Buildings Survey (HABS) and Historic American Engineering Record (HAER) specifications. HABS and HAER documentation packages shall be entered into the Library of Congress as well as the NWIC or NEIC of the CHRIS.	Assume costs to include preparation of HABS and HAER documentation. **$1,000,000 to $2,000,000**
Cul-3: Consult with Native American Communities regarding How to Mitigate for Impacts to TCPs	TCPs are often locations on the landscape that have sacred or other special meaning to Native American communities. Associated characteristics, such as an archaeological deposit, are not always present. Early and meaningful consultation with Native American communities shall occur to identify ways to mitigate impacts to TCPs. Interpretive programs, establishing or enhancing locations for traditional plants, or a visitor's center, are examples of ways to address these important issues. Consultation with Native American communities shall occur.	Cost components are related to *Cult-1 (e)*. Assume costs for ongoing consultation with tribes. Assume 4+ tribes and costs to include AB52 compliance. **$2,000,000 to $4,000,000**

Attachment 4F. Cultural Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Cul-4a: Relocation of Known Cemeteries	Consultation shall occur with the entity (County, City, private) that has jurisdiction over the cemetery, and interested parties as appropriate, to identify a satisfactory place that is protected from future disturbance for the relocation of human remains. Similarly, if Native American burials are known to exist in an archaeological site, the Project proponent shall work with the appropriate tribe to identify a satisfactory location for re-interment of burials in a protected location.	Assume two cemeteries: Town of Sites Cemetery – Assume 150 individuals and $3,000 for each individual grave site. **$450,000** Native American Cemetery – 100 individuals and $5,000 for each individual grave site. **$500,000** Midden Grave Sites – Assume **$10,000,000 to $20,000,000** **Total - $10,950,000 to $20,950,000**

Attachment 4F. Cultural Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Cul-4b: Immediately Halt Construction if Human Remains are Discovered and Implement a Burial Treatment Plan	Project construction activities have the potential to have unanticipated significant impacts to buried human remains where there is no surface indication of their presence. In these circumstances, the requirements of California Health and Human Safety Code 7050.5 must be followed. In accordance with the California Health and Safety Code, if human remains are uncovered during ground-disturbing activities, the potentially damaging excavation must halt in the area of the remains and the local County Coroner must be notified. The Coroner is required to examine all discoveries of human remains within 48 hours of receiving notice of a discovery on private or state lands (Health and Safety Code Section 7050.5[b]). If the Coroner determines that the remains are those of a Native American, he or she must contact the Native American Heritage Commission (NAHC) by phone within 24 hours of making that determination (Health and Safety Code Section 7050[c]). Pursuant to the provisions of California Public Resources Code Section 5097.98, the NAHC shall identify a Most Likely Descendent (MLD). The MLD designated by the NAHC shall have at least 48 hours to inspect the site and propose treatment and disposition of the remains and any associated grave goods. All of the activities identified above shall be detailed in a Burial Treatment Plan, as directed by the PA, and developed in consultation with local Native American tribes prior to Project construction so that all parties are aware of the actions required if buried human remains are uncovered during Project construction.	Preparation and implementation of a Burial Treatment Plan. **$500,000 to $800,000** Contingency costs to be included in project construction and O&M costs. Assume accidental discoveries - **$500,000 to $1,000,000 (contingency)**

Attachment 4G. Paleontological Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Paleo-1a: Retain a Qualified Paleontological Resource Specialist Prior to the Start of Construction	DWR and Reclamation shall retain a qualified Paleontological Resource Specialist at least 90 days prior to the start of construction.	No anticipated costs
Paleo-1b: Consultation with the Paleontological Resource Specialist Prior to and During Project Construction	At least 30 days prior to the start of Project construction, DWR and Reclamation shall provide maps or drawings to the Paleontological Resource Specialist that shows the planned construction footprint. Maps shall identify all areas of the Project where ground disturbance is anticipated. (Site grading plan and plan and profile drawings for the utility lines are appropriate for this purpose). The plan drawings shall show the location, depth, and extent of all ground disturbances affecting paleontologically sensitive sediment. If Project construction proceeds in phases, maps and drawings may be submitted prior to the start of each phase. In addition, the proposed schedule of each Project phase shall be provided to the Paleontological Resource Specialist. Before work commences on affected phases, DWR and Reclamation shall notify the Paleontological Resource Specialist of any construction phase scheduling changes. If paleontological resources monitoring is ongoing, DWR and Reclamation shall ensure that the Paleontological Resource Specialist or Paleontological Resource Monitor consults weekly with the Project superintendent or construction field manager to confirm area(s) to be worked the following week and until ground disturbance is completed.	Paleontological resource specialist staffing for plans and drawing reviews. **$250,000 to $500,000**

Attachment 4G. Paleontological Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Paleo-1c: Prepare and Implement a Paleontological Resources Monitoring and Mitigation Plan	DWR and Reclamation shall ensure that the Paleontological Resource Specialist prepares a Paleontological Resources Monitoring and Mitigation Plan (PRMMP) to identify general and specific measures to minimize potential impacts to significant paleontological resources. The PRMMP shall also provide guidance for preparation of a Paleontological Resources Report by the designated Paleontological Resource Specialist at the conclusion of ground-disturbing activities that may affect paleontological resources. The Paleontological Resources Report shall include an analysis of the collected fossil materials and related information, including a description and inventory of recovered fossil materials, a map showing the location of paleontological resources encountered, determinations of sensitivity and significance, and a statement by the Paleontological Resource Specialist that Project impacts to paleontological resources have been mitigated below the level of significance.	Preparation of Paleontological Resources Monitoring and Mitigation Plan and Paleontological Resources Report. **$200,000 to $300,000**
Paleo-1d: Conduct Paleontological Resources Awareness Training	Prior to ground disturbance and for the duration of Project construction activities involving ground disturbance, the Paleontological Resource Specialist shall prepare, and DWR and Reclamation shall conduct, weekly paleontological resources awareness training.	Paleontological resource specialist staffing for weekly construction meetings. **$50,000 to $200,000**

Attachment 4G. Paleontological Resources

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Paleo-1e: Conduct Monitoring During Project Construction and Prepare Monthly Reports	DWR and Reclamation shall ensure that the Paleontological Resource Specialist and Paleontological Resource Monitor(s) monitor construction excavations consistent with the PRMMP in areas where potential fossil-bearing materials have been identified, both at reservoir sites and along any constructed linear facilities associated with the Project. In the event that the Paleontological Resource Specialist determines full-time monitoring is not necessary in locations that were identified as potentially fossil-bearing in the PRMMP, the Paleontological Resource Specialist shall notify DWR and Reclamation. DWR and Reclamation shall ensure that the Paleontological Resource Specialist and Paleontological Resource Monitor(s) have the authority to halt or redirect construction if paleontological resources are encountered. DWR and Reclamation shall ensure that there is no interference with monitoring activities, as directed by the Paleontological Resource Specialist. DWR and Reclamation shall ensure that the Paleontological Resource Specialist prepares and submits monthly summaries of monitoring and other paleontological resources management activities. The summary shall include the name(s) of the Paleontological Resource Specialist or Paleontological Resource Monitor(s) active during the month, general descriptions of training and monitored construction activities; and general locations of excavations, grading, and other activities. A section of the report shall include the geologic units or subunits encountered descriptions of samplings, if any, and a list of identified fossils. A final section of the report shall address any issues or concerns about the Project relating to paleontological resources mitigation activities, including any incidents of non-compliance or any changes to the monitoring plan by the Paleontological Resource Specialist. If no monitoring took place during the month, the report shall include an explanation as to why monitoring was not conducted.	Paleontological resource specialist staffing for construction monitoring. **$250,000 to $2,000,000**
Paleo-1f: Ensure Implementation of the Paleontological Resources Monitoring and Mitigation Plan	DWR and Reclamation, through the designated Paleontological Resource Specialist, shall ensure that all components of the PRMMP are adequately performed during construction.	Paleontological resource specialist project staffing for oversight of plan implementation **$100,000 to $250,000**

