Biological Assessment
for the
U. S. Army Corps of Engineers
Authorized Operations and
Maintenance of Existing Fish Passage
Facilities at Daguerre Point Dam on
the Lower Yuba River

US Army Corps of Engineers ®
Sacramento District

Technical Assistance Provided By:
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# Biological Assessment for the U.S. Army Corps of Engineers Authorized Operations and Maintenance of Existing Fish Passage Facilities at Daguerre Point Dam on the Lower Yuba River

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1.0 Introduction and Background

1.1 Introduction

The U. S. Army Corps of Engineers, Sacramento District (Corps), as the Action Agency, is submitting this Biological Assessment (BA) to the National Marine Fisheries Service (NMFS) as part of a consultation process pursuant to Section 7(a)(2) of the Endangered Species Act (ESA). This BA was prepared in accordance with legal requirements set forth in Section 7 of the ESA (16 U.S.C. 1536; see also 50 CFR Part 402), as well as in the NMFS and the United States Fish and Wildlife Service (USFWS) Endangered Species Act Consultation Handbook, Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act (USFWS and NMFS 1998). This BA defines and evaluates the potential effects of the Corps’ limited ongoing discretionary activities at Daguerre Point Dam on threatened and endangered species and their designated critical habitats in the lower Yuba River. Specifically, the Corps’ discretionary activities at Daguerre Point Dam are: (1) the operation and maintenance of the fish ladders; (2) an outgrant to the California Department of Fish and Wildlife (CDFW) [formerly California Department of Fish and Game] for VAKI Riverwatcher operations; and (3) a license to Cordua Irrigation District for flashboard operations. These activities constitute the Proposed Action for purposes of this consultation.

Although previous consultations have been conducted addressing various Corps activities in the lower Yuba River, this BA has been prepared to more clearly define and deconstruct the Proposed Action, and potential effects on listed species and their designated critical habitats attributed to the Proposed Action, in response to the considerations presented below regarding the background associated with the Proposed Action. There are many Corps actions on the lower Yuba River. This BA provides detailed information regarding the Corps’ authorities and describes the Proposed Action for which the Corps is currently seeking Section 7 consultation, and also describes other actions that are not covered by the BA for clarification. To help illustrate the
deconstruction of Corps’ lower Yuba River activities (refer to Figure 1-1 in Section 1.3), the following categories have been created: (1) future actions requiring separate ESA consultation; (2) non-discretionary actions; (3) discretionary actions with no effect; (4) Englebright Dam and Reservoir discretionary actions that are not likely to adversely affect listed species, and are included in a separate informal ESA consultation; and (5) operations and maintenance (O&M) of existing fish passage facilities at Daguerre Point Dam included in the formal ESA consultation for this Proposed Action.

1.2 Background

The Section 7 ESA consultation process between the Corps and NMFS associated with Corps activities in the lower Yuba River extend back to 2000. Biological opinions (BOs) were issued by NMFS in 2002, 2007, and 2012. This section presents a description of the project history and an overview of the consultation history related to the NMFS BOs.

1.2.1 Consultation History

1.2.1.1 2002 Consultation

The Corps’ proposed action that was evaluated in the 2000 Corps BA and the 2002 NMFS BO included the following actions:

**Englebright Dam**

- O&M of Englebright Dam.
- Administration of License No. DACW05-9-95-604 to the Pacific Gas & Electric Company (PG&E) granting access for the Narrows I powerhouse near Englebright Dam. Narrows I is operated and maintained under Federal Energy Regulatory Commission (FERC) License No. 1403.
- Administration of Easement No. DACW05-2-75-716 to the Yuba County Water Agency (YCWA) granting a right-of-way for the Narrows II near Englebright Dam. Narrows II is operated and maintained under FERC License No. 2246.
Administration of the March 28, 1994 Agreement with PG&E for the operation and maintenance of the Narrows I FERC licensed hydroelectric project. The 1994 Agreement states that the Corps is responsible for maintaining Englebright Dam and the outlet facilities in good order and repair, while PG&E is responsible for the O&M of the FERC licensed hydroelectric facility.

Although recreation at Englebright Reservoir was briefly mentioned in both the 2000 Corps BA and the 2002 NMFS BO, detailed descriptions of the Corps’ specific operations and maintenance activities pertaining to recreation at Englebright Reservoir were not presented in the proposed action.

DAGUERRE POINT DAM

- O&M of Daguerre Point Dam and the North and South fish ladders.
- Administration of License No. DAW05-3-97-549 issued to the Hallwood Irrigation Company for a diversion in the vicinity of Daguerre Point Dam.
- Administration of License No. DACW05-3-85-537 granting a right-of-way for access to the South Yuba/Brophy Diversion Canal and Facilities in the vicinity of Daguerre Point Dam.

Although generally identified, specific Corps operations and maintenance activities pertaining to Daguerre Point Dam, including work with CDFW to maintain the two fish ladders at Daguerre Point Dam by clearing debris, were not presented in detail in the proposed action.

The following is a chronology of key events in the ESA consultation history that culminated with the 2002 BO.

- June 22, 2000. The Corps prepared a BA titled “Biological Assessment of the Effects of Operations of Englebright Dam/Englebright Lake and Daguerre Point Dam on Central Valley ESU Spring-Run Chinook Salmon and Steelhead Trout”.
- December 18, 2000. The Corps prepared a revised BA titled Biological Assessment of the Effects of Operations of Englebright Dam and Reservoir and
Daguerre Point Dam on Central Valley ESU Spring-Run Chinook Salmon and Steelhead Trout.

- March 27, 2002. NMFS issued a non-jeopardy 5-year interim BO that analyzed the effects of the Corps’ operation of Englebright Dam and Daguerre Point Dam on the threatened Central Valley spring-run Chinook salmon (*Oncorhynchus tshawtscha*), Central Valley steelhead (*O. mykiss*), and the respective designated critical habitats for these species. The 2002 NMFS BO concluded that the project was not likely to jeopardize the continued existence of the listed species, and was not likely to destroy or adversely modify designated critical habitat for these species, over the 5-year time period.

After 5 years, the Corps was required to reinitiate formal consultation on the effects of operations of Englebright Dam and Daguerre Point Dam on any species listed at that time.

The reason for the establishment of the 5-year time limit in the 2002 NMFS BO was that several programs and investigative studies (e.g., Daguerre Point Dam Preliminary Fish Passage Improvement Study (Corps 2001), Upper Yuba River Studies Program¹ (DWR 2007)) were underway, which were anticipated to provide new information affecting the Yuba River water management operations and the status of Yuba River fisheries resources (e.g., Chinook salmon and steelhead). In addition, the 2002 NMFS BO stated that recent changes to operational procedures as well as the physical structures associated with Englebright and Daguerre Point dams have provided a level of improvement to the situation for listed salmonids and their critical habitat within the lower Yuba

¹ Since 2008, the CALFED Ecosystem Restoration Program and the Fish Passage Improvement Program have been unable to fund continued work on the Upper Yuba River Studies Program (DWR 2011a).
River, and that additional actions planned for implementation within the next year were expected to further improve conditions for listed salmonids and their critical habitat. NMFS (2002) concluded that it is reasonable to expect that the recent and near-term improvements will at least stabilize population levels if not slightly increase them during the 5-year term of the BO as a result of decreases in the chronic effects of reduced survival of these species under past operations. NMFS (2002) therefore determined that the level of impacts over the 5-year period covered by the BO is unlikely to reduce the population numbers, reproductive success or the distribution of listed salmonids in the Yuba River to the point of reducing these populations' likelihood of survival and recovery. NMFS (2002) also concluded that the proposed action will not diminish the value of designated critical habitat for the survival and recovery of the Central Valley steelhead and spring-run Chinook salmon. The 2002 NMFS BO expired on March 27, 2007.

### 1.2.1.2 2007 Consultation

The Corps’ proposed action that was evaluated during the 2007 Corps BA and the 2007 NMFS BO included the following actions:

**Englebright Dam**

- O&M of Englebright Dam.
- Administration of Outgrant No. DACW05-9-95-604 to PG&E granting access for the Narrows I powerhouse near Englebright Dam. Narrows I is operated and maintained under FERC License No. 1403.
- Administration of Easement No. DACW05-2-75-716 to YCWA granting a right-of-way for the Narrows II powerhouse near Englebright Dam. Narrows II is operated and maintained under FERC License No. 2246.
- Administration of the March 28, 1994 Agreement with PG&E for the operation and maintenance of the Narrows I FERC licensed hydroelectric project. The 1994 Agreement states that the Corps is responsible for maintaining Englebright Dam and the outlet facilities in good order and repair, while PG&E is responsible for the O&M of the FERC licensed hydroelectric facility.
Recreation at Englebright Reservoir was not included in the 2007 Corps BA or the 2007 NMFS BO as part of the proposed action.

**Daguerre Point Dam**

- O&M of Daguerre Point Dam and the North and South fish ladders.
- Administration of License No. DAW05-3-97-549 issued for access to the Hallwood-Cordua diversion in the vicinity of Daguerre Point Dam.

Although License No. DACW05-3-85-537, granting access to the South Yuba/Brophy Diversion Canal and Facilities in the vicinity of Daguerre Point Dam was discussed, it was unclear to what extent, if any, administration of this license was included in the proposed action. Also, although generally identified, specific Corps operations and maintenance activities pertaining to Daguerre Point Dam, including work with CDFW to maintain the two fish ladders at Daguerre Point Dam by clearing debris, were not presented in detail in the proposed action.

The following is a chronology of key events in the ESA consultation history that culminated with the 2007 NMFS BO.

- **April 7, 2006.** NMFS issued a Final Rule to list the Southern DPS of North American green sturgeon (*Acipenser medirostris*) as a threatened species under the ESA.

- **February 28, 2007.** The Corps requested reinitiation of consultation for the species listed in the previous 2002 NMFS BO, and extension of the incidental take statement in the 2002 BO. The Corps also requested an incidental take statement for the Southern DPS of North American green sturgeon until NMFS issued a new BO and incidental take statement.

- **March 23, 2007.** The Corps delivered an initiation package including a cover letter requesting the initiation of formal consultation under Section 7 of the ESA for the proposed action along with a new BA and an Essential Fish Habitat (EFH) assessment for the proposed action to NMFS. Included in the Corps' March 23, 2007 cover letter was a request for the extension of the timeframe covered by the
2002 NMFS BO to maintain coverage for the proposed action until the current consultation could be completed and a final, long-term BO issued.

- **April 27, 2007.** NMFS issued a non-jeopardy BO that analyzed the effects of continuation of operation of the project for a period of up to one year.

- **November 21, 2007.** NMFS issued a non-jeopardy long-term BO (2007 NMFS BO) that analyzed the effects of operations of Englebright Dam and Daguerre Point Dam on threatened Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), the respective designated critical habitats for these salmonid species, as well as the threatened Southern DPS of North American green sturgeon. The long-term BO superseded the April 27, 2007 NMFS BO and was intended to be the final BO for the project.

NMFS (2007) stated that it would be likely that the facilities and operational procedures used in the past, if left uncorrected, would cause continued declines in population viability of these species and in the conservation value of critical habitat. However, NMFS also stated that there had been several recent changes to the facilities (e.g., fish screens at the Hallwood-Cordua diversion) and operational procedures (e.g., flashboard management, regular inspections and maintenance of the fish ladders, sediment management) at Daguerre Point Dam related to the Corp's Yuba River operations which were expected to improve conditions for Yuba River fisheries. Additionally, NMFS (2007) stated that recent salmonid monitoring data, while insufficient to allow detection of definite trends, did not suggest any significant, ongoing decline of salmonid populations or habitat variables in the lower Yuba River.

The 2007 NMFS BO concluded that the level of effects caused by Corps operations would be unlikely to cause a reduction in the population numbers, reproductive success or the distribution of listed fish in the Yuba River to the point of appreciably reducing these populations' likelihood of survival into the future. NMFS also concluded that there were several other actions and programs which were at varying stages of planning and implementation that were intended
to produce significant improvements to the accessibility and quality of the habitat
and viability of the populations of listed species on the Yuba River, and if fully
implemented, would greatly increase the likelihood of significant recovery of
these populations. Thus, the 2007 NMFS BO concluded that it was reasonable to
expect that the Corps’ proposed operations on the Yuba River should at least
maintain, if not slightly improve the value of critical habitat for the conservation
of spring-run Chinook salmon and steelhead above the value that was present
when critical habitat was designated on the Yuba River in 2005.

However, review of the 2007 Corps BA and the 2007 NMFS BO suggests that
effects of the proposed action were confused with effects of the environmental
baseline.

The environmental baseline was accurately defined in the 2007 NMFS BO, based
on the ESA regulations, to include “the past and ongoing human and natural
factors leading to the current status of the species and designated critical habitat
within the action area.” The 2007 NMFS BO explained that the environmental
baseline comprises all past impacts, including the effects of the proposed action
up to the present.

The 2007 NMFS BO further explained that the assessment of “future” effects of
the proposed action, by contrast to environmental baseline effects, should
“include the impacts to listed species and their critical habitat which will continue
to be caused by operations of the projects in the future.” In the view of the Corps,
effects of Englebright and Daguerre Point dams, that were due to the mere
existence of the dams and not a result of the Corps’ proposed action, should have
been part of the environmental baseline and not attributed to the Corps proposed
action. The 2007 NMFS BO did not distinguish between the future effects caused
by the operations and maintenance of Englebright and Daguerre Point dams, and
the future effects caused by the continued presence of the dams.

The 2007 NMFS BO discussion of critical habitat takes a similar approach, and
described effects resulting from the continued presence of both dams in the
analysis of the effects of the proposed action on critical habitat.
The 2007 NMFS BO included the existence of the dams and water diversions as effects of the proposed action. In the Corps’ view, this approach to effects assessment was not consistent with the ESA regulations, ESA guidance, or the environmental baseline approached by NMFS in BOs for other ongoing water projects such as the New Hogan Dam and Lake BO dated December 5, 2002, the FERC Yuba River Development Amendment BO dated November 4, 2005, and the Central Valley Project/State Water Project BO dated June 4, 2009.

The 2007 NMFS BO determined that many future effects solely attributable to the presence of Englebright and Daguerre Point dams also were effects of the proposed action, which was not correct. In summary, the species-specific effects resulting from the presence of Englebright Dam, which the 2007 NMFS BO previously attributed to the Corps’ operation and maintenance of Englebright Dam, should be included in the environmental baseline. Similarly, most of the effects that the 2007 NMFS BO previously attributed to the Corps’ operation and maintenance of Daguerre Point Dam, as well as the associated fish ladders, should be included in the environmental baseline. Only those effects of Corps facilities that the Corps has the authority to change through its discretionary operation and maintenance activities at Englebright and Daguerre Point dams and the fish ladders at Daguerre Point Dam should be included in the effects of the proposed action. For these and other reasons (see below), the Corps voluntarily reinitiated consultation during 2011.

Two environmental groups, South Yuba River Citizen’s League (SYRCL) and Friends of the River (FOR), sued NMFS, the Corps, and YCWA, alleging that NMFS’ BO was arbitrary and capricious and that the Corps’ operations of Englebright and Daguerre Point dams are causing take of protected salmon and steelhead. The *SYRCL v. NMFS* case was filed in the United States District Court, Eastern District of California, Case No. Civ. S-06-2845 LKK/JFM.

On June 16, 2010, the court entered a stipulated settlement order dismissing all the claims and relief sought against YCWA.
On July 8, 2010, the court issued an order, which concluded that NMFS acted arbitrarily and capriciously in reaching the BO’s no-jeopardy and no adverse modification conclusions, and in issuing the incidental take statement. On April 29, 2011, the Court ordered that the 2007 Biological Opinion be remanded to NMFS and a new Biological Opinion be prepared.

On July 26, 2011, the Court granted, in part, Plaintiffs’ Motion for Final Remedies ordering the Corps to take several actions, including: (1) develop a flashboard management plan; (2) conduct weekly inspections of the fish ladders at Daguerre Point Dam and removal of accumulated debris; (3) inspect and manage sediment accumulation in the channel upstream of Daguerre Point Dam after high flow events; and (4) install locking metal grates over the Daguerre Point Dam fish ladders.

On February 29, 2012, the Federal Defendants (NMFS) filed a notice of completion and issued a new Biological Opinion to the Corps. On May 31, 2012, the Court terminated the case.

1.2.1.3 2012 Consultation

The Corps voluntarily reinitiated formal consultation with NMFS on the Corps’ ongoing operation and maintenance of Englebright Dam and Daguerre Point Dam and associated facilities in October 2011 with transmission of a draft BA to NMFS. In January 2012, a final BA (referred to herein as the 2012 BA) was prepared to, among other things, describe the proposed action and analyze the effects of that action on listed species and designated critical habitat.