Attachment 4H. Land Use

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Land-2a: To the Extent Possible, Work with Glenn County to Encourage the County to Modify or Amend the Glenn County General Plan to Bring it into Consistency with the Proposed Project Land Uses	Prior to the start of Project construction, DWR and Reclamation shall, to the extent possible, work with Glenn County to modify or amend its General Plan for consistency with proposed Project land uses, or to implement other appropriate measures to minimize conflicts between the Project and County policies.	Assume coordination only **$50,000 to $100,000**
Land-2b: Execute an Agreement with NRCS to Amend WRP Easement Contract and Conduct Post-Construction Wetland Restoration	Prior to the start of Project construction, DWR and Reclamation shall execute an agreement with NRCS to amend the existing WRP easement contract to allow the construction and operation of the Delevan Transmission Line and Delevan Pipeline. Project Engineers shall design the transmission line and the construction contractor shall install the transmission line tower footings to span the parcel of land that has the WRP easement (a distance of approximately 680 feet). Project Engineers shall design the pipeline and the construction contractor shall install the pipeline to avoid the wetlands in the subject parcel of land, to the extent feasible. The pipeline length across the subject parcel is approximately 650 feet. Upon completion of pipeline installation, the area that was disturbed by Project construction shall be restored to a functional wetland condition.	Estimate costs for agreement/amendments. Cost of Post construction restoration. Costs for additional monitoring or management of the additional restored area. Assume 3:1 mitigation ratio—see Attachment 5. Refer to wetland mitigation.
Land-3a: To the Extent Possible, Work with Glenn and Colusa Counties to Encourage the Counties to Modify or Amend the Glenn County and Colusa County General Plans' Land Use Designations to Bring them into Consistency with the Proposed Project Land Uses	Prior to the start of Project construction, DWR and Reclamation shall, to the extent possible, work with Glenn and Colusa counties to modify or amend the counties' General Plan land use designations, or to implement other appropriate measures to eliminate the Project's conflicts with those designations	Estimate costs for coordination only—costs included in *Land-2a*.

Attachment 4H. Land Use

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Land-3b: Execute an Agreement with Maxwell Irrigation District to Minimize and Avoid Short-term and Long-Term Impacts to Existing Facilities and Operations	Prior to the start of Project construction, DWR and Reclamation shall execute an agreement with the Maxwell Irrigation District to ensure that Project construction and operation of the Delevan Pipeline Intake Facilities or the Delevan Pipeline Discharge Facility will not adversely affect the operation of the existing adjacent Maxwell Irrigation District facility.	Costs associated with implementing the agreement would be included under project construction and operation costs. **$50,000 to $100,000**
Land-4a: Enter into Agricultural Conservation Easements with Glenn and Colusa Counties	Establish agricultural conservation easements with Glenn and Colusa counties for lands used for agricultural production to ensure agriculture remains viable in perpetuity and to prevent incompatible development on the selected parcels.	Estimate costs to establish agricultural easements and ongoing reporting/monitoring requirements. Assume 1:1 mitigation ratio—see Attachment 4. **$5,000,000 (land easements)**
Land-5a: To the Extent Possible, Work with Glenn and Colusa Counties to Encourage the Counties to Modify or Amend the Glenn County and Colusa County General Plans' Zoning Designations to Bring them into Consistency with the Proposed Project Land Uses	Prior to the start of Project construction, DWR and Reclamation shall, to the extent possible, work with Glenn and Colusa counties to modify or amend the counties' zoning designations, or to implement other appropriate measures to eliminate the Project's conflicts with those designations.	Estimate costs for coordination only—costs included in *Land-2a*.
Land-5b: Acquire Lands through Eminent Domain	During the Project land acquisition process, DWR and Reclamation shall acquire parcels through eminent domain.	Estimate costs for mitigation measure to be included as part of real estate evaluation.

Attachment 4H. Land Use

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Land-5c: For Land Permanently Acquired other than by Eminent Domain, Seek County Approvals to Rescind Williamson Act Contracts and Enter into Open Space Contracts or Open Space Easements	Prior to permanently acquiring lands other than by eminent domain during the land acquisition process, DWR and Reclamation shall seek County approvals to rescind Williamson Act Contracts and enter into Open Space Use Agreements or Open Space Easements with the counties.	Costs include fee for cancelling Williamson Act contract and establishing open space easements and ongoing reporting/monitoring requirements. Assume approximately $2,500 per acre—see Attachment 4. Williamson Act Contract cancellation fees (12.5%) approximately. **$5,040,000 (fees)**

Attachment 4I. Air Quality

Mitigation Measure	Mitigation Measure Description	Cost Estimate Assumptions
Air Qual -1a: Develop a Fugitive Dust Control Plan	The Fugitive Dust Control Plan shall include avoidance and minimization measures and BMPs to reduce fugitive PM10 and PM2.5 emissions.	Preparation of Fugitive Dust Control Plan. **$100,000** Costs associated with plan implementation to be included in project construction costs.
Air Qual -1b: Implement Measures to Reduce Equipment and Vehicle Exhaust Emissions	• All construction equipment shall be maintained according to manufacturer's specifications. • Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to five minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations [CCR]). • During all construction activities, diesel -fueled portable equipment with maximum power greater than 25 horsepower shall be registered under the ARB's Statewide Portable Equipment Registration Program. • All fleets of diesel -fueled off -road vehicles shall comply with the emissions standards pursuant to CCR Title 13, Section 2449. To the extent feasible, operate off -road vehicles with engines certified to the Tier 2 or newer emissions standards. • All on -road trucks shall be operated in compliance with the emission standards per CCR Title 13, Section 2025. To the extent feasible, operate on -road trucks with engines certified to the 2007 model year or newer heavy -duty diesel engine emissions standards. • To the extent feasible, electric equipment shall be operated. • Alternatively fueled construction equipment shall be used, to the extent feasible, such as compressed natural gas (CNG), liquefied natural gas (LNG), propane, or biodiesel. • Electricity used to power facilities and equipment shall be generated by renewable energy sources with state -of -the -art emissions control systems, to the extent feasible.	Costs associated with emissions controls to be included in project construction costs. See Attachment 7 for emissions estimates for construction and O&M. Assume permit will be required for stationary emission sources (i.e., concrete batch plant and quarry operations) during 10-year construction period. **$5,000 per year (permit fees)** — Assume permit will be required for stationary emission sources (i.e., back-up emergency generators at the pumping plants) during O&M phase of the project. **$5,000 per year (permit fees)**

ATTACHMENT 5

Anticipated Land Use Impacts (Alternative C)

Attachment 5: Designated Land Uses Subject to Impacts (Alternative C)

Descriptor	Acreage		Mitigation Approach	Anticipated Mitigation Ratio (as applicable)		Mitigation Acreage	Estimated Cost
	Permanent Loss[b]	Temporary Disturbance		Permanent Loss[b]	Temporary Disturbance		
Number of Potentially Affected Parcels	278	209	NA	NA	NA	NA	NA
Acreage of Potentially Affected Parcels	19,636	26,425	NA	NA	NA	NA	NA
Zoning Designation of Potentially Affected Parcels (Acres)							
Agricultural Preserve	2,100	24,753	NA	NA	NA	NA	NA
Exclusive Agriculture	2,055	1,030	NA	NA	NA	NA	NA
Foothill Agriculture/Forestry	0	450	NA	NA	NA	NA	NA
Floodway	0	14	NA	NA	NA	NA	NA
Intensive Agriculture	0	0	NA	NA	NA	NA	NA
Light or Heavy Industrial	19	0	NA	NA	NA	NA	NA
N/A	43	174	NA	NA	NA	NA	NA
No Information Available	0	1	NA	NA	NA	NA	NA
Designation Undetermined	15,419	3	NA	NA	NA	NA	NA
Total	19,636	26,425	NA	NA	NA	NA	NA
FMMP Designation of Potentially Affected Parcels (Acres)							
Urban and Built-up Land	1	0[c]	NA	NA	NA	NA	NA
Grazing Land	369	2,601	NA	NA	NA	NA	NA
Farmland of Local Importance	1,624	21,514[b]	*May or may not need to mitigate for this particular FMMP category (Low range of costs excludes this FMMP designation).	1:1*	NA	1,624	
Local Potential Farmland	144	1,414		NA	NA	NA	NA

Descriptor	Acreage		Mitigation Approach	Anticipated Mitigation Ratio (as applicable)		Mitigation Acreage	Estimated Cost
	Permanent Loss[b]	Temporary Disturbance		Permanent Loss[b]	Temporary Disturbance		
Prime Farmland	960	606[b]	Protection of land in same county with same FMMP designation with conservation easement (Mitigation costs presented in Land-4a)	1:1	NA	960	
Farmland of Statewide Importance	0[c]	0[c]	Protection of land in same county with same FMMP designation with conservation easement (Mitigation costs presented in Land-4a)	1:1	NA	0c	
Unique Farmland	1,001	7	Protection of land in same county with same FMMP designation with conservation easement (Mitigation costs presented in Land-4a)	1:1	NA	1,001	
Water	0	3	NA	NA	NA	NA	NA
Other Land	123	287	NA	NA	NA	NA	NA
Designation Undetermined	15,414	3[b]	NA	NA	NA	NA	NA
Total	**19,636**	**26,425**	--	--	--	**1,961 to 3,585**	--
Number of Potentially Affected Parcels with Williamson Act Contracts	136	113	--	--	--	--	--
Acreage of Potentially Affected Parcels with Williamson Act Contracts	16,126	22,689	--	--	--	--	--

Descriptor	Acreage		Mitigation Approach	Anticipated Mitigation Ratio (as applicable)		Mitigation Acreage	Estimated Cost
	Permanent Loss[b]	Temporary Disturbance		Permanent Loss[b]	Temporary Disturbance		
Number of Potentially Affected Parcels with WRP Easements	1	0	--	--	--	--	--
Number of Potentially Affected Acres with WRP Easements	7	0	--	--	--	21	Assume cost comparable to obtaining mitigation credits.

Notes:

[1] Acreages for land use impacts for Alternative C are from Tables 20-27 in NODOS Preliminary Administrative Draft Environmental Impact Report (December 2013).

[a] Totals may not match due to the rounding of individual acreages that comprise the totals.

[b] A total of 2.5 acres would under Alternative A and C would be permanently disturbed from transmission line poles, but due to pole locations being currently unknown, the affected FMMP category cannot currently be determined. Therefore, 2.5 acres under Alternative A and C of land more than the total listed in Long-Term Impacts would be permanently affected.

[c] There is less than one acre in these categories, but more than zero.

FMMP = Farmland Mapping and Monitoring Program

WRP = Wetland Reserve Program

ATTACHMENT 6

Vegetation Community and Habitat Impacts (Alternative C)

Attachment 6. Acres of Habitat/Wetlands Subject to Alternative C Impacts[1,a]

Vegetation/Habitat Type	State-Federally-Listed Species Associations within Primary Study Area[1,2,3,4,5,6,7,8,9]	Acreage		Assumptions for Mitigation Approach (On-site/Off-site)	Anticipated Mitigation Ratio		Estimated Mitigation Acreage	Estimated Cost/Acre	Mitigation Cost	
		Permanent Loss[b]	Temporary Disturbance	Restoration/Mitigation Banking	Permanent Loss[b]	Temporary Disturbance			Low	High
Botanical Resource/Vegetation Community										
Annual grassland	Sidalcea keckii and Amsinckia lunaris	13,694.7	2,091.5	Assume 4,000 to 5,000 acres support CNPS recommends 1:1 for species Mitigation for permanent loss would be off-site mitigation.	1:1 to 3:1	1:1		$2,000 to $2,500 per acre Temporary mitigation included in construction costs	$35,389,400	$115,210,250
Alkaline wetland		0.5	14.0	*May affect an additional 14 acres of wetland (per MM Bot-1a) See wetlands impacts below	2:1 to 3:1	--			below	below
Blue oak woodland	Sidalcea keckii and Amsinckia lunaris and Lotus rubriflorus	478.6	353.5	*All known occurrences of *Lotus rubriflorus* are on private land or utility corridors (assume 5 to 10% of the acreage would include plant species) CNPS recommends 1:1 for species	1:1			$2,500 to $3,000 per acre	$59,825	$143,580
Blue oak savanna		375.5	269.7		see below			$2,500 to $3,000 per acre	below	below
Blue oak /mixed chaparral	Lotus rubriflorus	33.4	21.1	Assume 5-10% acreage to include plant species) CNPS recommends 1:1 for species	1:1			$2,500 to $3,000 per acre	$4,175	$10,020
Canal		9.1	14.1	Impacts mostly associated with Holthouse Reservoir 7.1 acres is the existing TC canal (no GGS) 0.9 acre for regulating reservoir (TRR) GCID improvements associated with temporary disturbance.	1:1 to 3:1		Assume 1 acre permanent loss for GGS Assume no suitable habitat would be temp disturbed.	$20,000 per acre	$20,000	$60,000
Chamise		0.6	2.1	Assume no mitigation needed; can be avoided					--	--
Crops/agriculture		700.0	2,307.7	No additional mitigation required beyond agricultural impacts					--	--
Fremont cottonwood riparian		1.1	0.0	See VFR					below	below
Fresh emergent wetland		0.0	4.5	See VFR					below	below
Mixed chaparral		0.8	1.8	See VFR					below	below
Pond		22.4	226.6	See VFR					below	below
Open water		1.6	0.0	See VFR					below	below
Urban/disturbed		90.8	46.9	See VFR					below	below
Valley foothill riparian		82.6	4.0	See VFR					below	below
Valley oak riparian		26.5	0.1	See VFR					below	below
Valley oak woodland		3.5	0.0		1:1 to 3:1			$2,500 to $3,000 per acre	$8,750	$31,500
Botanical Resources TOTAL		**15,521.7**	**5,357.6**						**$35,482,150**	**$115,455,350**