As discussed in the 2012 BA, the Corps’ responsibilities, as well as its ability to conduct operations- and maintenance-related actions at Englebright Dam and Reservoir and at Daguerre Point Dam, are primarily governed by each of the facilities’ respective authorizations and appropriations. Consequently, the Corps’ actions that were proposed and evaluated in the 2012 BA, which could potentially affect listed fish species in the lower Yuba River, were more clearly defined and limited relative to the previous two consultations. Additionally, review of Corps and NMFS documents previously prepared
in association with the 2002 and 2007 consultation processes suggests that several issues pertaining to the characterization of the Corps’ proposed action and other environmental baseline considerations potentially affecting listed fish species in the action area were inadvertently conflated during the previous two consultation processes.

By contrast to the assessments presented in the 2002 and 2007 consultation documents, a different approach was undertaken for the 2012 BA. Primarily, the analysis provided in the 2012 BA attempted to more clearly distinguish between the potential effects to listed fish species that are attributable to the environmental baseline (see Chapter 6.0 in the 2012 BA), compared to those that are expected to occur as a result of the proposed action (see Chapter 8.0 in the 2012 BA). The 2012 BA also provided information that the United States District Court, Eastern District of California identified as inadequacies in the 2007 NMFS BO.

The July 8, 2010 order of the United States District Court, Eastern District of California, in Case No. Civ. S-06-2845 LKK/JFM, held that the 2007 NMFS BO failed to address five stressors related to the Corps’ proposed action: (1) effects in the action area from the Feather River Fish Hatchery (FRFH); (2) effects in the action area from conditions in the Delta; (3) effects based on the species overall viability; (4) effects in the action area from global warming; and (5) effects in the action area from poaching.

The 2012 BA addressed whether the Corps has authority to reduce the future effects from these potential stressors through its operation and maintenance activities. With the possible exceptions of effects related to poaching, and effects of fish ladder performance that are associated with authorized routine maintenance activities, the Corps determined that it did not have the ability to lessen other stressors associated with the Corps facilities. Therefore, the 2012 BA determined that many of the ongoing and future effects from the identified stressors were associated with the environmental baseline, and not the proposed action.

The 2012 BA attributed species-specific effects resulting from the presence of Englebright Dam, which the 2007 NMFS BO previously attributed to the Corps’ operation and maintenance of Englebright Dam, to the environmental baseline. Also, in the 2012 BA, the anticipated potential direct and indirect effects associated with the
South Yuba/Brophy diversion were considered in the effects assessment for the proposed action, to the extent that the Corps has authority to mitigate these effects through conditions specified in the easement proposed at that time.

Additionally, several changed conditions had occurred since 2007 when the earlier consultation with NMFS was completed, including:

- **March 2008.** The State Water Resources Control Board (SWRCB) approved the petitions to change the water right permits of YCWA that were necessary to implement the Yuba Accord.

- **June 2009.** YCWA entered into Settlement Agreement with Plaintiffs (SYRCL and FOR) in their lawsuit against NMFS et al., which resulted in improvements to the maintenance and operations of the South Yuba/Brophy Diversion Canal and Facilities.

- **June 2009.** NMFS issued its Biological Opinion and Conference Opinion on the Long-term Operations of the Central Valley Project (CVP) and State Water Project (SWP).

- **October 2009.** NMFS issued the Draft Recovery Plan for the ESUs of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon, and the DPS of Central Valley Steelhead.

- **October 2009.** NMFS issued its final rulemaking to designate critical habitat for the threatened Southern DPS of North American green sturgeon.

Because the aforementioned changed conditions have the potential to influence the status of listed fish species and their habitats throughout each species’ respective ESU (Evolutionary Significant Unit) or DPS (Distinct Population Segment), as well as within the action area, each of these changed conditions was considered in the Corp’s 2012 BA, as appropriate.

The following is a chronology of key events in the ESA consultation history that culminated with the 2012 BO.

- **October 9, 2009.** NMFS issued a Final Rule designating critical habitat for the Federally threatened Southern DPS of North American green sturgeon.
June 2, 2010. NMFS issued a Final ESA Section 4(d) Rule establishing take prohibitions for the Federally threatened Southern DPS of North American green sturgeon.

December 17, 2010. The Corps and YCWA met to discuss the proposed ESA consultation approach, components of the proposed action, the environmental baseline, as well as the general content and organizational format of the revised BA.

January 5, 2011. The Corps and YCWA met to discuss components of the proposed action, the environmental baseline and other ESA compliance issues.

February 10, 2011. Coordination meeting between the Corps and NMFS to discuss current activities regarding the status of the terms and conditions of the 2007 BO and updates for the 2012 BA.

March 24, 2011. Coordination meeting between the Corps and NMFS to discuss current activities regarding the status of the terms and conditions of the 2007 BO and updates for the 2012 BA.

April 13, 2011. The Corps and YCWA met to discuss environmental baseline considerations and other effects of YCWA’s facilities associated with Daguerre Point Dam and Englebright Dam, and YCWA’s request for an easement for the South Yuba/Brophy Diversion Canal and Facilities.

April 28, 2011. Coordination meeting between the Corps and NMFS to discuss current activities regarding the status of the terms and conditions of the 2007 BO and updates for the 2012 BA.

May 9, 2011. YCWA submitted a letter to the Corps describing YCWA’s view of the legal requirements for ESA consultation on Englebright Dam and Daguerre Point Dam.

☐ **June 29, 2011.** Coordination meeting between the Corps and NMFS to discuss current activities regarding the status of the terms and conditions of the 2007 BO and updates for the 2012 BA.

☐ **July 28, 2011.** Coordination meeting between the Corps and NMFS to discuss current activities regarding the status of the terms and conditions of the 2007 BO and updates for the 2012 BA.

☐ **August 25, 2011.** Coordination meeting between the Corps and NMFS to discuss current activities regarding the status of the terms and conditions of the 2007 BO, updates for the 2012 BA, and status of the Corps' implementation of the interim measures required by the District Court's July 26, 2011 Order.

☐ **September 22, 2011.** Coordination meeting between the Corps and NMFS to discuss current activities regarding the status of the terms and conditions of the current BO, updates for the 2012 BA, and status of the Corps' implementation of the interim measures required by the District Court's July 26, 2011 Order.

☐ **October 5, 2011.** NMFS wrote a letter to the Corps requesting that the Corps expedite preparation of the draft BA.

☐ **October 17, 2011.** The Corps transmitted to NMFS the draft BA for the U.S. Army Corps of Engineers' Ongoing Operation and Maintenance of Englebright Dam and Reservoir and Daguerre Point Dam on the lower Yuba River.

☐ **October 27, 2011.** Coordination meeting between the Corps and NMFS to discuss current activities regarding the status of the Corps’ compliance with the terms and conditions of the 2007 BO incidental take statement and issues related to completion of the 2012 BO.

☐ **December 2, 2011.** NMFS sent a letter to the Corps identifying what NMFS believed to be deficiencies in the Corps draft BA.

☐ **January 10, 2012.** NMFS provided the Corps draft versions of the "action area" and "project description" portions of the 2012 BO for review and comment.

☐ **January 12, 2012.** Coordination meeting between the Corps and NMFS to discuss issues related to completion of the 2012 BO.
January 19, 2012. The Corps provided comments to NMFS on the draft versions of the "action area" and "project description" portions of the 2012 BO.

January 27, 2012. A meeting was held among the Corps, YCWA and NMFS regarding the ESA consultation for the Corps' operations on the lower Yuba River.

January 27, 2012. The Corps responds to NMFS’s December 2, 2011 letter and requests initiation of formal consultation on the proposed action. As part of the consultation request, the Corps submits the final 2012 BA to NMFS.

February 1, 2012. NMFS provides the Corps with draft Reasonable and Prudent Alternative (RPA) options for review and comment.

February 2, 2012. NMFS and the Corps meet to discuss Corps comments on NMFS draft project description for the BO.

February 8, 2012. YCWA submits comments to NMFS on the Corps’ final BA, requests a copy of the draft BO. YCWA also requests that the Corps ask that NMFS modify the present consultation schedule to allow sufficient time for YCWA to meaningfully participate in the consultation as well as review and offer comments on the draft BO.

February 27, 2012. NMFS provides a draft BO to the Corps and YCWA, and allows a 24-hour period for review and comment on the draft BO.

February 28, 2012. The Corps submits comments to NMFS on the draft BO.

February 28, 2012. YCWA submits comments to NMFS on the draft BO.

February 29, 2012. NMFS issued its Final BO (2012 BO) regarding the effects of Englebright Dam and Daguerre Point Dam on the Yuba River in Yuba and Nevada Counties, California on threatened Central Valley spring-run Chinook salmon (Oncorhynchus tshawytscha), threatened Central Valley steelhead (O. mykiss), the threatened Southern distinct population segment of North American green sturgeon (Acipenser medirostris), and their designated critical habitat in accordance with Section 7(a)(2) of the ESA of 1973, as amended (16 U.S.C. 1531 et seq.).
The February 29, 2012 Final BO concluded that the operation and maintenance of these two dams would likely jeopardize the continued existence of spring-run Chinook salmon, steelhead, and green sturgeon, and result in the adverse modification of critical habitat for each of these species. The BO includes an RPA that modified the proposed action to avoid jeopardizing the species and adversely modifying their critical habitat. The RPA was divided into eight categories containing almost 60 specific actions to be implemented by the Corps (NMFS 2012).

The 2012 NMFS BO provided a summary of the authorities NMFS believed would allow the Corps to implement the various measures described in the 2012 NMFS BO RPA. However, in many instances, the 2012 NMFS BO failed to acknowledge or mention the significant constraints associated with the cited authorities that might have precluded immediate action by the Corps. See Appendix A for a discussion/explanation of the Corps’ Authorities.

### 1.2.1.4 2013 Consultation

On July 3, 2012 the Corps transmitted a letter to NMFS memorializing the Corps’ concerns regarding the 2012 BO. The Corps’ concerns regarding the 2012 BO were related to the description of the proposed action and action area, NMFS' approach to baseline effects, the scientific basis for the analysis and conclusions, the scope and breadth of the RPA and the Reasonable and Prudent Measures (RPMs) associated with the incidental take statement, and the limitations of the Corps’ authorities (Corps 2012b). This letter is attached as Appendix B.

On February 26, 2013, the Corps notified NMFS of its intent to reinitiate consultation with NMFS to address the impacts of the Corps’ discretionary activities on Central Valley spring-run Chinook salmon, Central Valley steelhead, North American green sturgeon and their associated critical habitats. The Corps’ February 26, 2013 letter stated that reinitiation of consultation is appropriate when "...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," as well as when "...the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion." 50 CFR §402.16(b)-(c). The Corps’ letter further
stated that reinitiation of consultation is appropriate in order for the Corps to provide NMFS with additional information and clarification on subjects that include the following:

1. The scope of the Corps' authorities and discretion, for purposes both of appropriately defining the proposed action and ensuring that any RPMs or RPA are "within the scope of the [Corps'] legal authority and jurisdiction." See 50 C.F.R. §402.02.

2. The scope of the action area and the determination of which other activities are interrelated and interdependent with the proposed action.

3. Additional information regarding the nature of the Corps' proposed activities at Englebright and Daguerre Point dams.

4. Scientific and technical information regarding the listed species and the effects of the proposed action on them.

The Corps' stated that it would prepare a revised BA to support the reinitiation of consultation. The following is a chronology of key events leading up to, and contributing to the consultation history for the 2013 ESA consultation process.

- **March 14, 2012.** Meeting to discuss the February 29, 2012 Final BO with NMFS, the Corps, YCWA and Pacific Gas and Electric Company (PG&E).

- **May 29, 2012.** Clarification Workshop No. 1 regarding the February 29, 2012 Final BO with NMFS, the Corps, YCWA and PG&E.

- **June 22, 2012.** The Corps and NMFS meet to discuss the content and conclusions presented in the February 29, 2012 Final BO.

- **June 25, 2012.** The Corps submits technical comments to NMFS on the February 29, 1012 Final BO.

- **June 29, 2012.** YCWA submits comments and requested clarifications to NMFS on the February 29, 2012 Final BO.

- **July 3, 2012.** The Corps sends a letter to NMFS acknowledging receipt of the February 29, 2012 Final BO. Although the Corps conditionally accepted the RPA
described in the Final BO, the Corps expressed serious concerns about various aspects of the BO that need to be resolved.

- **July 12, 2012.** PG&E submits comments to NMFS on the February 29, 2012 Final BO.
- **July 19, 2012.** Clarification Workshop No. 2 regarding the February 29, 2012 Final BO with NMFS, the Corps, YCWA and PG&E.
- **September 11, 2012.** Coordination meeting between the Corps and NMFS to discuss the status of revising the BA and reinitiating consultation.
- **September 19, 2012.** Clarification Workshop No. 3 regarding the February 29, 2012 Final BO with NMFS, the Corps, YCWA and PG&E.
- **September 25, 2012.** YCWA submits a letter to NMFS regarding the Yuba River BO clarification process and the status of NMFS’s responses to comments submitted by the Corps, YCWA and PG&E.
- **October 4, 2012.** Corps submits a letter to NMFS requesting schedule adjustments pertaining to the implementation of certain actions of the RPA described in the February 29, 2012 Final BO.
- **October 30, 2012.** Yuba River BO Technical Meeting No. 1 with representatives from NMFS, the Corps, YCWA and PG&E.
- **November 16, 2012.** Yuba River BO Technical Meeting No. 2 with representatives from NMFS, the Corps, YCWA and PG&E.
- **November 27, 2012.** NMFS responds to the Corps’ October 4, 2012 letter regarding implementation of certain RPA actions, and recognizes that several of measures in the RPA contain deadlines that cannot be met for practical reasons, such as a lack of appropriations, the length of time required to comply with the National Environmental Policy Act (NEPA), and other implementation challenges. The NMFS letter also extends the required implementation dates of several of the measures in the RPA.
November 29, 2012. Yuba River BO Technical Meeting No. 3 was held among representatives from NMFS, the Corps, YCWA and PG&E.

December 11, 2012. Yuba River BO Technical Meeting No. 4 was cancelled per NMFS’s request.

January 24, 2013. Yuba River BO Technical Meeting No. 5 was cancelled per NMFS’s request.

February 26, 2013. The Corps submits a request to NMFS advising of the Corps’ intent to reinitiate consultation for the Corps’ discretionary activities on the Yuba River.

April 11, 2013. NMFS responds to the Corps February 26, 2013 request for reinitiation of consultation under Section 7 of the ESA (16 U.S.C. 1536(a) and the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-541). To meet the requirements of CFR 402.14(c) to initiate formal consultation, and 50 CFR 402.14(d) to provide the best scientific and commercial data available, NMFS recommended that the Corps develop an updated BA to evaluate the potential effects of the action on listed species and designated critical habitat, pursuant to 50 CFR 402.12.

April 17, 2013. YCWA submits a letter to the Corps requesting non-Federal applicant status due to its pending June 28, 2011 application for a new easement related to operation and maintenance of the South Yuba/Brophy Diversion Canal and Facilities.

July 18, 2013. The Corps and NMFS meet to discuss the characterization of the Proposed Action, the Action Area, the Environmental Baseline and the project schedule.

July 25, 2013. The Corps, NMFS and YCWA meet to discuss YCWA’s applicant status regarding the South Yuba/Brophy Diversion Canal and Facilities.

August 30, 2013. The Corps and NMFS meet to discuss comments on the draft status of the species chapter and the draft effects assessment methodology chapter of the Corps’ BA.
September 26, 2013. The Corps and NMFS meet to discuss the scope of the Corps’ authorities, as well as non-discretionary actions and discretionary actions within the scope of those authorities.

1.3 Deconstruction of Corps Activities

NMFS uses a series of sequential analyses to assess the effects of Federal actions on endangered and threatened species and designated critical habitat (NMFS 2009a). According to the document titled An Assessment Framework for Conducting Jeopardy Analyses Under Section 7 of the Endangered Species Act (NMFS 2004c), one of the early steps in NMFS evaluation process is to “deconstruct” the Proposed Action into its constituent parts. As part of the 2013 consultation between the Corps and NMFS, it was agreed that this BA would undertake a “deconstruction” process to more clearly define the Proposed Action, and distinguish the Proposed Action from other Corps’ activities in the Yuba River Basin, to assist NMFS in its jeopardy analysis.