Vegetation/Habitat Type	State-Federally-Listed Species Associations within Primary Study Area[1,2,3,4,5,6,7,8,9]	Acreage		Assumptions for Mitigation Approach (On-site/Off-site)	Anticipated Mitigation Ratio		Estimated Mitigation Acreage	Estimated Cost/Acre	Mitigation Cost	
		Permanent Loss[b]	Temporary Disturbance	Restoration/Mitigation Banking	Permanent Loss[b]	Temporary Disturbance			Low	High
Wildlife Habitats										
Barren		0.2	21.4	Assume no mitigation needed					--	--
Blue oak woodland	CRLF (also associated with blue oak foothill pine), GE; SH; WSF	887.5	644.3		2:1 to 5:1	1:1		$2,500 to $3,000 per acre	$6,048,250	$15,245,400
Canal	GGS, WPT	9.1	14.1	Assume no mitigation needed	3:1 for GGS*	1:1 for GGS*			above	above
Chamise-redshank chaparral		0.6	2.1	Assume no mitigation needed; can be avoided					--	--
Deciduous orchard	*confirm whether associated with GGS (pg. 14-6)	15.4	175.1	Include for GGS for any Orchard east of I-5	3:1 for GGS*	1:1 for GGS*	Assume 15.4 permanent only	$4,000 to 5,000 per acre	$184,800	$231,000
Dryland grain and seed crops	SH - Swainson's hawk	333.2	214.5	Assume 25%-50% acreage would be suitable foraging habitat.	0.5:1	--		$2,000 per acre	$83,300	$166,600
Eucalyptus		0	46.2	Assume no mitigation requirement	--	--			--	--
Fresh emergent wetland	GGS; CRLF; GSC4, GE	0.5	18.5		3:1 for GGS*	1:1 for GGS*	20.0		below	below
Irrigated row and field crops	SH - Swainson's hawk	155.6	225.7	Assume 25%-50% acreage would be suitable foraging habitat.	0.5:1			$2,500 per acre	$48,625	$97,250
Lacustrine	BE	22.4	226.6	Assume no mitigation needed; reservoir will be expanded					--	--
Mixed chaparral		0.8	1.8						above	above
Pasture	GSC, FH; BO; WTK	72.7	241.2		1:1	--		$4,000 to $5,000 per acre	$290,800	$363,500
Rice	GGS	122.9	1,383.6	Assume all rice suitable GGS habitat	3:1 for GGS*	1:1 for GGS*	1,752.3	$4,000 to $5,000 per acre	$7,009,200	$8,761,500
Riverine	BE, BS	1.6	0	Associated with fish screen Assume on-site restoration	2:1 to 3:1	--		Costs to be estimated as part of project design and construction	NA	NA
Urban/disturbed		90.8	46.9						--	--
Valley foothill riparian	GGS; VELB; CTS; BE; SH, WYBC; VRI; WPT; RT	110.2	4.1	The mitigation for loss of other wildlife habitat types could potentially compensate for the native planting requirement for elderberry plant mitigation. Elderberry plants are typically replaced at a ratio of 2:1 for stems greater than one inch in diameter; 3:1 for stems where emergence holes are documented in less than 50 percent of the shrubs, and 5:1 for stems greater than one inch in diameter with emergence holes 672 elderberry stems surveyed within the proposed Sites Reservoir footprint; emergence holes were found on 18 stems. [ASSUME 3:1 for VELB mitigation]	3:1 for GGS* 4:1	1:1 for GGS*		$2,500 to $3,000 per acre	$836,750	$1,004,100
Valley oak woodland	SH	3.5	0	See botanical above				$2,500 to $3,000 per acre	above	above
Wildlife Habitats TOTAL	--	**15,521.7**	**5,357.6**		--	--			**$14,501,725**	**$25,869,350**

Vegetation/Habitat Type	State-Federally-Listed Species Associations within Primary Study Area[1,2,3,4,5,6,7,8,9]	Acreage		Assumptions for Mitigation Approach (On-site/Off-site)	Anticipated Mitigation Ratio		Estimated Mitigation Acreage	Estimated Cost/Acre	Mitigation Cost	
		Permanent Loss[b]	Temporary Disturbance	Restoration/Mitigation Banking	Permanent Loss[b]	Temporary Disturbance			Low	High
Wetland Type										
Alkaline		37.0	--	Includes an additional 19.5 acres adjacent to Assume a total of 27 acres requiring mitigation. Assume off-site mitigation	2:1 to 3:1			150k to 200k/acre	$8,100,000	$27,000,000
Emergent		2.4	--	Assume off-site mitigation	1:1 to 5:1			100k to 150k/acre	$240,000	$1,800,000
Riparian		25.0	--	Riparian wetland mitigation assumed to be covered under VFR.					above	above
Seasonal		182.4	--		1:1 to 5:1			100k to 150k/acre	$18,240,000	$136,800,000
Vernal Pool		5.5	--	Vernal pool mitigation assumed to be covered under annual grassland					above	above
Wetlands TOTAL		**252.3**	**--**						**$26,580,000**	**$165,600,000**
Total Pond Acres[b]		35.8	--	Assume no mitigation needed. It is assumed that ponds within pipeline alignment can be avoided. Other "pond" impacts would be mitigated as part of vegetation community mitigation likely to include pond features like grassland or riparian.					--	--
Total Streams		227.7		Assume on-site restoration	2:1		455.4		NA	NA
Streams 0-5 Feet Wide		6.0	--	Assume on-site restoration	2:1		12		NA	NA
Streams 5-10 Feet Wide		15.1	--	Assume on-site restoration	2:1		30.2		NA	NA
Streams 10-15 Feet Wide		13.3	--	Assume on-site restoration	2:1		26.6		NA	NA
Streams <15 Feet Wide		77.0	--	Assume on-site restoration	2:1		144		NA	NA
Streams >15 Feet Wide		116.3	--	Assume on-site restoration	2:1		232.6		NA	NA
Other Waters of the US TOTAL			**--**						**NA**	**NA**

Notes:

[1]Acreages for Botanical Resource/Vegetation Community impacts for Alternative C are from Table 13-29; Acreages for Wildlife Habitats impacts for Alternative C are from Table 14-24; Acreages for Wetland Type impacts for Alternative C are from Table 15-20 in NODOS Preliminary Administrative Draft Environmental Impact Report (December 2013)

State-Federally-Listed Species Associations within Primary Study Area Vegetation Communities

1 – Vegetation and Habitat associations are taken from Table 14-3 (Golden Eagle, Western Pond Turtle) and Table 14-5 for Foothill Yellow Legged Frog in DWR 2013.

2 – Mitigation ratio for GGS is up to 6:1, if construction is performed during active season (May 1 to October 1).

3 – Wildlife habitat for Northern spotted owl - Douglas Fir, redwood, mixed hardwood conifer (MHC)

4 – Wildlife habitat for Greater Sandhill crane - Freshwater emergent marsh, Wet Meadow and PAS (Table 14-3) - Wintering habitat in Primary Study Area

5 – Wildlife habitat for Ringtail (Riparian habitats)

6 – Wildlife habitat for Willow flycatcher (MRI, WTM)

7 – Wildlife habitat for Pacific fisher (MHC, SMC)

8– Wildlife habitats for bat species (structures, woodland habitats, and orchards near intake)

9 – Wildlife habitats for Burrowing owl (Annual grassland and edge of blue oak woodland)

BE - Bald eagle
BS - Bank swallow
BO - Burrowing Owl
CRLF - California red-legged frog
CTS - California tiger salamander
FYLF - Foothill Yellow Legged Frog
FH - Ferruginous hawk
GE - Golden Eagle
GGS - Giant garter snake
GSC - Greater Sandhill crane
PF - Pacific fisher
NSO - Northern spotted owl
RT - Ringtail
SH - Swainson's hawk
VP Invertebrates - Conservancy fairy shrimp, Vernal pool fairy shrimp, Vernal pool tadpole shrimp
VELB - Valley elderberry longhorn beetle
WF - Willow flycatcher
WPT - Western Pond Turtle
WYBC - Western yellow-billed cuckoo
WSF - Western Spadefoot

Botanical Resources/Vegetation Communities

[a] Total permanent vegetation loss acreage includes the footprint of Sites Reservoir and Dams, Sites Reservoir Inlet/Outlet Structure, Sites Pumping/Generating Plant, Sites Electrical Switchyard, Field Office Maintenance Yard, Holthouse Reservoir Complex, Holthouse Reservoir Electrical Switchyard, GCID Canal Connection to the TRR, TRR, TRR Pumping/Generating Plant, TRR Electrical Switchyard, TRR Pipeline Road, Delevan Pipeline Electrical Switchyard, and the Delevan Pipeline Intake Facilities. Total permanent loss acreage also includes the estimated permanent loss from construction within the footprint of the Recreation Areas, within the construction disturbance area for the Road Relocations, and from construction of the transmission tower footings associated with the Delevan Transmission Line.

[b] Total temporary disturbance acreage includes the footprint of the Recreation Areas (minus the acreage of estimated permanent loss) and footprint of the existing Funks Reservoir, as well as the defined construction disturbance areas for the Road Relocations (minus the acreage of estimated permanent loss), Delevan and TRR pipelines, Holthouse to T-C Canal Pipeline, TRR to Funks Creek Pipeline, Delevan Transmission Line, and GCID Canal Facilities Modifications. Total temporary disturbance acreage also includes the estimated construction disturbance areas (outside of the footprints) for Sites Reservoir and Dams, Sites Reservoir Inlet/Outlet Structure, Sites Pumping/Generating Plant, Sites Electrical Switchyard, Field Office Maintenance Yard, Holthouse Reservoir Complex, Holthouse Reservoir Electrical Switchyard, GCID Canal Connection to the TRR, TRR, TRR Pumping/Generating Plant, TRR Electrical Switchyard, and Delevan Pipeline Intake Facilities.

c Total acreage does not include acreage associated with the Project Buffer.