Given the suite of Corps activities in the Yuba River Basin and perplexity associated with the previous consultations, the "deconstruction" step in this BA clearly distinguishes between discretionary actions that may affect listed species and their critical habitat in the lower Yuba River and: (1) future actions requiring separate ESA consultation; (2) non-discretionary actions; (3) discretionary actions with no effect; and (4) Englebright Dam and Reservoir discretionary actions that are not likely to adversely affect listed species (Figure 1-1). Appropriately, this BA does not include consultation on future actions requiring separate ESA consultation and non-discretionary actions. Also, the Corps is not required to consult with NMFS on actions that have no effect on listed species and critical habitat. Englebright Dam and Reservoir discretionary actions that are not likely to adversely affect listed species or critical habitat concludes with informal consultation, and are addressed in a separate ESA consultation. Discretionary actions in the lower Yuba River that are likely to adversely affect listed species or critical habitat are carried forward for formal consultation in this BA. Each of these categories of actions in the Yuba River Basin is described below.
Figure 1-1. Deconstruction of the Corps' lower Yuba River activities and the Proposed Action (i.e., discretionary actions that may affect listed species).
1.3.1 Corps Non-Discretionary Activities Not Subject to ESA Consultation

One of the key considerations emanating from the 2012 consultation process was the need for clear distinctions between Corps discretionary and non-discretionary actions regarding Englebright and Daguerre Point dams. As stated in 50 CFR §402.03, “Section 7 and the requirements of this part apply to all actions in which there is discretionary Federal involvement or control”. Therefore, non-discretionary activities at Englebright and Daguerre Point dams are not subject to ESA consultation.

The responsibility to maintain Civil Works structures so that they continue to serve their Congressionally authorized purposes is inherent in the authority to construct them and is therefore non-discretionary. Only Congressional actions to de-authorize the structures can alter or terminate this responsibility and thereby allow the maintenance of the structures to cease. Congress authorized Englebright and Daguerre Point dams on the Yuba River to prevent hydraulic mining debris from washing downstream and blocking the navigation channel of the Sacramento River. The Corps inspects Englebright and Daguerre Point dams to ensure their safety and integrity, and to take the minimal maintenance actions needed to ensure that the dams can continue to serve their Congressionally authorized purposes. Corps non-discretionary activities and associated authorities pertinent to Englebright and Daguerre Point dams on the lower Yuba River are described below.

1.3.1.1 Background Regarding Corps’ Authorities Related to Dam Inspections and Hydropower Facilities on Federal Lands

NATIONAL DAM INSPECTION ACT OF 1972

In the early 1970s, several dam failure events prompted the passage of legislation aimed at establishing a national program to protect human life and property from the hazards of improperly constructed or poorly maintained dams (GAO 1977). Consequently, the U. S. Congress enacted Public Law 92-367, which is known as the National Dam Inspection Act of 1972. Under this law, the Secretary of the Army, acting through the Corps of
Engineers, was directed to inspect all dams in the United States except: (1) dams under
the jurisdiction of the Bureau of Reclamation, the Tennessee Valley Authority, and the
International Boundary and Water Commission; (2) dams constructed pursuant to
licenses issued under the authority of the Federal Power Act; (3) dams that had been
inspected by a State agency within the 12-month period immediately preceding the
enactment of the law and for which the Governor of the respective State requested
exclusion; and (4) dams that the Secretary of the Army determined do not pose any threat
to human life and property (GAO 1977).

Public Law 92-367 defined the term “dam” to mean any artificial barrier, including
appurtenant works, which impounds or diverts water, and which: (1) is twenty-five feet
or more in height from the natural base of the stream or watercourse measured at the
downstream toe of the barrier, or from the lowest elevation of the outside limit of the
barrier, if it is not across a stream channel or watercourse, to the maximum water storage
elevation; or (2) has an impounding capacity at maximum water storage elevation of fifty
acre-feet (AF) or more.

For the purpose of determining whether a dam (including the waters impounded by such
dam) constitutes a danger to human life or property, the law states that the Secretary of
the Army shall take into consideration the possibility that the dam might be endangered
by overtopping, seepage, settlement, erosion, sediment, cracking, earth movement,
earthquakes, failure of bulkheads, flashboard, gates on conduits, or other conditions
which exist or which might occur in any area in the vicinity of the dam (Public Law
92-367).

The law also states that as soon as practicable after inspection of a dam, the Secretary of
the Army shall notify the Governor of the State in which such dam is located the results
of such investigation. The Secretary of the Army shall immediately notify the Governor
of any hazardous conditions found during an inspection. The Secretary of the Army shall
provide advice to the Governor, upon request, relating to timely remedial measures
necessary to mitigate or obviate any hazardous conditions found during an inspection
(Public Law 92-367).
The National Dam Safety Program Act was signed into law on October 12, 1996 as part of the Water Resources Development Act of 1996 (PL 104-303) and authorized the Secretary of the Army to undertake a national program of inspection of dams.

The objectives of the National Dam Safety Program (Program) are to: (1) ensure that new and existing dams are safe through the development of technologically and economically feasible programs and procedures for national dam safety hazard reduction; (2) encourage acceptable engineering policies and procedures to be used for dam site investigation, design, construction, operation and maintenance, and emergency preparedness; (3) encourage the establishment and implementation of effective dam safety programs in each State based on State standards. The Federal element of the Program shall incorporate the activities and practices carried out by Federal agencies under Section 7 of the Act to implement the Federal Guidelines for Dam Safety.

Public Law 109–460 (December 22, 2006; 109th Congress) amended the National Dam Safety Program Act to reauthorize the National Dam Safety Program. Section 6 of Public Law 109–460 states “The Secretary of the Army shall maintain and update information on the inventory of dams in the United States. Such inventory of dams shall include any available information assessing each dam based on inspections completed by either a Federal agency or a State dam safety agency.”

The Corps continues to implement its dam safety program under Engineer Regulation (ER) 1110-2-1156.

1.3.1.2 Englebright Dam Non-Discretionary Activities

Englebright Dam and Reservoir are located downstream of New Bullards Bar Dam on the Yuba River and is part of the Sacramento River and Tributaries project, which was authorized by the Rivers and Harbors Act of August 30, 1935 (P. L. 409, 74th Congress, 1st Session, 49 Stat. p. 1028-1049). The Sacramento River and Tributaries project was constructed by the California Debris Commission in 1941. The Rivers and Harbors Act of 1935 also authorized the development of power at Englebright Dam.
Englebright Dam is 260 feet high, and the storage capacity of Englebright Reservoir was 69,700 AF at the time of construction, as estimated by the U.S. Geological Survey (USGS) using a pre-dam elevation model (Childs et al. 2003 as cited in YCWA 2010). However, due to sediment buildup since construction, the gross storage capacity was more recently estimated at approximately 50,000 AF (USGS 2003).

Upon decommissioning of the California Debris Commission by Section 1106 of the 1986 Water Resources Development Act (P. L. 99-662, 99th Congress, 2nd Session, November 7, 1986), administration of Englebright Dam was assumed by the Corps. Because Englebright Dam was constructed as a sediment retention facility (debris dam) it does not contain a low-level outlet. Unregulated flood flows spill over Englebright Dam. Following construction of Englebright Dam in 1941 and extending until approximately 1970, controlled flow releases from Englebright Dam were made through the PG&E Narrows I hydropower facilities. Since about 1970 to the present, controlled flow releases from Englebright Reservoir into the lower Yuba River have been made from the PG&E Narrows I and the YCWA Narrows II power plants, both FERC licensed facilities.

The Corps’ ongoing activities of Englebright Dam infrastructure pertain to dam maintenance, safety and security. The Corps does not have authority or discretion to control Narrows I, Narrows II, or Englebright Reservoir operations regarding water releases. The water stored in Englebright Reservoir provides recreation and hydroelectric power, and YCWA and PG&E administer water releases for hydroelectric power, irrigation, and other beneficial uses (e.g., instream flow requirements).

**ONGOING INFRASTRUCTURE INSPECTION AND SECURITY AT ENGLEBRIGHT DAM**

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

**DAM INSPECTION**

The Corps’ general responsibilities and activities associated with dam maintenance and safety, which are applicable to Englebright Dam, are described in the document titled USACE - Engineering and Design Safety of Dams – Policy and Procedure ER 1110-2-1156 Regulation No. 1110-2-1156 (Corps 2003). The Corps conducts two different types...
of regular inspections: (1) annual pre-flood inspections; and (2) periodic inspections
every 5 years. These inspections are conducted to address the legal requirement that the
Corps shall maintain in good order and repair Englebright Dam and outlet facilities in
accordance with its authorized purposes.

The purpose of the Corps’ periodic inspections is to evaluate the condition of the critical
components of Englebright Dam in order to assure the safety, continuing structural
integrity, and operational adequacy of the structure (Corps 2004). Periodic inspections
conducted from 1970 to date include the inspections described in the following reports.

- Periodic Inspection and Continuing Evaluation Report No. 1, November 1970
- Periodic Inspection and Continuing Evaluation Report No. 2, December 1975
- Periodic Inspection and Continuing Evaluation Report No. 3, June 1981
- Periodic Inspection and Continuing Evaluation Report No. 4, March 1985
- Periodic Inspection and Continuing Evaluation Report No. 5, August 1987
- Periodic Inspection and Continuing Evaluation Report No. 6, December 1993
- Periodic Inspection and Continuing Evaluation Report No. 7, July 1999
- Periodic Inspection and Continuing Evaluation Report No. 8, June 2004

The Corps also conducts Pre-flood Inspections for Englebright Dam. A report of the
most recent of these inspections was published in 2012.

At the onset of each inspection, Englebright Reservoir water surface elevation and the
maximum pool elevation attained during the season, as well as mean total outflow,
weather conditions and air temperature, are recorded. Based upon Corps observations
and information provided from past inspections (Corps 2004; Corps 2008a; Corps 2012),
examples of the Englebright Dam facilities and appurtenant features addressed as part of
the Pre-flood Inspection process generally include the following:

**Crest**

- Overflow and non-overflow sections of the crest are checked for signs of distress,
surface delamination, concrete deterioration and movement of the training wall.
The downstream face of the dam is inspected for signs of cracking, seepage, and other structural problems that could affect the structural integrity of the dam.

Upstream and downstream areas of the left and right abutments are checked for notable movement, instability, seepage and debris.

Corps gatehouse interior and gate chamber, and the bulkhead gate are inspected for signs of concrete deterioration, distress, and misalignment.

The adit portal, including internal and external examination of the concrete bulkhead wall, the projecting conduit and the riveted dished head closure of the projecting conduit are inspected for possible structural or corrosion problems.

The reservoir rim is inspected from a Corps patrol boat.

New and/or previously identified relief landslides are located, photographed, compared to aerial photos and occasionally identified for further monitoring to determine whether a landslide has the potential to present a hazard to the dam from slope-failure induced seiches or to affect nearby roadways.

**Hydropower Facilities**

The PG&E Narrows I Hydropower Project intake structure, trash rack, and the first 700 feet of the conduit are regularly inspected on a 5-year cycle by the Corps. The Corps’ inspections are limited to: (1) the Narrows I intake structure; (2) the trash rack; and (3) the first 700 feet of the conduit because these three components are owned and maintained by the Corps. These three components extend to the structure known as the “adit”. The remaining portion of the conduit, extending from the adit to the Narrows I power plant, including all appurtenances in the plant, is owned and maintained by PG&E. PG&E conducts separate inspections of its Narrows I facility for hydropower purposes.

Because the Narrows II penstock extends through the abutment of the dam, the Corps also inspects the YCWA Narrows II hydropower penstock on a 5-year cycle to ensure that the penstock is in good condition and will not threaten the
stability and safety of Englebright Dam. YCWA conducts separate inspections of its Narrows II facility for hydropower purposes.

**Plunge Pool**

- A visual inspection of the plunge pool and downstream overflow sections at Englebright Dam are conducted periodically. It was recommended that the Corps map the plunge pool area (Corps 2008a), which will be accomplished after receiving appropriations by Congress.

Based on the above criteria, the overall condition of Englebright Dam was rated as **Very Good** during the Corps’ 2012 Pre-flood Inspections.

**Project Safety Plan and Hazard Communication Program**

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

If a need for maintenance repairs or other corrective actions is identified during the inspection process, authorization and funding to conduct the repairs or corrective actions will be included in the Corps’ budget two years later.

**DAM SECURITY**

The baseline security posture for Corps dams will be based on the completion of project specific Vulnerability and Risk Assessments which take into account project criticality, threat (criminal or terrorist), current physical security posture, and law enforcement
response capabilities. Once established, the baseline security posture will become the norm (Corps 1992).

All dams will have project-specific Physical Security Plans. The format for these plans should follow the format detailed in Appendix F of the USACE Engineering and Design Safety of Dams – Policy and Procedure ER 1110-2-1156 Regulation No. 1110-2-1156 (Corps 2003).

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

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

These Corps dam safety and security activities are Federally mandated actions, and are not subject to ESA consultation. Activities conducted as part of the Corps’ regular inspections of infrastructure maintenance at Englebright Dam are restricted to the physical facilities at Englebright Dam and do not extend downstream to the lower Yuba River. Additionally, the continuation of these activities will have no effect on listed fish species or critical habitat in the lower Yuba River.

1.3.1.3 Daguerre Point Dam Non-Discretionary Activities

ONGOING INFRASTRUCTURE INSPECTION AND SECURITY AT DAGUERRE POINT DAM

Ongoing infrastructure inspections at Daguerre Point Dam include dam safety and dam security inspections. Specific inspection activities at Daguerre Point Dam are specified in the Corps’ O&M Manual, Yuba River Debris Control Project” (Corps 1966), which is
used in conjunction with Corps’ Engineering Manuals EM 1130-2-203 - Project

**INSPECTION AND MAINTENANCE**

The Daguerre Point Dam O&M Manual states that periodic inspections shall be made as
required, to determine maintenance measures necessary to insure serviceability of the
facility during flood conditions. Such inspections shall be made immediately prior to the
beginning of the flood season, and immediately after each high water period. Immediate
steps shall be taken to correct dangerous conditions observed during such inspections,
and regular maintenance repair measures shall be accomplished during the appropriate
season as determined by the Corps. The ongoing non-discretionary inspection and
maintenance activities address the following.

**DAGUERRE POINT DAM STRUCTURE**

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

- Cracks or settlement of concrete structures.
- Misuse of structures, such as burning of debris in them.
- Condition of the stop logs, stop gates and guides.
- Corrective action taken since the last inspection.

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

These Corps safety and security activities at Daguerre Point Dam are Federally mandated actions, and are not subject to ESA consultation.

1.3.2 Corps’ Discretionary Activities that have No Effects to Listed Species or Critical Habitat

Another key consideration emanating from the 2012 consultation process was the need to clearly identify Corps discretionary actions that have no effects to listed species or critical habitat. The Action Area for this consultation (see Chapter 3) is determined considering the extent of the direct and indirect effects of the Proposed Action. The Action Area is defined as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action” (50 CFR § 402.02).

The Corps conducts discretionary activities upstream of the Action Area. These activities are conducted in locations that are not occupied by any of the listed species addressed in this BA, and are not designated as critical habitats. Although these discretionary Corps activities occur upstream of the Action Area, they are evaluated to demonstrate that they do not have the potential to transmit effects downstream to the lower Yuba River.
These discretionary activities upstream of the Action Area are those associated with maintenance of recreational facilities and continued administration of maintenance service contracts on and around Englebright Reservoir, and continued administration of outgrants at or near Englebright Dam. The Corps is not required to consult with NMFS on actions that have no effect on listed species and critical habitat (USFWS 2013; USFWS and NMFS 1998). For clarification, these discretionary activities that have no effects to listed species or critical habitat are described below.

### 1.3.2.1 Englebright Dam and Reservoir Discretionary Activities

**ONGOING MAINTENANCE OF RECREATIONAL FACILITIES ON AND AROUND ENGLEBRIGHT RESERVOIR**

Recreation-related operations and maintenance activities on and around Englebright Reservoir, as identified and described in the 2007 Harry L. Englebright Lake Operational Management Plan (Corps 2007) are discretionary actions. The types of discretionary ongoing activities described in the 2007 Harry L. Englebright Lake Operational Management Plan (Corps 2007) include:

- Maintenance Facilities Upkeep
- Grounds Maintenance
- Sign and Waterway Marker Maintenance
- Roads and Parking Area Maintenance
- Narrows Day Use Facility Improvements
- Maintenance of Recreation Area Buildings
- Wastewater Monitoring Plan Implementation
- Campground Repairs and Renovations
- Park Office Facility Upkeep
- Campground Fire Break Clearing

Along the 24 miles of Englebright Reservoir’s shoreline, the Corps has developed facilities including: (1) 96 campsites; (2) 9 picnic sites; (3) 1 group picnic shelter with 4 tables; (4) 2 boat launching ramps (Narrows and Joe Miller Ravine) maintained by the Corps; (5) a private marina operated by a concessionaire; and (6) 5 parking lots
containing a total of 163 parking spaces. During the May 1 to September 30 recreation season, daily maintenance/safety inspections are conducted in all developed recreation areas. Facilities receiving consistent use and open to the public outside this time frame are also inspected daily (Corps 2007). The Corps also inspects these recreation facilities during the October 1 to April 30 off-season to determine whether it needs to make repairs or rehabilitate campsites during this period.