Wildlife Habitats

[a] Calculated acreage does not include acres associated with the Project Buffer because the location and extent of disturbance is not yet specified.

[b] Total permanent habitat loss acreage includes the footprint of Sites Reservoir and Dams, Sites Reservoir Inlet/Outlet Structure, Sites Pumping/Generating Plant, Sites Electrical Switchyard, Field Office Maintenance Yard, Holthouse Reservoir Complex, Holthouse Reservoir Electrical Switchyard, GCID Canal Connection to the TRR, TRR, TRR Pumping/Generating Plant, TRR Electrical Switchyard, TRR Pipeline Road, Delevan Pipeline Electrical Switchyard, and the Delevan Pipeline Intake Facilities. Total permanent loss acreage also includes the estimated permanent loss from construction within the footprint of the Recreation Areas, within the construction disturbance area for the Road Relocations, and from construction of the transmission tower footings associated with the Delevan Transmission Line.

[c] Total temporary disturbance acreage includes the footprint of the Recreation Areas (minus the acreage of estimated permanent loss) and the footprint of the existing Funks Reservoir, as well as the defined construction disturbance areas for the Road Relocations (minus the acreage of estimated permanent loss), Delevan Pipeline, TRR Pipeline, Holthouse to T-C Canal Pipeline, TRR to Funks Creek Pipeline, Delevan Transmission Line, and GCID Canal Facilities Modifications. Total temporary disturbance acreage also includes the estimated construction disturbance areas for Sites Reservoir and Dams, Sites Reservoir Inlet/Outlet Structure, Sites Pumping/Generating Plant, Tunnel from Sites Pumping Generating Plant to Sites Inlet/Outlet Structure, Sites Electrical Switchyard, Field Office Maintenance Yard, Holthouse Reservoir Complex, Holthouse Reservoir Electrical Switchyard, GCID Canal Connection to the TRR, TRR, TRR Pumping/Generating Plant, TRR Electrical Switchyard, and Delevan Pipeline Intake Facilities.

Wetlands and Waters of the US

[a] The northwest 0.5 acre of swale feeding marsh is within proposed footprint, but hydrologically connected to a 20-acre (estimated minimum area) marsh/swale/vernal pool complex. Wetlands themselves equal 13 acres; entire complex with connecting upland watersheds equal 20 to 40 acres.

[b] Ponds counted separately from streams.

[c] Includes 6.1 acres for Salt Lake. All other pond acreages are stock ponds.

[d] Acres of wetlands and other waters of the U.S. types are unknown because the Project Buffer was added after surveys were conducted; consequently, wetland/WUS features were not mapped.

[e] Total acreage does not include acreage associated with the Project Buffer, which has not been surveyed or mapped.

[f] Primary Study Area is defined as the Project facility footprints except for the Delevan Pipeline, which also includes a wider construction disturbance area corridor, and for Holthouse Reservoir complex, where Alkaline wetlands potentially affected include acres adjacent to dam footprint as well as overlapping with the footprint.

ATTACHMENT 7

Air Quality Impacts (Alternative C)

Attachment 7A. Average Daily Emission Rates for Criteria Pollutants by Year for Construction of Alternatives C[1]

Construction Year	Emissions (pounds per day)					
	NOx	PM10	PM2.5	ROG	CO	SOx
2013	**2,171**	**344**	124	**247**	833	3
2014	**4,487**	**860**	274	**508**	1,749	6
2015	**4,012**	**765**	246	**455**	1,565	5
2016	**4,061**	**770**	250	**460**	1,593	5
2017	**2,286**	**528**	153	**257**	920	3
2018	**990**	**319**	83	109	412	1
2019	**990**	**319**	83	109	412	1
2020	**892**	**298**	76	98	360	1
2021	98	21	8	11	52	0
Significance Threshold (lb/day)	**137**	**137**	**n/a**	**137**	**n/a**	**n/a**

Notes:

[1] Emissions estimates are from Appendix 24 Table 24A.B-1 for construction emissions for Alternatives B and C in NODOS Preliminary Administrative Draft Environmental Impact Report (December 2013)

[2] The average daily construction emission rates in lb/day for each construction year are the sum of the average daily emission rates estimated for each of the project features that would be constructed in the indicated construction year.

[3] Bolded values indicate an exceedance of the significance threshold.

[4] Significance Threshold is from Tehama County APCD Level C: Greater than 137 pounds per day of emissions. If emissions from a project would exceed the Level C thresholds, mitigation measures (BAMMs and SMMs), including off-site mitigation measures following the guidelines, may be required to reduce the overall air quality impacts of the project to a level of insignificance (TCAPCD 2009).

Attachment 7B. Construction On-Site Concrete Batch Plant PM10 Emissions [1]

Project Feature	Total Concrete Mass (tons)	Number of Days	Daily Rate (tons/day)	PM10 Emissions (lb/day)
Tunnel - Inlet and Outlet Including Sites Pump Plant	77,515	194	400	10.14
Pipelines - Delevan and TRR	11,100	28	396	10.07
Dams & Sites Inundation	85,951	215	400	10.14
TRR Pump Plant	55,500	139	399	10.13
Funks Reservoir Modification	23,773	59	403	10.22
Sacramento River Intake & P/G Plant	55,500	139	399	10.13
Paved Roads & Bridges	186,110	310	600	14.81
GCID Canal & Headworks	21,090	35	603	14.86
Transmission Lines	16,095	40	402	10.20
Recreation	8,780	44	200	5.49

Batch Plants Controlled Emission Factors[a]		
Sand Transfer[b]	0.000297	lb PM10/ton cement
Aggregate Transfer[b]	0.00099	lb PM10/ton cement
Cement Unloading to Storage Silo	0.00034	lb PM10/ton cement
Cement Supplement Unloading to Storage Silo	0.0049	lb PM10/ton cement
Weigh Hopper Loading[b]	0.00072	lb PM10/ton cement
Truck Loading[c]	0.016	lb PM10/ton cement
Total	0.023	lb PM10/ton cement

Notes:

[1] Emissions estimates are from Appendix 24 Table 24A.B-11 for concrete batch plant PM10 emissions for Alternatives B and C in NODOS Preliminary Administrative Draft Environmental Impact Report (December 2013)

[a] Emission factors from AP-42, Section 11.12, June 2006

[b] The batch plants will have dust control equipment and was assumed to control dust emissions with an efficiency of 70% during sand and aggregate transfer. Source for control efficiency: BAAQMD Permit Handbook, Section 11.5 Concrete Batch Plants, March 2009

[c] It was assumed the truck loading process would also include dust controls. Therefore, the controlled truck loading emission factor was used.

Attachment 7C. Summary of Criteria Pollutant Emissions for Operations and Maintenance of Alternatives[1]

Summary O&M Emissions (lb/day)						
	NOx	**PM10**	**PM2.5**	**ROG**	**CO**	**SOx**
Total Average Daily Emissions (lb/day)	33	7	7	38	1308	0.1
TCAPCD Threshold (lb/day), Level A	< 25	< 25		< 25		
Threshold Exceeded?	**Yes, subject to standard mitigation measures**	**No**		**Yes, subject to standard mitigation measures**		
TCAPCD Threshold (lb/day), Level B	> 25	> 25		> 25		
Threshold Exceeded?	**Yes, incorporate Best Available Mitigation Measures**	**No**		**Yes, incorporate Best Available Mitigation Measures**		
TCAPCD Threshold (lb/day), Level C	> 137	> 137		> 137		
Threshold Exceeded?	No	No		No		

Notes:

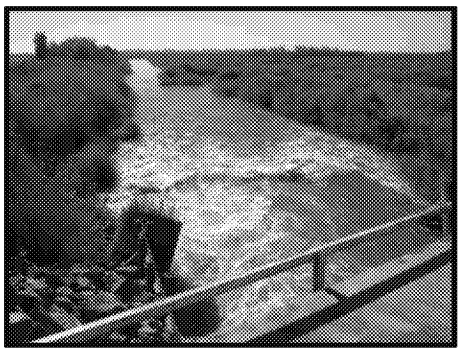
[1] Emissions estimates are from Appendix 24 Table 24A.D-1 in NODOS Preliminary Administrative Draft Environmental Impact Report (December 2013)

[2] It was assumed that sedans/pickups would travel at a speed of 15 mph which equates to 3 roundtrips per hour at a distance of 5 miles per roundtrip.

[3] There would be a total of 60 employees supporting work at all sites so the employee commute emissions are represented under the "Reservoirs, Recreation Facilities, Dams, Roads, Bridges" category but this covers all O&M employees.

North Delta Flow Action Study
2019 OPERATIONS FACT SHEET

What is planned?



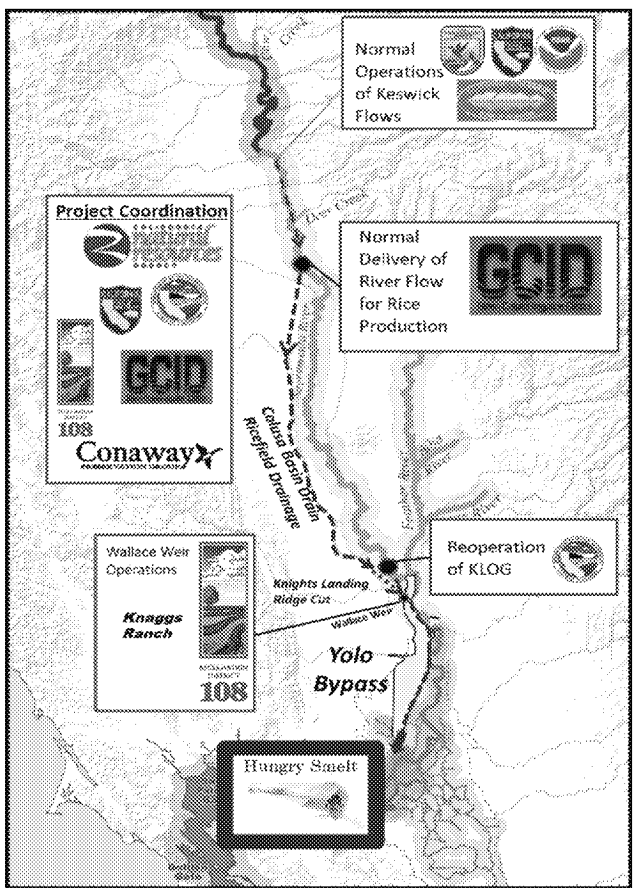
- *Late-August to September 2019* (peak rice-field drainage period): redirect agricultural return flows from Colusa Basin Drain through Knights Landing Ridge Cut and Wallace Weir into the Yolo Bypass for (see map below).
- Maintain flow for up to 4-weeks.
- Generate a modest, positive flow pulse (e.g. 24 TAF) through the Yolo Bypass Toe Drain.
- Limit diversion amount to avoid localized flooding.
- Action goal: benefit the downstream Delta food web for fish.

Primary water operation changes during the Flow Action

- Knights Landing Outfall Gate (KLOG): set elevation to 27' during the brief study.
- Wallace Weir: adjust operations to convey agricultural return water at a target flow of 300-700 cfs
- Swanston Ranch Road Crossing (Ag. Crossing #4): modify culverts to allow additional flow to pass through the Toe Drain.

Monitoring of Water Operations

- Colusa Basin Drain flows will be primarily controlled and monitored by Glenn Colusa Irrigation District (GCID) at Davis Weir.
- KLOG operations and elevation changes will be monitored by Dept. of Water Resources (DWR) Division of Flood Management and Reclamation District 108 (RD 108)
- DWR stage monitors will be deployed from Charter property south to RD 16 bridge to monitor how increased KLOG elevation affects water levels in the lower Colusa Basin Drain.
- Knights Landing Ridge Cut will be monitored using existing DWR stage data collected in Ridge Cut Slough at Hwy 113 Bridge (Site RCS: https://cdec.water.ca.gov/) and at new Wallace Weir.
- RD 108 will reduce outflows at Wallace Weir once flows drop below 250-300 cfs at Davis Weir to ensure water levels are maintained in lower Colusa Basin and Ridge Cut Slough for late-fall and winter irrigation needs.



Approach planned to Generate a Flow Pulse in 2019

Partners working on the project

- The Department of Water Resources is leading the effort as part of the *Delta Smelt Resiliency Strategy*.
- The project is a major collaboration with action coordinators (Resources Agency, DWR), fisheries agencies (DFW, NMFS, FWS), diverters (GCID, RD108, Conaway Group), funding sources (DWR, USBR, SFCWA), and scientists (USGS, SFSU, UCD).

North Delta Flow Action Study
2019 OPERATIONS FACT SHEET

Why the interest in enhancing the food web via the Flow Action?

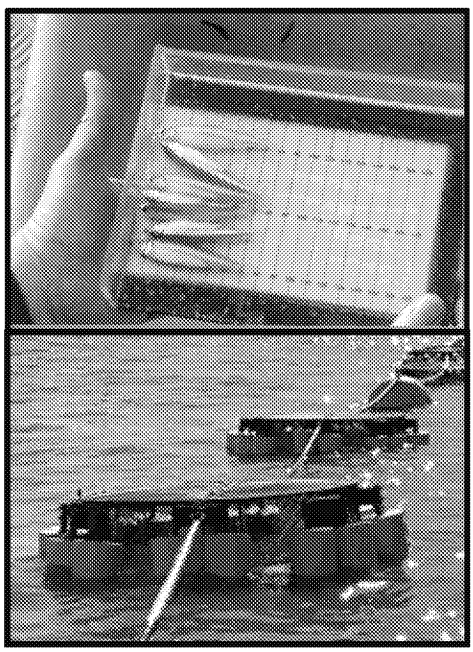
- Loss of plankton is a major factor responsible for the decline of many fishes including the endangered Delta Smelt.
- The loss of these species impacts the ecosystem and affects water supply reliability in the state.

Why is Yolo Bypass a focus?

- Lower Yolo Bypass is known to be richer in plankton than most other parts of the Delta.
- Much of this productivity may not reach the Delta in drier months because local water diversions tend to pull water away from the lower Sacramento River.
- Scientists observed that larger-than-normal fall 2011 and 2012 agricultural flow pulses were followed by downstream Delta plankton blooms. These were the first fall blooms in over 20 years.

The basic idea behind the action

- By routing agricultural drain water through Yolo Bypass instead of the Sacramento River, DWR scientists predicted that a flush of plankton-rich water would provide a "seed" for the downstream Delta, enhancing food resources for Delta Smelt.
- A similar managed flow pulse was generated in July 2016 with the help of Sacramento Valley water users, and as predicted, the flow pulse coincided with a wave of increased phytoplankton through Yolo Bypass and in the Delta at Rio Vista.
- The action is designed to maximize the environmental benefits of water. Water isn't "consumed" by the action--it is directed down a different and more productive path to the Delta.



Measurements and how the study results will be used

- Water quality, contaminants, plankton, and clams (consumers of plankton) will be monitored before, during, and after experimental flows.
- Cages of hatchery Delta Smelt deployed in the Yolo Bypass Toe Drain will be monitored for growth and survival for 4 weeks before and after the flow action.
- The combined results of water quality, productivity, and fish survival monitoring are intended to guide future possible operations to benefit Delta Smelt.
- The major findings will be presented in management and technical forums, and summarized for publication in scientific journals.