The 800-acre Englebright Reservoir attracts large numbers boaters and campers during the summer months and has an excellent year-round trout fishery\(^2\) (Corps 2007). Even though there are ten other reservoirs within a 50-mile radius, the boat-in-only style of camping and the scenic steep canyons make it a popular destination. Unlike most area reservoirs that are affected by summer draw-downs, Englebright Reservoir water surface levels remain fairly constant throughout the year. This results in an influx of park users during the late summer months, especially during drought years (Corps 2007).

The Narrows and Joe Miller Recreation Areas are the primary visitor access points to the lake. Both have launch ramps, restrooms, and parking areas, but only Narrows has a picnic area with individual tables and a reservable group shelter. Privately-owned Skipper’s Cove Marina is situated adjacent to these areas, and provides mooring to hundreds of houseboats and pleasure craft at its facility (Corps 2007).

\(^2\) Englebright Reservoir is currently managed as a cold water and warm water fishery under the direction of CDFW, and the fish stocking program at Englebright Reservoir is conducted and directed by CDFW, or by PG&E in coordination with CDFW. The Corps does not conduct or direct fish stocking at Englebright Reservoir.
CONTINUED ADMINISTRATION OF MAINTENANCE SERVICE CONTRACTS AT ENGLEBRIGHT DAM AND RESERVOIR

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

- Garbage Pickup
- Water Quality Testing
- Janitorial Service

CONTINUED ADMINISTRATION OF OUTGRANTS DESCRIBED IN THE 2007 HARRY L. ENGLEBRIGHT LAKE MANAGEMENT PLAN

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

- Road Right-of-Way Easement to YCWA for Narrows II
- Power Transmission Line Easement to PG&E for Narrows I
- Easements for Use of Power Generation Facilities to YCWA and PG&E

For the purposes of this BA, the “administration of existing permits, licenses, leases and easements” is defined as the activities related to the safety and inspection of facilities by the Corps.

ASSESSMENT OF THE CORPS’ DISCRETIONARY ACTIVITIES AT AND AROUND ENGLEBRIGHT DAM AND RESERVOIR THAT HAVE NO EFFECTS TO LISTED SPECIES OR CRITICAL HABITAT

The proposed action evaluated in the Corps’ 2012 BA included the Corps’ discretionary activities associated with Englebright Dam and Reservoir. However, further review of the effects analysis presented in the Corps 2012 BA indicates that several discretionary activities have no effect on listed fish species or critical habitat in the lower Yuba River. Consequently, these activities are not carried forward for Section 7 consultation because
they have no effects on the listed species. Each of these activities is further
discussed below.

ONGOING MAINTENANCE OF RECREATIONAL FACILITIES ON AND AROUND ENGLEBRIGHT RESERVOIR

Recreation-related operations and maintenance activities conducted by the Corps on and
around Englebright Reservoir are restricted to the 800-acre Englebright Reservoir, the 24
miles of Englebright Reservoir shoreline, and various upland campsite areas in the
vicinity of the reservoir.

Project maintenance is accomplished by using service contracts, maintenance staff and
ranger staff in a variety of ways, including: (1) service contract specifications; (2)
scheduled inspections of facilities, equipment, grounds, and resources; (3) specific job
assignments to park staff; (4) specific assignments to park staff for inspection of
contractor performance and maintenance/safety inspections; and (5) general project
inspections by all employees during the course of daily activities. Work areas are
cleaned at the end of each workday, with tools and materials put in their proper place.
Clean, safe, and properly stored and maintained tools represent an important step toward
efficient maintenance facilities.

During the May 1 to September 30 recreation season each year, daily maintenance/safety
inspections are conducted by the Corps in all developed recreation areas around
Englebright Reservoir. Facilities are cleaned, serviced, repaired, or replaced as
applicable in order to maintain them in proper working condition. Facilities receiving
consistent use and open to the public outside this time frame also are inspected daily.

Corps maintenance staff are responsible for miscellaneous repairs to existing roadways.
Potholes, depressions and sub-grade failures to pavements are repaired promptly. With
the recent addition of the computerized road inventory program at Englebright Reservoir,
all roadways are inspected annually and minor repairs made and major overlay needs
reported.

Campground repairs and renovations are periodically needed at the campsites around
Englebright Reservoir. Common types of improvements include site leveling and pad
enlargement, tie replacement, table and fire ring replacement, installing stairs, trail
improvement, tree removal, and bulletin board replacement. Occasionally, campground
fire breaks also need to be cleared of trees and vegetation.

With respect to grounds maintenance, most areas are mowed to minimize and prevent fire
danger in and around recreation areas. Day use areas are also mowed and trimmed for
visitor use and aesthetics. The Corps conducts periodic inspections of turf areas during
the recreation season and maintenance is scheduled as needed for repair of holes, ruts,
depressions, erosion, bare areas, overuse, weeds, disease, debris, and litter.

The Corps also conducts a project sign inventory each fall to determine signage needs for
the following year. All signs are inspected for damage, vandalism, deterioration, fading,
placement, secure fastening, and appropriateness. Repairs and replacements are made as
necessary.

The foregoing activities are primarily conducted in upland areas around Englebright
Reservoir and have limited or no potentiality to affect aquatic habitat in the reservoir.
These maintenance activities do not have the potential to transmit physical habitat
alteration effects downstream to the lower Yuba River. Listed fish species do not inhabit
Englebright Reservoir and there is no fisheries-related critical habitat designated in or
around the reservoir. The continuation of the Corps’ ongoing maintenance of
recreational facilities on and around Englebright Reservoir will have no effect on listed
fish species or critical habitat in the lower Yuba River. Consequently, these activities are
not carried forward for Section 7 consultation because they have no effects on the listed
species.

CONTINUED ADMINISTRATION OF MAINTENANCE SERVICE CONTRACTS AT ENGLEBRIGHT DAM AND
RESERVOIR

The Corps’ discretionary activities include administration of the following maintenance
service contracts at Englebright Reservoir: (1) garbage pickup; (2) janitorial service; and
(3) water quality testing. Maintenance activities associated with these contracts would
occur at and around Englebright Reservoir and at various upland campsite areas in the
vicinity of the reservoir.
The administration of these maintenance service contracts constitutes ministerial actions, and not activities that have the potential to affect listed species or their critical habitats in the lower Yuba River. Any potential effects associated with the conduct of these activities would be locally constrained, and would not extend to the lower Yuba River. These maintenance activities are primarily conducted in upland areas around Englebright Reservoir and have limited or no potentiality to affect aquatic habitat in the reservoir. These maintenance activities do not have the potential to transmit physical habitat alteration effects downstream to the lower Yuba River. The Corps’ continuation of the maintenance of service contracts at and around Englebright Reservoir would have no effect on listed fish species or critical habitat in the lower Yuba River. Consequently, these activities are not carried forward for Section 7 consultation because they have no effects on the listed species.

**CONTINUED ADMINISTRATION OF OUTGRANTS DESCRIBED IN THE 2007 HARRY L. ENGLEBRIGHT LAKE MANAGEMENT PLAN**

The Corps’ discretionary activities include the continued administration of permits, licenses, leases, and easements related to the Corps’ outgrants for project lands used to maintain public utilities and right-of-way purposes. Outgrants have been issued to various entities, examples of which include: (1) road right-of-way permits and easements; (2) telephone line license; (3) power transmission line easements; and (4) concessionaire lease at the Englebright Dam marina.

The Corps conducts annual compliance inspections on outgranted lands, including lands outgranted for commercial concessions. Major purposes of the inspections are to establish a good liaison with outgrantee, to provide assistance to outgrantee handling problems and planning, and to ascertain outgrantee compliance with terms of the outgrant (Corps 2007). These inspections constitute administrative actions, and not activities that have the potential to affect listed species or their critical habitats in the lower Yuba River. Moreover, inspection activities conducted by the Corps are restricted to locations that do not extend to the lower Yuba River. Therefore, the Corps’ continued administration of permits, licenses, leases, and easements is anticipated to have no effect on listed fish species or critical habitat in the lower Yuba River. Consequently, these activities are not
carried forward for Section 7 consultation because they have no effects on the listed species.

1.3.3 Corps’ Discretionary Activities at and around Englebright Dam and Reservoir that May Affect but are Not Likely to Adversely Affect Listed Species or Critical Habitat

The proposed action evaluated in the Corps’ 2012 BA included the Corps’ discretionary activities associated with Englebright Dam and Reservoir. However, further review of Corps' authorizations and the effects analysis presented in the Corps 2012 BA indicates that the discretionary activities at Englebright Dam and Reservoir identified below may affect, but are not likely to adversely affect listed species or critical habitat in the lower Yuba River. The “may affect, but is not likely to adversely affect” conclusion is appropriate when effects to the species or critical habitat are expected to be beneficial, discountable, or insignificant. The Corps has prepared a separate BA for their discretionary activities at and around Englebright Dam and Reservoir. In that BA, the Corps has determined that their activities are not likely to adversely affect listed species or critical habitat. If NMFS agrees with that determination, informal consultation on these activities can be concluded with a concurrence letter. For clarification purposes, each of these activities are briefly discussed below.

The Corps conducts discretionary actions at and around Englebright Dam and Reservoir that have a remote possibility of transmitting contaminants downstream to the lower Yuba River. The types of discretionary ongoing activities described in the 2007 Harry L. Englebright Lake Operational Management Plan (Corps 2007) with the potential to transmit contaminants downstream include:

- Vehicle, Equipment and Vessel Maintenance
- Boat Ramps and Courtesy Docks Maintenance
- Herbicide and Pesticide Application
Additionally, nine separate buoy lines are located on the lake surface at Englebright Reservoir. Maintenance and repair of these waterway markers are performed by the Corps, as needed.

The Corps engages in some activities associated with herbicide and pesticide application, and also administers contracts for application. Thus, potential effects associated with herbicide and pesticide application are briefly summarized below in the next section titled “Continued Administration of Maintenance Service Contracts at Englebright Dam and Reservoir”.

1.3.3.1 Ongoing Maintenance of Recreational Facilities on and around Englebright Reservoir

Maintenance of recreational facilities on and around Englebright Reservoir only has the potential to impact the lower Yuba River through the inadvertent release of contaminants into Englebright Reservoir. Recreation-related areas in the vicinity of Englebright Reservoir that may be subject to a contaminant spill include: (1) areas with high public visitation such as campgrounds, marinas, and launch ramps; (2) petroleum products storage and delivery points; (3) water intake points; and (4) septic distribution, pumping, and treatment systems.

Corps personnel are required to perform a walk-a-round inspection of their vehicle at least once a day and also to check oil, water, battery and tires when fueling the vehicle or at the start of their shift each day. When not in use, vehicles are parked inside the Corps’ secure Maintenance Shop Facility compound. Maintenance of all vehicles operated by the Corps is accomplished off-site at an authorized dealer. The maintenance of gasoline and diesel powered equipment is conducted by Corps’ contractor personnel, maintenance staff and equipment operators. All equipment is scheduled for routine maintenance by Corps maintenance personnel at prescribed intervals. Equipment operations are required to conduct equipment inspections prior to operating equipment at each use. Corps maintenance personnel also conduct periodic equipment inspections for quality of operation and safety purposes. The Corps also maintains three 20-21 foot aluminum jet boats and one 40-foot aluminum utility barge.
Boat ramps at Englebright Reservoir are located at the Narrows and Joe Miller Recreation Areas. Each boat ramp has a courtesy dock adjacent to it for visitor convenience. These ramps are inspected daily by the Corps, and kept clean of debris, driftwood and sediment. All parts are inspected and replaced or repaired as needed including decking, framing, flotation, fasteners, cables, and anchors. Docking is maintained with a slip-free surface. After flood waters recede, all launch ramps are inspected for damage or undercut concrete and repaired as needed. Signs are maintained at each boat ramp to prohibit parking on the ramps and swimming in their vicinity. The courtesy docks are repaired by the Corps, as necessary.

There have been few recreation-related hazardous materials release incidents at Englebright Reservoir. However, there have been minor instances including vehicles ending up in the lake during boat launching, and sinking boats. Notable spill incidents are as follows:

- On July 3, 1996, a water line on a boat broke while it was being trailered at the boat launch. The boat sank and released several quarts of oil that was contained with spill containment booms.

- On July 25, 1996, gasoline was spilled from a leaking fuel delivery line at the private marina's fuel float. Emergency shut-off valves were quickly closed which limited the spill to approximately one gallon.

- On August 27, 1999, a Nevada County sanitation truck leaked hydraulic oil on the boat ramp and into the reservoir. Marina personnel who were first to arrive at the scene successfully deployed absorbent pads and containment booms.

Vehicle and equipment maintenance activities generally occur in the Corps’ Maintenance Shop Facility compound, which is not proximal to Englebright Reservoir. Although vessel maintenance, and boat ramp and courtesy dock maintenance have a remote potential for hazardous materials or other hydrocarbon-based contaminants to be released and enter Englebright Reservoir, it is reasonable to expect that potential spills would be locally constrained, and the volume of contaminants resulting from a spill would be relatively minor in comparison to the total volume of water in the reservoir. For example and contextual purposes, given the descriptions of the above occurrences of minor
contamination incidences, one gallon of contaminant spilled into Englebright Reservoir with an estimated storage capacity of about 50,000 AF would result in a concentration of less than about 1 part per 16 billion.

Long-term sublethal effects of oil pollution refer to interferences with cellular and physiological processes such as feeding and reproduction, and do not lead to immediate death of an organism (EPA 1986). Disruption of such behavior apparently can result from petroleum product concentrations in the range of 10 to 100 ug/L (EPA 1986). In addition to sublethal effects reported at the 10 to 100 ug/L level, it has been shown that petroleum products can harm aquatic life at concentrations as low as 1 ug/L (Jacobson and Boylan 1973 in EPA 1986).

For comparison purposes, 1 part per billion (ppb) is a microgram (μg or ug), or 1/1,000,000th of a gram, of a contaminant present in one liter of water or one kilogram of soil (ADEC 2009). Therefore, a petroleum product concentration of less than 1 part per 16 billion is considerably below the EPA (1986) thresholds of: (1) 10 to 100 ug/L (i.e., 10 to 100 ppb) that has been identified as having the potential to cause sublethal (e.g., behavioral) disruptions to aquatic life; and (2) 1 ug/L (1 ppb) shown to potentially harm aquatic life.

Additionally, Corps employees working at Englebright Reservoir are routinely trained in the storage and handling of hazardous materials. The Corps also implements the Harry L. Englebright Lake Operational Management Plan (Corps 2007) for Englebright Reservoir, which includes a Hazardous Materials Plan and a Spill Prevention and Response Plan to address potential hazards associated with the accidental release of hydrocarbons into aquatic habitat in Englebright Reservoir. Although contaminants accidentally entering Englebright Reservoir would be subject to dilution, the containment procedures were developed to further restrict the movement of a spill to soil or water. Therefore, it is not reasonable to suggest that adverse effects to listed species in the lower Yuba River would occur as a result of Corps activities related to: (1) vehicle, equipment, and vessel maintenance; and (2) boat ramps and courtesy docks maintenance.

Overall, although the possibility is extremely remote given all of the above considerations, the continuation of these Corps’ activities associated with ongoing
maintenance of recreational facilities on and around Englebright Reservoir do have the 
potential to transmit contaminants downstream to the lower Yuba River. For this reason,  
the Corps has determined through a separate ESA consultation process that these  
activities may affect, but are not likely to adversely affect, listed fish species and critical  
habitat in the lower Yuba River.

1.3.3.2 Continued Administration of Maintenance Service Contracts at  
Englebright Dam and Reservoir

The Corps’ discretionary activities include administration of: (1) portable restroom  
pumping; and (2) herbicide application maintenance service contracts in areas  
surrounding Englebright Reservoir. These maintenance activities have a remote  
possibility to impact the lower Yuba River, as discussed below.  