Study Contacts

Brittany.E.Davis@water.ca.gov 916-376-9756 (Monitoring and Analysis Lead)
Joshua.Martinez@water.ca.gov 916-376-9725 (Operations Lead)
Jared.Frantzich@water.ca.gov 916-376-9823
Ted.Sommer@water.ca.gov 916-376-9772

North Delta Flow Action
2019 FOOD WEB STUDY FACT SHEET

What is planned?



- In fall 2019 agricultural flows will be directed into Yolo Bypass for up to a month (see map below).
- The action is designed to generate a modest, seasonal positive flow pulse (e.g. 24 TAF) through the Yolo Bypass, but will be well below levels that would result in local flooding.
- The goal of the action is to support the Delta food web in downstream areas.

Who is working on the project?

- Department of Water Resources with funding support from US Bureau of Reclamation is leading the effort as part of the *Delta Smelt Resilience Strategy*.
- The project is a major collaboration with action coordinators (Resources Agency, DWR), fisheries agencies (DFW, NMFS, FWS), diverters (GCID, RD108, Conaway Group), funding sources (USBR, SFCWA), and scientists (USGS, SFSU, UCD).

Why is there an interest in enhancing the food web?

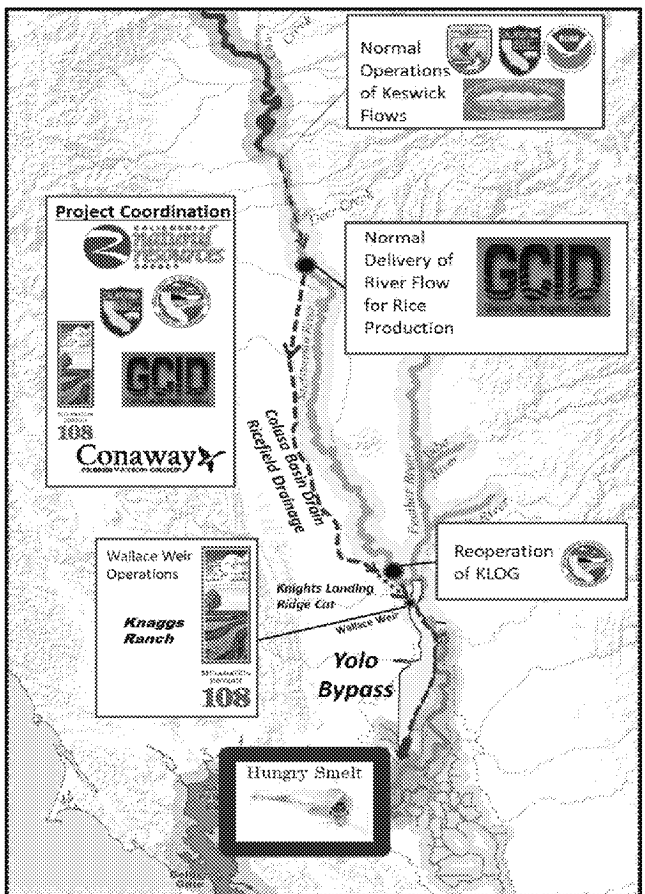
- Loss of plankton is a major factor responsible for the decline of many fishes including the endangered Delta Smelt.
- The loss of these species impacts the ecosystem and affects water supply reliability in the state.

Why is Yolo Bypass a focus?

- Yolo Bypass and Cache Slough Complex are known to be relatively richer in plankton than most other parts of the Delta.
- Much of this productivity may not reach the Delta in drier months because local water diversions tend to pull water away from the lower Sacramento River.
- Scientists observed that larger-than-normal fall 2011 and 2012 agricultural flow pulses were followed by downstream Delta plankton blooms. These were the first fall blooms in over 20 years.

What is the basic idea behind the action?

- By routing agricultural drain water through Yolo Bypass instead of the Sacramento River, DWR scientists predicted that a flush of plankton-rich water would provide a "seed" for the downstream Delta, enhancing food resources for Delta Smelt.



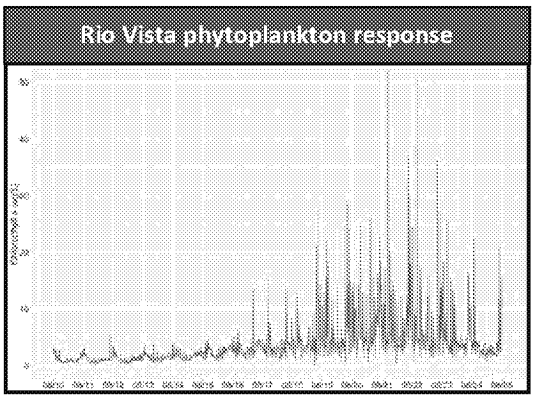
Approach planned to Generate a Flow Pulse in 2019

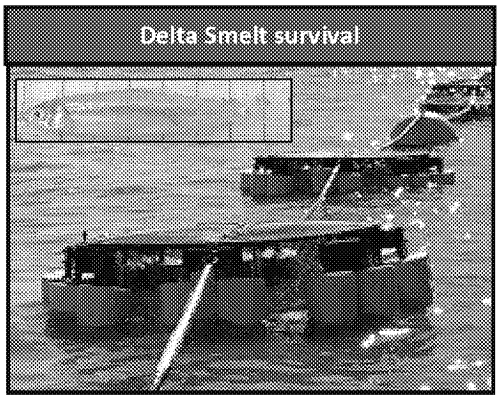
North Delta Flow Action
2019 FOOD WEB STUDY FACT SHEET

- A similar managed flow pulse was generated in July 2016 and 2018 with the help of Sacramento Valley water users (see map).
- The action is designed to maximize the environmental benefits of water. Water is not "consumed" by the action--it is directed down a different and more productive path to the Delta.

What will be measured in the study and how will the results be used?

- Water quality, contaminants, plankton, and clams (consumers of plankton) will be measured before, during, and after experimental flows at multiple locations.
- Cages of hatchery Delta Smelt deployed in the Yolo Bypass Toe Drain will be monitored for growth and survival for 4 weeks before and after the flow action.
- The results are intended to guide future possible operations to benefit Delta Smelt.
- The major findings will be presented in management and technical forums, and summarized for publication in scientific journals.





Did the 2016 and 2018 Actions Work?

2016

- The action generated a substantial flow pulse (12,700 AF) for over two weeks in July.
- As predicted, the flow pulse coincided with a wave of phytoplankton (as measured by chlorophyll *a*) through Yolo Bypass.
- The action was followed by a major increase in phytoplankton in the Delta at Rio Vista.
- The bloom was dominated by a "good" variety (*Aulacoseira granulata*), not a harmful species.

2018

- The action generated a near-targeted flow pulse (19,824 AF) over 4 weeks from Aug. to Sept.
- The flow pulse did not coincide with a wave of phytoplankton through Yolo Bypass, suggesting an initial "seed" of plankton-rich water may have been absent evident in low nutrients and food web productivity.
- The flow pulse did export higher densities of zooplankton into downstream habitats of lower Cache Slough and Sacramento River at Rio Vista.

Study Contacts

Brittany.E.Davis@water.ca.gov 916-376-9756; Joshua.Martinez@water.ca.gov 916-376-9725;
Jared.Frantzich@water.ca.gov 916-376-9823; Ted.Sommer@water.ca.gov. 916-376-9772

From: Jeffrey Mount [mount.jeffrey@gmail.com]
Sent: 1/24/2020 12:58:50 PM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: Re: environmental water

Ally,

Thanks so much for this. It is incredibly useful and, given our interest in how to allocate environmental water, really interesting.

It is interesting to me that the Sites project has been kind of off the radar on the Voluntary Agreement negotiations. That is, it sits in the background without coming up in the horse trading. But since I am not a part of all of that I am only informed by rumors.

Thanks again. Have a great weekend.