Sewage from portable restroom pumping around the lake is recognized in the Englebright  
Operations Management Plan as a common hazardous material found on Corps’ project  
lands (Corps 2007), which could pose a threat to public and environmental health. For  
these reasons, portable restroom pumping is managed as part of the Corps’ Wastewater  
Monitoring Plan, which addresses the management of wastewater from Corps’  
maintained facilities and monitoring of wastewater generated by houseboats on  
Englebright Reservoir. As described in Corps (2007), the Corps has established a  
Hazardous Materials Plan and a Spill Prevention and Response Plan that provide spill  
response guidance and containment procedures to be implemented in the event of an  
emergency at or around Englebright Reservoir. Although wastewater accidentally  
entering Englebright Reservoir would be subject to dilution, the containment procedures  
were developed to further restrict the movement of a spill to soil or water.  

Poison oak is a problem in day use areas, campgrounds, trails, roadsides, and operations  
areas. Because the presence of poison oak in high-use recreation and operations areas is  
an unacceptable nuisance and health hazard, exposure must be controlled or eliminated to  
reduce risk to visitors and Corps employees. Annual and perennial grasses, as well as  
assorted noxious herbaceous weeds, also are common to the area. This vegetation has the  
potential to grow very tall, blocking facilities, harboring insects in recreation sites and  
creating an extreme fire hazard when dry. Consequently, herbicide application is
conducted, on an as-needed basis, around Englebright Reservoir, primarily at campsites, firebreaks and nature trails.

The areas of herbicide and pesticide application are generally located in more upland areas not proximal to Englebright Reservoir. Moreover, herbicides are applied in relative dilute quantities that would not represent significant contributions affecting water quality in Englebright Reservoir. Annual herbicide application around Englebright Reservoir is relatively minor. For example, a usage report dated January 29, 2008 indicates that 2 gallons of herbicide were used on 8 acres of land, and 3 gallons used on 10 acres of recreation and operation areas to control weeds, grasses and poison oak. Thus, any potential effects associated with the conduct of these activities would be locally constrained, and would not extend to the lower Yuba River. Also, the Corps Operations Management Plan for Englebright Reservoir includes a Hazardous Materials Plan and a Spill Prevention and Response Plan to address potential hazards associated with herbicide application. Given the minor amounts and upland areas of herbicide application, it is reasonable to conclude that adverse effects to listed species in the lower Yuba River would not occur.

Overall, the Corps has determined through a separate ESA consultation process that the continuation of activities associated with administration of maintenance service contracts at Englebright Dam and Reservoir that have the potential to transmit contaminants downstream to the lower Yuba River may affect, but are not likely to adversely affect listed fish species or critical habitat in the lower Yuba River.

1.3.4 Future Corps Actions in the Yuba River Basin Requiring Separate ESA Consultation

Future Corps’ actions in the Yuba River Basin requiring separate ESA consultation have been identified in this BA for clarification and informational purposes. Within the foreseeable future, the Corps has identified three projects that are expected to occur within the Yuba River Basin, as follows.

- Corps’ Issuance of a right-of-way to PG&E for access to the PG&E Narrows I via a separate FERC Relicensing Process (anticipated to occur in 2023)
Corps’ Issuance of a right-of-way to YCWA for access to the YCWA Narrows II via a separate FERC Relicensing Process (anticipated to occur in 2016)

Corps’ Issuance of right-of-way to YCWA for access to the South Yuba/Brophy Diversion Canal and Facilities (anticipated to occur in 2018)

Once the technical investigations and regulatory compliance documentation for these projects are completed, these projects would likely require a Federal approval from the Corps. At this time, however, none of these three projects are at the appropriate level of completion to allow the Corps to become involved through the appropriate mechanism associated with each respective regulatory compliance process (e.g., FERC relicensing, 404 permitting). Hence, these three projects represent future actions requiring separate ESA consultation, and are not included in the consultation for this Proposed Action.

### 1.3.4.1 Hydroelectric Generation Facilities in the Vicinity of Englebright Dam

Besides flood flow spills over the top of Englebright Dam, releases from Englebright Reservoir are made through two FERC licensed hydroelectric power facilities, one of which (YCWA’s Yuba River Development Project (YRDP) Narrows II) is located just below the base of the dam, and the other of which (PG&E’s Narrows I) is located approximately 0.2 mile downstream (Corps 2007; NMFS 2007) (Figure 1-2).

**NARROWS I**

PG&E’s operations of Narrows I are authorized by a license for these facilities issued by FERC under the Federal Power Act.

On February 11, 1993, PG&E received License No. 1403-004 from the FERC, which grants PG&E the right to conduct the continued operation and maintenance of the Narrows I Hydroelectric Project.

On March 28, 1994, the Corps issued a right-of-way (license) No. DACW05-9-95-604 to PG&E for Narrows I, granting access to the FERC licensed powerhouse and for PG&E to utilize Corps outlet facilities and storage space between elevation 450 and 527 in Englebright Reservoir. The 1994 agreement (assigned License No. DACW05-9-95-604
Figure 1-2. Hydroelectric generation facilities in the vicinity of Englebright Dam.

by the Corps) between the Corps and PG&E for access to the Narrows I Hydroelectric Project states that the Corps is responsible for maintaining Englebright Dam and the outlet facilities, including the first 700 feet of the outlet tunnel (Corps and PG&E 1994), in good order and repair, while PG&E is responsible for the operation and maintenance of the hydroelectric facility (Corps 2007).

The Corps also has issued a right-of-way (easement) No. DACW05-2-95-587 making lands available for PG&E’s electric transmission lines that run from the Corps’ gatehouse (where the control for the bulkhead gate is located) to the Narrows I substation, and
right-of-way No. DACW05-2-69-102 to PG&E for power transmission lines that run from the Narrows I substation to Narrows II.

Related to ongoing operations and maintenance responsibilities for the power transmission line easements, Corps personnel perform compliance inspections on outgranted lands pursuant to Engineer Regulation 405-1-12, Chapter 8. The compliance inspections are performed on an annual basis, or more often if circumstances dictate. Corps personnel also perform interim inspections on outgrants in connection with day-to-day administration, and instances of unsatisfactory outgrantee performance are noted and reported immediately. Corrective actions will be immediately taken if emergency health or safety is involved (Corps 2007).

**NARROWS II**

YCWA’s operations of Narrows II are authorized by a license for these facilities issued by FERC pursuant to the Federal Power Act.

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

The 1966 Agreement specifies that operations and maintenance of the intake works, tunnel, power plant, access roads and appurtenances are the responsibility of YCWA, and are not the responsibility of the Corps.

In 1975, the Corps issued a right-of-way (easement) No. DACW05-2-75-716 to YCWA for access to the construction site of the Narrows II powerplant, intake works and tunnel which is associated with the FERC license. The term of this easement is for a fifty-year period beginning August 14, 1967 and ending August 13, 2017. Also, in 1975, the Corps issued right-of-way (easement) No. DACW05-2-75-715 to YCWA for access to the construction site, use and maintenance of access roads, including culverts and other drainage facilities, associated with the FERC license. The term of this easement is for a
fifty-year period beginning August 14, 1967 and ending August 13, 2017. The Corps has no ongoing operation and maintenance responsibilities associated with these two easements (D. Grothe, Corps, pers. comm. 2011).

In 2005, the Corps issued a Right of Entry (No. DACW05-9-06-510) to YCWA for the construction of the Narrows II Full Flow Bypass, which is associated with the FERC license. In 2006, YCWA constructed a full-flow bypass on Narrows II powerhouse which allows approximately 3,000 cfs (or 88 percent of the full 3,400 cfs capacity of the powerhouse) to be bypassed around the power generation facilities to maintain river flows during emergencies, maintenance, and accidental shut-downs of the powerhouse. Although emergency and maintenance shutdowns occur infrequently, the full-flow bypass was designed to eliminate most flow fluctuations that would result from such shutdowns. Since the flow bypass system was installed in 2006, YCWA has been able to more consistently operate the Narrows II facility to reduce most short-term flow fluctuations by providing nearly instantaneous restoration of flows to the lower Yuba River. The full-flow bypass has resulted in an overall improvement in conditions for listed anadromous salmonids and green sturgeon by reducing the potential for severe flow reductions and fluctuations to adversely affect these species in the lower Yuba River (FERC 2005). The Corps has no ongoing operation and maintenance responsibilities associated with this Right of Entry.

Presently, the Corps is simply administering the existing rights-of-way associated with FERC licenses to PG&E for the Narrows I facility and to YCWA for the Narrows II facility. At the time of this consultation, the Corps is not proposing to take any actions related to the aforementioned, pre-existing rights-of-way, and these rights-of-way will remain in effect until the existing FERC licenses for both the PG&E and YCWA FERC hydropower projects expire in 2023 and 2016, respectively.

An example of a license article that FERC has recently included in FERC project licenses that would use Corps’ facilities (T. Mansholt, FERC Office of the General Counsel – Energy Projects, pers. comm. 2013) is:

“Article 309. Agreement with Corps. The licensee shall within 90 days from the issuance date of the license, enter into an agreement with the
U.S. Army Corps of Engineers (Corps) to coordinate its plans for access to and site activities on lands and property administered by the Corps so that the authorized purposes, including operation of the Federal facilities, are protected...”

The Corps will re-evaluate the rights-of-way during the FERC relicensing processes. These evaluations will be conducted as part of separate, future ESA consultations, and are not included in the consultation for the Proposed Action.

1.3.4.2 Right-of-Way to YCWA for the South Yuba/Brophy Diversion Canal and Facilities Near Daguerre Point Dam

Approximately 1,000 feet upstream of Daguerre Point Dam on the south side of the Yuba River, the South Yuba/Brophy Diversion Canal and Facilities divert water through an excavated channel from the Yuba River's south bank. The South Yuba/Brophy diversion facility includes a 450-foot long porous rock weir fitted with a fine-mesh barrier (geotextile cloth) within the weir, intended to protect juvenile fish from becoming entrained into the canal (Corps 2007). Over the years, various rights-of-way (permits, licenses, easements) have been issued to provide access to the diversion facilities.

The Corps issued a right-of-way (license), No. DACW05-3-83-593, to Brophy Water District on August 29, 1983. This license is no longer in force because it was discovered to be a duplicate. License No. DACW05-3-85-537 was issued to South Yuba Water District on March 15, 1985, for the South Yuba/Brophy diversion. This license is currently in a hold-over status, because it expired in March 2000.

The Corps issued a 50-year right-of-way (easement), No. DACW05-2-98-612, to YCWA on October 19, 1998. The Corps subsequently retracted this easement in March 1999 because of land administration issues associated with Bureau of Land Management (BLM) lands (Corps 2000).

A BLM right-of-way (Serial No. CACA 44390) to YCWA was issued by BLM on June 24, 2002. It grants YCWA the right to operate, maintain, and terminate an existing canal on public lands until December 31, 2031 (30-year term). YCWA’s activities under the grant are limited to operations and maintenance of the existing facilities.
Although the diversion structure addressed CDFW fish screening requirements at the time of construction in 1985, fish screening requirements have changed over time and the diversion structure does not meet current NMFS and CDFW screening criteria. The potential replacement or modification of the rock gabion fish screen at the South Yuba/Brophy Diversion Canal and Facilities has been under consideration for many years. A collaborative process to undertake a feasibility assessment was initiated by YCWA and CDFW in late 2005. A final feasibility study titled “Feasibility Study for the South Canal Fish Screen” (Feasibility Study) was issued in April 2009.

In August 2009, YCWA initiated the environmental review process pursuant to the California Environmental Quality Act (CEQA) for the South Diversion Canal Screening Project. For a variety of reasons (including uncertainty regarding various aspects of the litigation regarding Daguerre Point Dam), YCWA suspended the CEQA process in July 2010.

Since July 2010, YCWA has worked with local stakeholders, water users and water right holders to address concerns about the cost and reliability of a new water diversion structure. YCWA has engaged a consultant team to undertake an Enhanced Feasibility Assessment, to expand on the feasibility work previously completed by YCWA and CDFW. YCWA will re-initiate the CEQA process, as well as a parallel NEPA process with the Corps after completion of the Enhanced Feasibility Assessment. Final permitting and final design work for the preferred alternative will be undertaken after the completion of the full CEQA/NEPA process.

At such time as YCWA develops the final plan for a new water diversion structure and completes any required permitting (including 404) and ESA consultation, the Corps plans to issue a right-of-way (easement) to YCWA for access to the diversion facilities and canal, located near Daguerre Point Dam. The Corps will have no responsibility for designing such facilities, or operating or maintaining the South Yuba/Brophy Diversion Canal and Facilities. This project represents a future action that may require separate ESA consultation(s), and is not included the Corps’ consultation for this Proposed Action.
2.0 Description of the Proposed Action

The Corps' identification and definition of an "action" must comply with the procedural and substantive requirements of the ESA. A comprehensive project description is vital to determining the scope of the proposed action. The ESA Section 7 regulations define “action” as: “...all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas. Examples include, but are not limited to: ...(d) actions directly or indirectly causing modifications to the land, water, or air” (50 CFR 402.02).

The Corps’ authorized O&M and planning activities associated with the Proposed Action includes making minor modifications to the fish ladders at Daguerre Point Dam. The Corps’ O&M of the fish ladders at Daguerre Point Dam does not include major ladder reconfigurations or reconstruction. According to the Corps Regulation (No. 1165-2-119) titled “Modifications to Completed Projects” (Corps 1982), such activities would require additional Congressional authorization and appropriation of necessary funding. Consequently, the Proposed Action is comprised of O&M of the existing fish passage facilities at Daguerre Point Dam, and specified conservation measures.

When used in the context of the ESA, “conservation measures” represent actions pledged in the project description that the action agency (in this case, the Corps) will implement to further the recovery of the species under review (USFWS and NMFS 1998). Such measures should be closely related to the action, and should be achievable within the authority of the action agency. For the present consultation, such measures correspond to the “Protective Conservation Measures” described below.

Because conservation measures are part of a proposed action, their implementation is required under the terms of the consultation. However, NMFS can make conservation recommendations, which are discretionary suggestions for consideration by the Corps. For the present consultation, the "Voluntary Conservation Measures for Habitat Enhancement Purposes" generally correspond to conservation recommendations, because although these measures are planned for implementation, they are subject to funding availability.
The beneficial effects of conservation measures are taken into consideration for both jeopardy and incidental take analyses by NMFS. However, USFWS and NMFS (1998) caution that… "the objective of the incidental take analysis under section 7 is minimization, not mitigation. If the conservation measure only protects off-site habitat and does not minimize impacts to affected individuals in the action area, the beneficial effects of the conservation measure are irrelevant to the incidental take analysis."

2.1 Proposed Action Components

The formal Section 7 consultation, for which this BA has been prepared, includes Corps discretionary actions pertaining to O&M of the fish passage facilities at Daguerre Point Dam, including administration of outgrants associated with O&M of the facilities, and conservation measures. The Proposed Action is consistent with the Congressional authorization (Rivers and Harbors Act of 1935) for Daguerre Point Dam, and consists of the following components:

- Operation and maintenance of the fish passage facilities at Daguerre Point Dam
- Maintenance of the staff gage at Daguerre Point Dam
- Administration of a right-of-way (license) issued to CDFW for VAKI Riverwatcher operations at Daguerre Point Dam
- Administration of a right-of-way (license) issued to Cordua Irrigation District for flashboard installation, removal and maintenance at Daguerre Point Dam

Protective Conservation Measures (annual funding availability and ongoing implementation is reasonably certain to occur based on past operations).

- Implementation of the Daguerre Point Dam Fish Passage Sediment Management Plan
- Administration of a long-term Flashboard Management Plan at Daguerre Point Dam
- Implementation of a Debris Monitoring and Maintenance Plan at Daguerre Point Dam
Voluntary Conservation Measures for Habitat Enhancement Purposes (planned for implementation, but less certain and subject to funding availability).

- Gravel Injection in the Englebright Dam Reach of the lower Yuba River
- Large Woody Material Management Program

In addition, Corps discretionary activities also include the review of requests for temporary right-of-ways (permits) or use of portions of Corps owned right-of-ways associated with Daguerre Point Dam. All requests for permits for temporary right-of-ways or use of portions of the Government owned right-of-ways are carefully reviewed to determine that such use will not adversely affect maintenance operations, or the safety and functioning of the project structures (Corps 1966). Each request is processed on a case-by-case basis. No specific requests are presently identified, and the Corps review of such requests is not included in formal consultation for this BA.

It also is important to note that, for this consultation, the Corps has no water rights or authority to regulate water rights on the Yuba River. Because water right issues on the Yuba River are not within the Corps’ authority or discretion to regulate, they are not part of the Proposed Action.

2.1.1 Operation and Maintenance of the Fish Passage Facilities at Daguerre Point Dam

Daguerre Point Dam (Figure 2-1) is located on the lower Yuba River approximately 11.5 River Miles (RM) upstream from the confluence of the lower Yuba and lower Feather rivers. Concrete fish ladders are located on both the North and South abutments of the Dam (Figure 2-2, Figure 2-3). The park personnel of the Corps administer the operation and maintenance of the fish ladders, in coordination with CDFW.
2.1.1.1 Fish Ladder Operations

Fish ladder operations consist of adjusting the fishway gates, within-ladder flashboards, and the fish ladder gated orifices. Fishway gates allow water to enter the fish ladders, and the fish ladder gated orifices regulate the point where upstream migrating fish can most easily enter the ladders (Corps 1966). Within-ladder flashboards influence flow hydraulics within the bays of the ladders.

The Corps continues to operate the fish ladders at Daguerre Point Dam to improve fish passage. The Corps’ past operational criteria required that the fish ladders at Daguerre Point Dam be physically closed when water elevations reached 130 feet, or when flows were slightly less than 10,000 cfs (SWRCB 2003), and to keep them closed until the water recedes to an elevation of 127 feet (CALFED and YCWA 2005). Presently, the Corps is collaborating with resource agencies (CDFW, NMFS) and the Yuba Accord River Management Team (RMT) to improve fish passage by keeping the ladders open at
Figure 2-2. North fish ladders at Daguerre Point Dam (Corps 2012c).

Figure 2-3. South fish ladders at Daguerre Point Dam (Corps 2012c).
all river elevations. The Proposed Action includes continuation of this collaboration, and keeping the ladders open.

Within-ladder flashboards were installed in the lower bays of the south fish ladder during June 2010 by CDFW. Adjustment of these within-ladder flashboards influence hydraulics and have been shown to improve adult anadromous salmonid attraction flows to the south ladder (Grothe 2011). The Proposed Action includes the continued collaboration with CDFW regarding adjustment of these within-ladder flashboards.

2.1.1.2 Fish Passage Facility Maintenance

The Corps coordinates with CDFW and NMFS to determine when maintenance of the fish passage facilities at Daguerre Point Dam is to be conducted, which is when it is least stressful to fish. Corps and CDFW joint maintenance activities include cleaning the bays of the fish ladders, cleaning the grates covering the fish ladder bays, and other minor maintenance activities. Since the spring of 2010, the Corps and NMFS have been holding monthly meetings to coordinate regarding maintenance activities and other issues pertaining to the lower Yuba River. The Proposed Action includes the continuation of the Corps-NMFS coordination meetings.

CDFW is responsible for inspecting and clearing debris from the upper portion of the ladders containing the VAKI Riverwatcher devices (see Section 2.1.3), and the Corps is responsible for all other parts of the ladders. Presently, Pacific States Marine Fisheries Commission (PSMFC) staff, in collaboration with CDFW, operating the VAKI Riverwatcher devices make observations of the fish ladders on an approximately daily basis, and the Corps coordinates with them regarding observations of debris or blockages, and/or adult salmonid upstream passage observations. Any debris that could affect fish passage is removed as soon as possible when personnel can safely access the area. Since August 2010, the Corps has also conducted sub-surface inspections of the ladders, after NMFS advised the Corps of the possibility of sub-surface blockage. The Proposed Action includes continuation of the routine maintenance of removal of debris from the fish ladders.
2.1.1.3 Daguerre Point Dam Fish Passage Sediment Management Plan

The Corps routinely removes the gravel and sediment that accumulates upstream of Daguerre Point Dam. The Corps, through collaboration with NMFS, CDFW, and USFWS, developed an updated Daguerre Point Dam Fish Passage Sediment Management Plan in February 2009 (Corps 2009). The purpose of the plan is to describe the methods used to manage the sediment that accumulates upstream of Daguerre Point Dam in order to improve flows to the ladders at Daguerre Point Dam, to provide suitable adult salmonid migratory habitat conditions upstream of the Daguerre Point Dam fish ladders, and to provide attraction to the ladders downstream of Daguerre Point Dam. Details of the plan include the following.

Upstream of Daguerre Point Dam, adequate water depth will be maintained across the upstream face of the dam to allow unimpeded fish passage from the ladders to the main channel of the lower Yuba River upstream from Daguerre Point Dam. An adequate water depth is defined as a “channel” at least 30 feet wide when measured from the face of the dam upstream, and 3 feet deep when measured from the crest of the dam to the riverbed.

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

A tracked excavator will be used to remove the sediment/gravel (Figure 2-4). The excavator will be cleaned of all oils and greases, and will be inspected and re-cleaned daily as necessary to insure no contaminants are released into the lower Yuba River. All hydraulic hoses and fittings also will be inspected to insure there are no leaks in the hydraulic system.
Figure 2-4. Excavator removing sediment above Daguerre Point Dam during August 2011.

Material removed shall be managed in one of two ways. If all required permits can be obtained (expected to occur during the summer of years when excavation is necessary), then it is anticipated that the excavated material will be placed on a downstream bank of the lower Yuba River approximately ¼ mile downstream of Daguerre Point Dam (Grothe, Corps, pers. comm. 2013). Materials will be placed in a location that will provide an opportunity for the gravel to be mobilized by the river during high flow conditions and transported downstream to augment downstream spawning gravels. If permits cannot be obtained or conditions do not allow for the downstream placement, then the material will be removed and stored above the ordinary high water mark until both permits are obtained and it can be moved downstream to a location where the gravel can be mobilized by the river during high flow conditions and transported downstream.

The Proposed Action includes continued implementation of the Daguerre Point Dam Fish Passage Sediment Management Plan.
2.1.2 Staff Gage Maintenance

Hydrologic facilities consist of a staff gage on the right abutment of Daguerre Point Dam. As described in the Daguerre Point Dam O&M Manual (Corps 1966), the Corps’ Engineering Division is responsible for maintaining, reading, and filing all records obtained from this gage. The Proposed Action includes continuation of the routine maintenance activities associated with the staff gage.

2.1.3 Administration of a License Issued to CDFW for VAKI Riverwatcher Operations at Daguerre Point Dam

The Corps administers a license to CDFW (DACW05-3-03-550) to install and operate electronic fish counting devices, referred to as a VAKI Riverwatcher infrared and photogrammetric system, in the fish ladders at Daguerre Point Dam and is revocable at will by the Corps (Amendment 2 to License DACW05-3-03-550). The Proposed Action includes continued administration of this license, which remains in effect until 2018.

The license specifies that CDFW shall pay the cost, as determined by the Corps, of producing and/or supplying any utilities and other services furnished by the Government or through Government-owned facilities for the use of CDFW, including CDFW’s proportionate share of the cost of operation and maintenance of the Government-owned facilities by which such utilities or services are produced or supplied. The Government is under no obligation to furnish utilities or services.

The license further specifies that CDFW shall keep the premises in good order and in a clean, safe condition by and at the expense of CDFW. CDFW is responsible for any damage that may be caused to property of the United States by CDFW activities and shall exercise due diligences in the protection of all property located on the premises against fire or damage from any and all other causes.

The Proposed Action includes continued administration of the license to CDFW to operate the VAKI Riverwatcher infrared and photogrammetric system in the fish ladders at Daguerre Point Dam.
2.1.4 Administration of a License Issued to Cordua Irrigation District for Flashboard Installation, Removal and Maintenance at Daguerre Point Dam

To benefit listed fish species by improving the ability of the fish to locate the fish ladders and migrate upstream to spawning and rearing habitats, the Corps, in coordination with CDFW and NMFS, developed and implemented a Daguerre Point Dam Flashboard Management Plan in 2011. The Plan addresses the use, placement, monitoring and removal of flashboards at Daguerre Point Dam. To improve management of the flashboards at Daguerre Point Dam on a long-term basis, the Flashboard Management Plan was incorporated into the September 27, 2011 license amendment issued by the Corps to Cordua Irrigation District. The Proposed Action includes continued administration of the license issued to Cordua Irrigation District which incorporates the Flashboard Management Plan, until the license expires in 2016.

Installation of these flashboards directs some sheet flow from over the top of Daguerre Point Dam into the fish ladders. In accordance with the terms of the 2011 amended license, which will continue to be administered by the Corps as part of the Proposed Action, Cordua Irrigation District will install, remove and maintain the anchoring system, supporting brackets and flashboards and must coordinate its activities with the Corps, NMFS, and CDFW. These agencies will work with Cordua Irrigation District to direct the placement, timing and configuration of the flashboards to best manage flows to benefit fish (Grothe 2011). The long-term flashboard operations plan developed by the Corps includes the following.

- **Conditions of Placement.** Flashboards will be used in periods of low flow to direct water toward the fish ladders to provide optimal flow conditions. Because there is no recorded flow information at this time to set a flow-based trigger, the flashboards will be set in place when the flows recede to a point that only part of the dam has water flowing over it. Flows will be recorded at the time of placement to determine the flow rate trigger for future placement.
Period of Placement. Flashboards and brackets will be installed as described above, but only after April 15 and will be removed before November 1 of each year. Further, flashboards will be removed within 24 hours, if directed by the Corps, NMFS or CDFW.

Flashboard Adjustments. Flashboards will be closely monitored in accordance with monitoring and inspection activities (see below) to ensure they have been placed in a manner that leads to actual improvement in fish passage and will be adjusted accordingly based on such monitoring. All adjustments will be coordinated with NMFS and CDFW. Any recommended adjustments will be made within 24 hours of notification unless flow conditions prohibit them. In that case, the adjustments will be made as soon as conditions allow.

Method of Placement. Flashboards will be installed using metal brackets that are attached to the dam with anchor bolts. The brackets will be fabricated of material that is light enough that it will break away if the flows increase too rapidly before the brackets can be removed.

Location of Placement. When flashboards placement is required, they will be placed in the center portion of the dam in such a way that the flows are directed toward both fish ladders. This will ensure adequate flows through the fish ladders to promote optimal flow conditions and attraction flows to the fish ladders. The number of boards placed and the exact location will be determined based upon flow conditions and channel position. Adjustments will be made as necessary to provide optimal fish attraction and passage. All adjustments will be coordinated with NMFS and CDFW.

Flashboard Material. Flashboard material will be 2” x 10” Douglas Fir or equal material. Material will be free of preservatives and other contaminants – no pressure treated material will be used.

Monitoring and Inspection. Once the flashboards have been placed, fish passage will be closely monitored for the first week after placement to confirm that the flashboards installation improves fish passage. This monitoring will be conducted via the VAKI in coordination with the RMT. Additionally, during the period that
flashboards are installed in accordance with this plan, the flashboards will be
monitored at least once per week to make sure that the flashboards have not
collected debris that might contribute to juvenile fish mortality. The flashboards
will be cleared within 24 hours of finding a blockage, or as soon as it is safe to
clear them.

- **Updates.** The Corps will update and adjust this plan as required based upon new
  information generated through monitoring efforts.

As part of future Cordua Irrigation District license renewal and approval processes after
2016, the Corps will refine the description of specific operations addressing the
placement, timing and configuration of the flashboards at Daguerre Point Dam and
incorporate changes to the Flashboard Management Plan into the terms and conditions
for the Corps license to be re-issued to Cordua Irrigation District (Grothe 2011), and
Cordua Irrigation District will remain responsible for implementing the flashboard
operations.

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

- **The flow conditions in the lower Yuba River flow that will prompt the placement
  and removal of the flashboards.**

- **The responsibility of Cordua Irrigation District for monitoring the flashboards at
  least once a week to make sure that they have not collected debris that might
  contribute to juvenile fish mortality.**

- **The responsibility of Cordua Irrigation District for monitoring the effects of the
  flashboards on juvenile salmonids and the potential for direct mortality due to
  entrainment or concentrating juveniles in a manner that promotes predation.**

If the Corps does not renew the license to Cordua Irrigation District or another entity
when it expires in 2016, then the Corps will assume responsibility for implementing the
operations and maintenance activities addressing the placement, timing and configuration
of the flashboards at Daguerre Point Dam that are described in the Flashboard Management Plan on a long-term basis.

2.1.5 Protective Conservation Measures

The ESA mandates Federal agencies to utilize their authorities to carry out programs for the conservation and survival of Federally-listed endangered and threatened species (Corps 1996).

The Corps has committed to incorporate several conservation measures into its activities for this Proposed Action (Appendix C). These measures are intended to improve conditions for listed salmonids in the lower Yuba River. The Corps will implement the following protective conservation measures under the Corps’ obligation to Section 7(a)(1) of the ESA for the conservation of threatened and endangered species.

2.1.5.1 Implementation of the Daguerre Point Dam Fish Passage Sediment Management Plan

The Proposed Action includes continued implementation of the 2009 Fish Passage Sediment Management Plan (see Section 2.1.1.3). The Corps considers the Fish Passage Sediment Management Plan to be a protective conservation measure because it includes activities beyond those specified in the Daguerre Point Dam O&M Manual (Corps 1966).

2.1.5.2 Management of a Long-term Flashboard Program at Daguerre Point Dam

The Proposed Action includes implementation of the Flashboard Management Plan (see Section 2.1.4) through the administration of a license issued to Cordua Irrigation District. If the Corps does not renew the license to Cordua Irrigation District, or another entity, when it expires in 2016, then the Corps will assume responsibility for implementing the operations and maintenance activities addressing the placement, timing and configuration of the flashboards at Daguerre Point Dam that are described in the Flashboard Management Plan on a long-term basis.
2.1.5.3 Implementation of a Debris Monitoring and Maintenance Plan at Daguerre Point Dam

Through coordination with CDFW and NMFS, the Corps will implement the Debris Monitoring and Maintenance Plan for clearing accumulated debris and blockages in the fish ladders at Daguerre Point Dam. This plan specifies that CDFW is responsible for inspecting and clearing the portion of the ladders containing the VAKI device, and that the Corps is responsible for all other parts of the ladders. Inspections will include subsurface inspections of the ladders. The Corps will conduct weekly inspections of the Daguerre Point Dam fish ladders for surface and subsurface debris. The Corps also will routinely inspect the fish ladder gates to ensure that no third parties close them. Routine inspections shall occur at least weekly, and may be conducted under agreement with CDFW. This plan also specifies that routine inspection and clearing of debris from the two fish ladders at Daguerre Point Dam may be conducted by CDFW pursuant to agreement with the Corps, or by other parties (e.g., PSMFC) under CDFW direction. Routine inspections and debris clearing will occur weekly, although more frequent inspections and debris clearing activities may be conducted by CDFW, or other parties (e.g., PSMFC) under CDFW direction.

When river flows are 4,200 cfs or greater, the Corps or other designated parties as described above, will conduct daily manual inspections of the Daguerre Point Dam fish ladders. Upon discovering debris in the ladders, the debris will be removed within twelve hours, even if the Corps or CDFW determines that flow levels are adequate for fish passage. If conditions do not allow for safe immediate removal of the debris, the debris will be removed within twelve hours after flows have returned to safe levels.

The Corps will reconsider the need for specific provisions, and may modify the Debris Monitoring and Maintenance Plan upon issuance by NMFS of a BO for the Proposed Action.

2.1.6 Corps’ Voluntary Conservation Program

With respect to the conservation of Federally-listed endangered and threatened species on existing Corps’ project lands, the Corps’ Environmental Stewardship and Maintenance
Guidance and Procedures (Corps 1996) state that identified conservation activities will be accomplished when funds are available through the budget priority process presented in the Annual O&M Budget Guidance. Therefore, conservation measures contained within the Corps’ Voluntary Conservation Program are subject to the availability of funding. Limited financial resources are presently available for the Corps to proceed with implementing the Voluntary Conservation Program measures described below. In the past, the Corps has been successful in obtaining the additional funding as it places a high priority on these measures. These voluntary conservation measures were previously identified in the Corps’ 2012 BA, and the Corps will continue to diligently seek opportunities for future implementation, subject to available funding (Appendix D).

2.1.6.1 Gravel Injection in the Englebright Dam Reach of the Lower Yuba River

The Corps has been injecting a mixture of coarse sediment in the gravel (2-64 mm) and cobble (64-256 mm) size ranges into the lower Yuba River below Englebright Dam, as part of their voluntary conservation measures associated with ESA consultations regarding Daguerre Point Dam. Four separate gravel injection efforts have been undertaken from 2007-2013, with approximately 15,500 tons of gravel/cobble placed into the Englebright Dam Reach.