Jeff

On Fri, Jan 24, 2020 at 9:10 AM Alicia Forsythe <aforsythe@sitesproject.org> wrote:

> Great to see you last week also! And sorry it has taken me a few days to get back to you. Its been a busy week!
>
> The answer is that it varies and is a little complicated. As are most things in California water, right?!?!
>
> I've attached a "cash flow tool" that we created for the member agencies. This has been released to the public, so there is nothing "confidential" in here. It provides potential, financed costs of Sites using a range of assumptions, a few of which the user can define (see the green boxes). On the "Annual Cash Flow Estimates" tab, see the box on the left, lines 34 to 39 and columns C to H. This isn't precise, but its our initial estimate of Prop 1 water under different reservoir costs and different water deliveries (which varies based on diversion criteria).
>
> The attached file only identifies the Prop 1 water. This is the water that would really be storable and schedulable for the environment (and the environment would have a corresponding storage account based on the percent of Prop 1 funds for environmental benefits). This sheet does not account for Federal public benefits – which we continue to work with Reclamation on. The sheet actually assumes no Federal funding (really beyond the initial planning funds) as the participants wanted to have a sense of whether they could afford the project without Federal funding. The sheet also does not account for "secondary" environmental benefits, like cold water benefits between Keswick and Bend Bridge that result from coordinated operations with Reclamation and backing water up in Shasta.
>
> Also, keep in mind that the Prop 1 funds for Sites were for flood control, recreation and ecosystem benefits. The amount for ecosystem benefits was $598M, so the calculations in the attached sheet are using the $598M only. We are also assuming that the environment pays the same per AF cost as all other investors (of course, without finance costs).

Clearly, the lower we can get the cost of the reservoir and the higher we can get the yield, the more water there is for Prop 1 ecosystem benefits.

We're making some updates and corrections to the sheet now and plan to issue a revised version in the February timeframe.

Hope this helps and happy to chat if you have questions on any of this. Hope you have a great weekend!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Jeffrey Mount <mount.jeffrey@gmail.com>
Sent: Wednesday, January 22, 2020 8:49 AM
To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: environmental water

What else? I didn't get to say hello last Friday and to talk more substantively. I wanted to ask what your ballpark figure is these days for the amount of water to be stored and used for the environment in the current, but evolving, configuration for Sites. I know this is unknowable at this point, but nice to have a guestimate.

Thanks. I hope all is well in Maxwell.

Jeff

--

Jeffrey Mount
Public Policy Institute of California and UC Davis
mount.jeffrey@gmail.com

--

Jeffrey Mount

Public Policy Institute of California and UC Davis
mount.jeffrey@gmail.com

Sent: 1/24/2020 4:05:56 PM
To: mount.jeffrey@gmail.com
Subject: RE: environmental water

No problem. Two things I've heard on the Vas and Sites.

- Sites likely wont be constructed and fully operational in time to make a meaningful difference for the current VA timeframe. Since the current VA effort is only 15 years,

---

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Jeffrey Mount <mount.jeffrey@gmail.com>
Sent: Friday, January 24, 2020 12:59 PM
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Jeffrey Mount
Public Policy Institute of California and UC Davis
mount.jeffrey@gmail.com

From: William Vanderwaal [wvanderwaal@rd108.org]
Sent: 1/29/2020 7:31:09 AM
To: Alicia Forsythe [aforsythe@sitesproject.org]
Subject: RE: Sites - Ad Hoc Environmental and Permitting Work Group

So, I personally don't see a change in reservoir size like you describe happening but operations may be a different horse. Keeps work interesting.

Thanks!
Bill V

William R Vanderwaal
RD-108/DWD
530.812.6276

From: Alicia Forsythe [mailto:aforsythe@sitesproject.org]
Sent: Wednesday, January 29, 2020 7:19 AM
To: William Vanderwaal <wvanderwaal@rd108.org>
Subject: RE: Sites - Ad Hoc Environmental and Permitting Work Group

Yes, we've been thinking about how we add in enough flexibility for future design changes but not so much that we cause ourselves other problems. If the Ad Hoc Work Group recommends we get going again, then I am suggesting that we have a small group of planning, permitting, and engineering folks meet on a regular basis to develop the project description, which would include both identify these items and teeing them up for resolution / confirmation of a suggested approach thru the appropriate work group. We will also have to make some assumptions in the documents as we wont have detailed design information and will want some flexibility – its figuring out what are good assumptions to minimize our work later and making sure the work groups are aware of these and agree.

Depending on footprint issues and resulting impacts, some assumptions / flexibility are going to be easier to do than others. Meaning, if the footprint or operations are dramatically different, and thus impacts are dramatically different, its going to get really complicated to leave a lot of flexibility. But I don't see this with 750 cfs vs 900 cfs release (the team may tell me I am wrong, but I don't see it). Its things like leaving the flexibility to go from a 1.0 MAF reservoir to a 1.5 MAF reservoir in the future that worry me more as this changes footprints for a number of items (dams, bridges, roads, etc), changing impacts. But maybe these are different alternatives in the document. We will tee these things up and work thru them.

Really great point.

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: William Vanderwaal <wvanderwaal@rd108.org>
Sent: Wednesday, January 29, 2020 7:03 AM

To: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: RE: Sites - Ad Hoc Environmental and Permitting Work Group

Thanks Ali, in reality I'll be driving from Colusa to Chico so will just be listening in.

Rob Kunde, Lee and I discussed the Value Planning Executive Summary yesterday and one important point Rob made that we should keep in mind is that from a Strategic Planning perspective we want to make sure that our environmental assessments and products don't limit future expansion, if at all possible. To expand on that, we're thinking of the outlet which seems likely to be around 750 cfs capacity for what we have right now, but once the project has gained more certainty, possibly more investors, we might need a 900 cfs outlet. If there's a way to do the environmental work in such a way that it enables that flexibility, it should be done. I think you probably already have that in mind, but just want to make sure I've communicated that. It's a fine line because at the same time, we don't want to overdo it and lose the "lean & mean" principle we're working under.

Cheers
Bill V

William R Vanderwaal
RD-108/DWD
530.812.6276

From: Alicia Forsythe [mailto:aforsythe@sitesproject.org]
Sent: Wednesday, January 29, 2020 6:52 AM
To: Fisher, Linda <Linda.Fisher@hdrinc.com>; William Vanderwaal <wvanderwaal@rd108.org>
Subject: RE: Sites - Ad Hoc Environmental and Permitting Work Group

Thanks Bill. We will have a presentation, so if you can join on Skype, that would be great. If not, we'll be walking thru it and hopefully it wont be too challenging to follow along.

Hope you have a great day!

Ali

Alicia Forsythe | Environmental Planning and Permitting Manager | Sites Reservoir Project | 916.880.0676 | aforsythe@sitesproject.org | www.SitesProject.org

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From: Fisher, Linda <Linda.Fisher@hdrinc.com>
Sent: Tuesday, January 28, 2020 1:12 PM
To: Bill Vanderwaal (WVanderwaal@rd108.org) <WVanderwaal@rd108.org>
Cc: Alicia Forsythe <aforsythe@sitesproject.org>
Subject: FW: Sites - Ad Hoc Environmental and Permitting Work Group

Thanks Bill.

Ali - please see note below.

Linda Fisher, M.S.
D 916.817.4962 M 530.400.3212

hdrinc.com/follow-us

-----Original Appointment-----
From: William Vanderwaal [mailto:wvanderwaal@rd108.org]
Sent: Tuesday, January 28, 2020 6:57 AM
To: Fisher, Linda
Subject: Tentative: Sites - Ad Hoc Environmental and Permitting Work Group
When: Wednesday, January 29, 2020 1:00 PM-4:30 PM (UTC-08:00) Pacific Time (US & Canada).
Where: ICF 980 9th St #1200, Sacramento, CA 95814; Skype meeting; Call in: 866-583-7984, code: 4974650#

Can you let Ali know I'll telephone into this meeting after the Colusa GSA meeting ends, please?
Thanks
Bill Vanderwaal