Future gravel injections are anticipated as one of the Corps voluntary conservation measures associated with the current ESA consultation. The Corps’ Gravel Augmentation Implementation Plan (GAIP) provides guidance for a long-term gravel injection program to provide Chinook salmon spawning habitat in the bedrock canyon downstream of Englebright Dam. The Corps has contracted bathymetric survey monitoring to compare volumetric differences between pre- and post-gravel injection distributions, to further evaluate the disposition of the injected gravels. Additionally, the Corps has funded PSMFC to conduct redd surveys in the Englebright Dam Reach to investigate whether Chinook salmon and steelhead are utilizing areas where gravel placement occurred. If the monitoring suggests alternative locations or gravel injection methods, then the Corps will continue the long-term gravel injection program accordingly. In addition, the frequency of gravel injection will be dependent upon annual monitoring results.
The GAIP (Pasternack 2010) describes present and proposed future gravel injection efforts, based on information available in 2010. The long-term plan calls for continuing gravel/cobble injection into the Englebright Dam Reach until the estimated coarse sediment storage deficit for the reach is eradicated, and then it calls for subsequent injections as needed to maintain the sediment storage volume in the event that floods export material downstream of the reach. The Corps does not currently have the authority to completely eradicate the deficit created by various causes in one placement, nor is that the intent of the Corps gravel injection program.

2.1.6.2 Large Woody Material Management Program

The Corps has prepared the Large Woody Material Management Plan (LWMMP), which includes the implementation of a Pilot Study in order to enhance rearing conditions for spring-run Chinook and Central Valley steelhead (Corps 2012d). The Corps proposed to initiate a pilot study to determine an effective method of replenishing the supply of large woody material (LWM) back into the lower Yuba River. As described in the LWMMP, the Pilot Study will use LWM from existing stockpiles at New Bullards Bar Reservoir for placement at selected sites along the lower Yuba River. The Pilot Study would include monitoring of placed materials, and used to assess the effectiveness of LWM placement in the lower Yuba River in order to develop a long-term program (Corps 2012d).

As part of this conservation measure, the Corps will: (1) refine the draft plan that was prepared for management of LWM, consistent with recreation safety needs; (2) conduct a pilot project to identify suitable locations and evaluate the efficacy of placing large in-stream woody material to modify local flow dynamics to increase cover and diversity of instream habitat for the primary purpose of benefitting juvenile salmonid rearing; and (3) based upon the outcomes of the pilot program, develop and implement a long-term large woody material management plan for the lower Yuba River, anticipated to occur within one year following completion of the pilot program, and subject to available funding.
2.2 Interrelated Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification (50 C.F.R. 402.02). There are no anticipated interrelated actions associated with the Proposed Action.

2.3 Interdependent Actions

Interdependent actions are those that have no independent utility apart from the action under consideration (50 C.F.R. 402.02). There are no anticipated interdependent actions associated with the Proposed Action.
3.0 Description of the Action Area

3.1 Action Area Definition and Description

The regulations governing consultations under the federal ESA define the “action area” as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action” (50 CFR §402.02). Direct effects are defined as “the direct or immediate effects of the project on the species or its habitat” (USFWS and NMFS 1998). Indirect effects are defined as “those [effects] that are caused by the proposed action and are later in time, but still are reasonably certain to occur” (50 CFR §402.02).

Consistent with 50 CFR 402.02, the Action Area for this consultation is determined considering the extent of the direct and indirect effects of the Proposed Action. As described in Chapter 2, the Proposed Action includes the Corps’ authorized discretionary O&M of the fish passage facilities at Daguerre Point Dam and specified conservation measures. O&M activities of the Proposed Action would indicate that the Action Area would be restricted to the immediate vicinity adjacent to Daguerre Point Dam. Similarly, administration of the licenses to CDFW and Cordua Irrigation District also would be restricted to the immediate vicinity adjacent to Daguerre Point Dam. However, the conservation measures in the Proposed Action have a broader geographic extent of potential direct and indirect effects.

The LWMMP does not specifically indicate the upstream and downstream boundaries for potential wood placement in the lower Yuba River. By contrast, the gravel augmentation project specifies that the gravel placement site is located within the first 300-feet downstream of Englebright Dam, downstream of the Narrows II Powerhouse. The project site is less than one-acre and is confined to the river channel within the Englebright Dam Reach, a 0.89-mile long bedrock reach starting at Englebright Dam and ending at the junction with Deer Creek.
The Daguerre Point Dam Fish Passage Sediment Management Plan includes excavation of sediment immediately upstream of Daguerre Point Dam and placement of excavated materials on a downstream bank of the lower Yuba River approximately ¼ mile downstream of Daguerre Point Dam. Materials will be placed in a location that will provide an opportunity for the gravel to be mobilized by the river during high flow conditions and transported downstream to augment downstream spawning gravels. Although fate and transport studies of the excavated materials have not been conducted, it is reasonable to assume that some of these materials may be transported as far downstream as the confluence with the lower Feather River.

Therefore, the Action Area for this Proposed Action includes the lower Yuba River starting at the upstream extent of where in-river gravel placement has occurred, an area which is located within the first 300 feet downstream of Englebright Dam (39°14'18"N, 121°16'07"W, Yuba River (RM 23.9), downstream to the confluence with the lower Feather River (39°07'46"N, 121°35'56"W, Yuba River mile 0) (Figure 3-1).

The descriptions that follow identify prominent features and characteristics of the Action Area. Specific information related to physical habitat conditions and species-specific utilization within the Action Area, as well as throughout the respective ESU/DPS is provided in Chapter 4.0 – Status of the Species and in Chapter 5.0 – Environmental Baseline.

3.1.1 Daguerre Point Dam

Daguerre Point Dam is located about ten miles east of Marysville, California, in the Yuba Goldfields (Figure 3-1). The dam is located on a bedrock bench in the piedmont plain of the ancestral Yuba River. A cut 600 feet wide and 25 feet deep was dug in the bedrock bench for the footing of the dam, which was completed in 1910 (Hunerlach et al. 2004). The current configuration of Daguerre Point Dam is an overflow concrete ogee (“s-shaped”) spillway with concrete apron and concrete abutments. The ogee spillway section is 575 feet wide and 24 feet tall. The purpose of Daguerre Point Dam was to retain hydraulic mining debris. This purpose was later modified to include diversion of
The dam is not operated for flood control and there is no water storage capacity as the entire reservoir has been filled with hydraulic mining debris and sediments.

3.1.2 Lower Yuba River

The lower Yuba River consists of the approximately 24-mile stretch of river extending from Englebright Dam, downstream to the confluence with the Feather River near Marysville.

Recently, the RMT (2013) conducted specific studies to rigorously investigate spatial structure in the lower Yuba River by developing an approach to identify the fluvial-geomorphologic dynamics affecting: (1) adult spatial structure components, including the availability of fish habitat for immigrating, holding, and spawning adult salmonids; and
(2) the seasonal availability of rearing habitat for juvenile salmonids. The RMT (2013) morphological unit and mesohabitat classification studies: (1) identified morphological units throughout the lower Yuba River; (2) evaluated the quality, number, size and distribution of mesohabitats for various lifestages of adult and juvenile anadromous salmonids; and (3) evaluated the maintenance of watershed processes in the lower Yuba River. Part of the RMT (2013) process included the identification of morphological reaches in the lower Yuba River, identified and described in Table 3-1.

Table 3-1. Morphological reaches and delineating transparent geomorphic features in the lower Yuba River.

<table>
<thead>
<tr>
<th>Reach Name</th>
<th>Reach Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Englebright Dam Reach</td>
<td>Englebright Dam to confluence with Deer Creek</td>
</tr>
<tr>
<td>Narrows Reach</td>
<td>Deer Creek to onset of emergent gravel floodplain</td>
</tr>
<tr>
<td>Timbuctoo Bend Reach</td>
<td>Emergent gravel floodplain to upstream of Blue Point Mine</td>
</tr>
<tr>
<td>Parks Bar Reach</td>
<td>Upstream of Blue Point Mine to Highway 20 Bridge</td>
</tr>
<tr>
<td>Dry Creek Reach</td>
<td>Highway 20 Bridge to Yuba River confluence with Dry Creek</td>
</tr>
<tr>
<td>Daguerre Reach</td>
<td>Yuba River confluence with Dry Creek downstream to Daguerre Point Dam</td>
</tr>
<tr>
<td>Hallwood Reach</td>
<td>Daguerre Point Dam downstream to Eddie Drive aims at Slope Break</td>
</tr>
<tr>
<td>Marysville Reach</td>
<td>Eddie Drive aims at Slope Break downstream to the mouth of the lower Yuba River</td>
</tr>
</tbody>
</table>

Source: RMT 2013

3.2 Other Aquatic Habitat Areas Affecting the Species’ Status in the ESU/DPS

The discussion of the status of each species includes appropriate information on the species’ life history, current known range and habitat use, distribution, and other data regarding factors necessary to the species’ survival (USFWS and NMFS 1998). Because many listed species are declining throughout their range, the overall population trend of a species has implications for new proposals that could result in additional effects on the
species (USFWS and NMFS 1998). The trends of the remaining populations of listed species form the basis for evaluating the effects of a proposed action on that species. USFWS and NMFS (1998) further state that “Unless a species’ range is wholly contained within the action area, this analysis [describing the status of a species within the action area] is a subset of the preceding rangewide status discussion.”

Because the listed fish species (i.e., spring-run Chinook salmon, steelhead and green sturgeon) that inhabit the lower Yuba River are anadromous, they do not reside in the lower Yuba River for their entire lifecycles. On an ESU/DPS scale, aquatic habitat conditions throughout each species’ range, including the Feather River, the Sacramento River, and the Sacramento-San Joaquin Delta (Delta) affect spring-run Chinook salmon, steelhead, and green sturgeon (Figure 3-2). Although these areas are not contained within the Action Area, they are briefly described here to provide context regarding the lower Yuba River.

### 3.2.1 Feather River

The Feather River Basin encompasses an area of about 5,900 square miles (DWR 2007). The Feather River is considered to be a major tributary to the Sacramento River and provides about 25 percent of the flow\(^1\) in the Sacramento River (DWR 2007). The lower Feather River extends from the Fish Barrier Dam (RM 67.25) near Oroville Reservoir downstream to the confluence of the Feather and Sacramento rivers (RM 0) (Figure 3-2).

Flows in the lower Feather River are influenced by releases from Oroville Dam and Reservoir, which is operated by the California Department of Water Resources (DWR) as part of the SWP). Downstream of Oroville Dam, water is diverted in several directions to: (1) the Thermalito Complex; (2) the Feather River Fish Hatchery (FRFH); and (3) the Low Flow Channel. The sources combine below the Thermalito Afterbay, creating the High Flow Channel. The Low Flow Channel is highly regulated and contains the majority of the anadromous salmonid spawning habitat. The Yuba and Bear rivers are both tributaries to the Feather River. The Yuba River flows into the Feather River near the

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\(^1\) As measured at Oroville Dam.
Figure 3-2. Other aquatic habitat areas affecting Yuba River spring-run Chinook salmon, steelhead and green sturgeon throughout the ESU/DPS (Source: YCWA et al. 2007).
City of Marysville, 39 RM downstream of the City of Oroville. The Bear River flows into the Feather River about 55 RM downstream of the City of Oroville. Approximately 67 RM downstream of the City of Oroville, the Feather River flows into the Sacramento River near the town of Verona (DWR 2007).

### 3.2.2 Sacramento River

The Sacramento River (Figure 3-2) is the largest river system in California, yielding 35 percent of the state’s water supply. Most of the Sacramento River flow is controlled by Reclamation’s Shasta Dam and Reservoir, and river flow is augmented by transfer of Trinity River water through Clear and Spring Creek tunnels to Keswick Reservoir. Immediately below Keswick Dam, the river is deeply incised in bedrock with very limited riparian vegetation.

The upper Sacramento River is often defined as the portion of the river from Princeton (RM 163; downstream extent of salmonid spawning in the Sacramento River) to Keswick Dam (the upstream extent of anadromous fish migration and spawning). The Sacramento River is an important corridor for anadromous fishes moving between the ocean and Delta and upstream river and tributary spawning and rearing habitats. The upper Sacramento River is differentiated from the river’s “headwaters” which lie upstream of Shasta Reservoir. The upper Sacramento River provides a diversity of aquatic habitats, including fast-water riffles and shallow glides, slow-water deep glides and pools, and off-channel backwater habitats (Reclamation et al. 2004).

The lower Sacramento River is generally defined as the portion of the river from Princeton to the Delta at approximately Chipps Island (near Pittsburg). The lower Sacramento River is predominantly channelized, leveed and bordered by agricultural lands. Aquatic habitat in the lower Sacramento River is characterized primarily by slow water glides and pools, is depositional in nature, and has lower water clarity and habitat diversity, relative to the upper portion of the river.
3.2.3 Sacramento-San Joaquin Delta

The Delta is a vast, low-lying inland region located east of the San Francisco Bay Area, at the confluence of the Sacramento and San Joaquin Rivers. Geographically, this region forms the eastern portion of the San Francisco estuary, which includes San Francisco, San Pablo, and Suisun Bays (Figure 3-2). An interconnected network of water channels and man-made islands, the Delta stretches nearly 50 miles from Sacramento south to the City of Tracy, and spans almost 25 miles from Antioch east to Stockton (Public Policy Institute of California 2007). The Delta is a complex area for both anadromous fisheries production and distribution of California water resources for numerous beneficial uses. The Delta also includes the federal CVP Jones Pumping Plant and the SWP Banks Pumping Plant in the south Delta (export pumps). Water withdrawn from the Delta provides for much of California's water needs, including both drinking water and water for agricultural irrigation purposes.
4.0 Status of Listed Species and Critical Habitat

4.1 Physical Features and Habitat Conditions

4.1.1 Hydrology

Historically, the Yuba River supported large numbers of spring-run Chinook salmon, fall-run Chinook salmon, and steelhead. Extensive hydraulic mining in the late 1800s resulted in the massive influx of mining sediments that filled the lower river valleys and profoundly changed the physical character of the lower Yuba River (Moir and Pasternack 2008). The resulting habitat degradation followed by the construction of a series of impassable debris dams from the early to mid-1900s likely caused major reductions in salmon and steelhead populations in the Yuba River Basin (Mitchell 2010). Loss of access to much of their historic spawning and rearing habitat in the upper basin likely had particularly severe impacts on spring-run Chinook salmon and steelhead populations, which depended on the upper basin for successful summer holding and rearing (Yoshiyama et al. 1998; 2001).

The Yuba River suffered perhaps the most significant damage from hydraulic mining of any California river. Approximately 1.5 billion cubic yards of mining debris were washed into the Central Valley from five rivers, with the Yuba River accounting for 40 percent of that total (Mount 1995). Gilbert (1917) as cited in Yoshiyama et al. (2001) estimates that “…during the period 1849-1909, 684 million cubic yards of gravel and debris due to hydraulic mining were washed into the Yuba River system – more than triple the volume of earth excavated during the construction of the Panama Canal”, and Beak Consultants, Inc. (1989) states “The debris plain ranged from about 700 feet wide and up to 150 feet thick near the edge of the foothills to nearly 3 miles wide and 26 feet tall near Marysville” (Beak Consultants, Inc. 1989). In addition to eliminating much of the riparian vegetation corridor along the lower Yuba River (NMFS 2005b), the hydraulic mining debris probably had devastating impacts on salmonids because the sediments in
these debris would have suffocated incubating eggs and pre-emergent fry (NMFS 2001).

Even by the 1870s and 1880s, the Yuba River salmon runs had been greatly diminished by hydraulic mining debris effects (Yoshiyama et al. 2001). In addition, because mercury was used to extract gold from mining debris, mercury exists in the Yuba River system, and this mercury can be extremely toxic to salmonids (NMFS 2001). Cyanide also was used in hard-rock mining to recover gold from the finely ground ore (Sumner and Smith 1940). Along the South Fork of the Yuba River, it was reported that “An occasional heavy dose of the cyanide would kill of fish and their food, even though a stream might otherwise remain unpolluted.” (Sumner and Smith 1939).

The hydrology of the Yuba River has been altered by a series of reservoirs and water conveyance facilities that are operated for water supply, hydropower production, and flood control (Mitchell 2010). Three projects export significant amounts of water from the Yuba River watershed. South Feather Water and Power Agency (formerly Oroville-Wyandotte Irrigation District) diverts water from Slate Creek (a tributary to the North Yuba River) to the South Fork Feather River via its South Feather Power Project. PG&E’s South Yuba Canal diverts water from the South Yuba River, some of which is consumptively used by the Nevada Irrigation District (NID) and some of which is released into the Bear River watershed. These diversions also support NID’s Yuba-Bear Hydroelectric Project. PG&E’s Drum-Spaulding Project diverts water from the South Yuba watershed, via the Drum Canal, to the Drum Forebay. If that water is used at PG&E’s Drum Powerhouse, it is released to the Bear River watershed. If the water is not used there, it is released to Canyon Creek (a tributary of the north fork of the North Fork American River), where it is eventually used for consumptive purposes by Placer County Water Agency and other entities.

The amount of water that these projects collectively export from the Yuba River watershed ranges between 589,000 acre-feet (17.3 percent of unimpaired runoff in wet years) and 267,000 acre-feet (31.1 percent of unimpaired runoff) in critical years1 (SWRI et al. 2000). The impairment of the runoff in the lower Yuba River resulting from these

1 Water year types are defined by the Yuba River Index of SWRCB Decision 1644.
diversions is particularly high during the April through September period during snowmelt runoff, reaching an average of 43.2 percent of the runoff in critical years and an estimated 50.7 percent during hydrologic conditions like those that occurred in 1931 (SWRI et al. 2000).

Located upstream of the Action Area, New Bullards Bar Reservoir was constructed by YCWA on the North Yuba River in the late 1960s, and is the largest water storage reservoir in the watershed. This reservoir is operated for flood control, power generation, irrigation, recreation, and protection and enhancement of fish and wildlife. Since 1970, operation of New Bullards Bar Reservoir has modified the seasonal distribution of flows in the lower Yuba River by reducing spring flows and increasing summer and fall flows. However, the Yuba River below Englebright Dam still experiences a dynamic flood regime because of frequent uncontrolled winter and spring flows (Moir and Pasternack 2008).

Although not part of the Action Area for this ESA consultation, New Bullards Bar Reservoir operations are discussed below in recognition that water released from New Bullards Bar Reservoir flows into Englebright Reservoir and water is then released into the lower Yuba River. The magnitude and timing of water releases controlled by YCWA’s operation of New Bullards Bar Reservoir influence flow and water temperature conditions in the lower Yuba River.

Operations of New Bullards Bar Reservoir can be described in terms of: (1) water management operations (i.e., baseflow operations); (2) storm runoff operations; and (3) flood control operations (NMFS 2009). Baseflow operations describe normal reservoir operations when system flows are controlled through storage regulation. These operations occur outside periods of flood control operations, spilling, bypassing uncontrolled flows into Englebright Reservoir, and outside periods of high unregulated inflows from tributary streams downstream from Englebright Dam (NMFS 2009). Flood control space in New Bullards Bar Reservoir is addressed through a Water Management Group, which was developed by YCWA. During flood control operations, the seasonal flood pool specified in the Corps flood operation manual for New Bullards Bar Reservoir is kept evacuated for flood protection, and to avoid unnecessary flood control releases.
Storm runoff operations occur during the storm season (typically between October and May), but reservoir releases may be required to maintain flood control space between September 15 and June 1 (YCWA et al. 2007). The Corps does not regulate the operations of New Bullards Bar Reservoir and Englebright Dam and Reservoir, which influence flow and water temperature conditions downstream in the lower Yuba River.

Water from Englebright Dam is released through either the Narrows I Powerhouse or the Narrows II Powerhouse or, if Englebright Reservoir is full, over the top of the dam (FERC 1992). Controlled releases are made through the Narrows I and Narrows II powerhouses at total rates of up to about 4,200 cfs; above that rate, releases are made over the spillway at the top of Englebright Dam and are essentially uncontrolled (JSA 2008). Englebright Dam has no low-level outlet.

Narrows I Powerhouse, owned by PG&E, is a 12 MW FERC-licensed facility, with a discharge capacity of approximately 730 cfs and a bypass flow capacity (when the generator is not operating) of 540 cfs. Narrows II, which is part of YCWA’s YRDP, is a 50 MW FERC-licensed facility, with a discharge capacity of approximately 3,400 cfs and a bypass flow capacity of 3,000 cfs. Annual maintenance requires the Narrows II Powerhouse to be shut down for a two- to three-week period, or longer if major maintenance is performed. Maintenance is typically scheduled for mid-September each year. Outflows from Englebright Reservoir pass through either the Narrows II full-flow bypass or through Narrows I during Narrows II maintenance activities.

YCWA and PG&E coordinate the operations of Narrows I and II for hydropower efficiency and to maintain relatively stable flows in the lower Yuba River. The Narrows I Powerhouse typically is used for low-flow reservoir releases (less than 730 cfs), or to supplement the Narrows II Powerhouse capacity during high flow reservoir releases (JSA 2008).

**4.1.1.1 PG&E Narrows I**

PG&E built the Narrows I Powerhouse in the 1940s (NMFS 2005a). Several times during the 1950s, PG&E drew water from storage in Englebright Reservoir to generate power at the Narrows I Powerhouse during October, when adult Chinook salmon were
returning to the Yuba River to spawn (Wooster and Wickwire 1970). PG&E’s releases attracted adult Chinook salmon in the lower Yuba River, but most of them were stranded, and subsequently died when PG&E reduced its releases, and there was very little water left in the lower Yuba River (Wooster and Wickwire 1970). In 1960, several parties, including PG&E and CDFW, reached an agreement to prevent similar fish losses in future years. Under that agreement, CDFW agreed to install a temporary barrier across the lower Yuba River’s mouth before September 7th to prevent Chinook salmon from entering the Yuba River “until October 15, when adequate transportation and spawning flows are provided” (Wooster and Wickwire 1970). While this measure may have helped protect fall-run Chinook salmon, it would not have provided protection for spring-run Chinook salmon, because these fish would have entered the river long before September 7th, and would therefore have been exposed to all of the adverse conditions that occurred in the river during the late summer and fall (NMFS 2005a). These practices were halted following the construction of New Bullards Bar Dam and Reservoir, because the new reservoir provided enough water storage to ensure adequate fall flows during most years (NMFS 2005a).

As previously discussed, the Corps does not regulate or control water rights or releases. Although the Corps does coordinate with PG&E, the Corps does not have the authority to require Narrows I operations-related changes, nor does the Corps control water operations in the upper Yuba River Basin or inflows into Englebright Reservoir.

### 4.1.1.2 YCWA Narrows II

The Narrows II Powerhouse, located about 400 feet downstream of Englebright Dam, was constructed in 1970 as part of the Yuba Project (FERC No. 2246). Narrows II includes one power tunnel and penstock, and one powerhouse. The penstock has a maximum capacity of 3,400 cfs.

YCWA’s maintenance activities at Narrows II include generator brush replacement, which requires a 6-hour shut down 2 to 3 times per year, and annual maintenance, which typically requires a 2 to 3 week shut down, but may be longer if major maintenance is needed (NMFS 2005a). During annual maintenance prior to 2006, the 650 cfs Narrows II bypass valve usually could not be opened, and Narrows I was used to maintain instream
flows in the lower Yuba River. Consequently, in the absence of water spilling over the top of Englebright Dam, flows in the lower Yuba River were reduced to a maximum of 650 cfs for several days to several weeks, depending on the type of maintenance (NMFS 2005a). YCWA schedules annual maintenance activities at Narrows II from late August to mid-September.

**FLOW FLUCTUATIONS AND POWERHOUSE SHUTDOWNS**

In addition to regularly scheduled maintenance outages, low-flow shutdowns (outages) at the Narrows II Powerhouse used to occur when streamflows in the lower Yuba River were below 650 cfs. During such times, YCWA’s and PG&E’s coordinated operation of Narrows I and Narrows II Powerhouses resulted in releases to the lower Yuba River being made exclusively by the Narrows I Powerhouse (NMFS 2005a).

Short-term emergency outages at the Narrows II Powerhouse typically resulted from electrical transmission line faults (e.g., birds, trees, lightning strikes, storms) or plant malfunctions. Depending on the cause of the outage, the Narrows II Powerhouse release could be reduced to somewhere between 0 and 650 cfs (the capacity of the Narrows II Powerhouse bypass) for a period of minutes to one or more hours. In the past, the frequency of these types of outages ranged from none to several in a year, with an annual average of about two per year.

In 2006, YCWA constructed a full-flow bypass on the Narrows II Powerhouse, which allows approximately 3,000 cfs (or 88%), of the 3,400 cfs capacity of the powerhouse to be bypassed around the power generation facilities to maintain river flows during emergencies, maintenance, and accidental shut-downs of the powerhouse (NMFS 2007). This bypass minimizes the possibility that emergencies or other events requiring that the Narrows II Powerhouse be taken offline will cause significant flow fluctuations in the lower Yuba River, and thereby minimizes the possibility that such fluctuations will strand juvenile spring-run Chinook salmon and steelhead, or dewater redds of those species (NMFS 2005a).

Before this bypass was completed, flow reductions resulting from emergency and accidental shutdowns of the Narrows II Powerhouse were a major concern due to adverse flow and water temperature effects on listed spring-run Chinook salmon and steelhead.
The ability to manage releases during maintenance and emergency operations was limited by the design of Englebright Dam and the bypass capability of the Narrows II Powerhouse which was previously only able to bypass 650 cfs (or approximately 20%) of the 3,400 cfs capacity of the powerhouse. In the past, uncontrolled flow reductions due to unexpected outages at Narrows II adversely affected spawning redds and fry/juvenile rearing areas (FERC 2001). However, with the completion of the full-flow bypass in 2006, adverse effects to listed species due to emergencies, maintenance, and accidental shut-downs of the powerhouse have been virtually eliminated.

4.1.2 Fluvial Geomorphology

According to Pasternack (2010), no known records of conditions prior to placer gold mining in the mid-nineteenth century are available that describe the hydrologic conditions in the river reach of the canyon where Englebright Dam and Reservoir are located. During the era of placer gold mining, Malay Camp on the northern bank of the lower Yuba River near the confluence of Deer Creek served as a base of operations for miners working Landers Bar, an alluvial deposit in the nearby canyon. The historical records of the existence of this camp and placer-mining site proves that coarse sediment was stored in the canyon prior to hydraulic mining in a large enough quantity to produce emergent alluvial bars (Pasternack 2010).

During the period of hydraulic gold mining, vast quantities of sand, gravel, and cobble entered the Yuba River (Gilbert 1917 as cited in Yoshiyama et al. 2001) and deposited throughout the system. This human impact completely transformed the river. Historical photos from 1909 and 1937 document that the canyon was filled with alluvial sediment with an assemblage of river features including riffles (Pasternack et al. 2010). Conditions downstream of the canyon during that period were described by James et al. (2009). Even though Daguerre Point Dam was built on the valley floor to prevent the transport of hydraulic mining debris in 1906, it is too small to block sediment migration during floods (Pasternack 2010).

Following the construction of Englebright Dam, historic photographs show that the amount of alluvium in the entire lower Yuba River, including the canyon, decreased
(Pasternack et al. 2010). At the Marysville gaging station, the river incised about 20 feet from 1905-1979, while 0.5 miles downstream of the Highway 20 Bridge it incised about 35 feet over the same period (Beak Consultants, Inc., 1989). Landform adjustments continue to occur - as illustrated by Pasternack (2008), who estimated that about 605,000 yds$^3$ of sediment (primarily gravel and cobble) were exported out of Timbuctoo Bend from 1999 to 2006. Further investigations of landform and sediment-storage changes are on-going.

The reported changes conform with the expected, natural response of a river to blockage of downstream sediment passage (e.g. Williams and Wolman 1984). For most rivers, such geomorphic changes represent a harmful human impact on a river, but here, where there is a pre-existing, unnatural condition of the river corridor influenced by mining debris, the dam is actually contributing to the restoration of the river toward its historical geomorphic condition, in the truest meaning of the term – going back to the pre-existing state prior to hydraulic gold mining (Pasternack 2010).

Despite evidence that Timbuctoo Bend is undergoing significant sediment export and river-corridor incision, White et al. (2010) reported that eight riffles persisted in the same locations over the last 26 years, and possibly longer. Most of these persistent riffles are positioned in the locally wide areas in the valley, while intervening pools are located at valley constrictions. Thus, incision and sediment export do not necessarily translate into harmful degradation of fluvial landforms.

The lower Yuba River has been subjected to harmful in-channel human activities that further altered it. The greatest impact came from dredgers processing and re-processing most of the alluvium in the river valley in the search for residual gold and to control the river (James et al. 2009). First, there was the formation of the approximately 10,000-acre Yuba Goldfields in the ancestral migration belt. Subsequently, there was the relocation of the river to the Yuba Goldfield’s northern edge and its isolation from most of the Goldfields by large “gravel berms” of piled-up dredger spoils. Dredger-spoil gravel berms also exist further upstream in Timbuctoo Bend away from the Yuba Goldfields; these berms provide no flood-control benefit (Pasternack 2010).
Although no gravel berms exist in the canyon downstream of Englebright Dam, mechanized gold mining facilitated by bulldozers, beginning in about 1960, completely reworked the alluvial deposits in the vicinity of the confluence with Deer Creek, changing the lower Yuba River geomorphology (Pasternack et al. 2010). Prior to mechanized mining, glide-riffle transitions were gradual, enabling fish to select among a diverse range of local hydraulic conditions. Bulldozer debris constricted the channel significantly, induced abrupt hydraulic transitioning, and caused the main riffle at the apex of the bar to degrade into a chute. In addition, mining operations evacuated the majority of alluvium at the mouth of Deer Creek, and the 1997 flood caused angular hillside rocks and “shot rock” debris from the canyon bottom to be deposited on top of the hydraulic-mining alluvium in the canyon (Pasternack 2010).

Physical habitat conditions related to salmonids downstream of Englebright Dam have been studied over the years. With respect to the spawning lifestage, Fulton (2008) investigated salmon spawning habitat conditions in the canyon below Englebright Dam and found the conditions to be very poor to nonexistent. No rounded river gravels/cobbles, suitable for spawning, were present in the canyon immediately downstream of Englebright Dam and Sinoro Bar, which is located near the confluence with Deer Creek, until a small amount (500 tons) of gravel was injected artificially by the Corps in November 2007 (see Chapter 2 for additional discussion).

Farther downstream, spawning habitat does not appear to be limited by an inadequate supply of gravel in the lower Yuba River due to ample storage of mining sediments in the banks, bars, and dredger-spoil gravel berms (RMT 2013).

### 4.1.2.1 Englebright Dam Effects

Englebright Dam was not constructed for fish passage and therefore blocks access by anadromous salmonids to the historically utilized habitat located upstream above the dam. Consequently, spring-run Chinook salmon, fall-run Chinook salmon and steelhead in the lower Yuba River are restricted to the 24 miles extending from Englebright Dam to the mouth of the lower Yuba River.
Historically, spring-run and fall-run Chinook salmon were reproductively isolated due to spatial and temporal segregation. Under historic natural conditions, spring-run Chinook salmon migrated during spring high-flow conditions into the upper reaches of the Yuba River watershed, held over the summer in relatively deep coldwater pools, and then spawned in the late summer beginning in early to mid-September (Campbell and Moyle 1990). Fall-run Chinook salmon entered the lower Yuba River later in the year, were generally unable to reach the upper reaches of the Yuba River watershed due to fall low-flow conditions, and are believed to have spawned in areas located farther downstream than those used by spawning spring-run Chinook salmon (NMFS 2007).

The existence of Englebright Dam blocks the migration of spring-run fish, resulting in some overlaps in the temporal and spatial distributions of spawning fall-run and spring-run Chinook salmon in the lower Yuba River. The resultant reduction in reproductive isolation is believed to have resulted in interbreeding and genetic dilution of the genetics of the much smaller spring-run Chinook salmon population (NMFS 2007). There is also the potential, in areas heavily used by spawning fall-run Chinook salmon, for the later spawning fall-run to superimpose their redds onto previously constructed spring-run redds, thereby disrupting the spring-run redds and reducing the survival of eggs in those redds (NMFS 2007).

Another potential adverse effect resulting from the existence of Englebright Dam is that it requires anadromous salmonids to complete their freshwater lifestages in the lower Yuba River without the benefit of (historically available) smaller tributaries, which can provide some level of refuge in the event of catastrophic events such as chemical spills or massive flood events (NMFS 2007). Major catastrophic events are rare, but have the potential to occur in any given year.

Nonetheless, because of the loss of historical spawning and rearing habitat above Englebright Dam, resultant loss of reproductive isolation and subsequent hybridization with fall-run Chinook salmon, restriction of spatial structure and associated vulnerability to catastrophic events, the existence of Englebright Dam represents a very high stressor to Yuba River spring-run Chinook salmon.
4.2 Central Valley Spring-run Chinook Salmon ESU

4.2.1 ESA Listing Status

On September 16, 1999, NMFS listed the Central Valley ESU of spring-run Chinook salmon (Oncorhynchus tshawytscha) as a “threatened” species (64 FR 50394). On June 14, 2004, following a five-year species status review, NMFS proposed that the Central Valley spring-run Chinook salmon remain listed as a threatened species based on the Biological Review Team strong majority opinion that the Central Valley spring-run Chinook ESU is “likely to become endangered within the foreseeable future” due to the greatly reduced distribution of Central Valley spring-run Chinook salmon and hatchery influences on the natural population. On June 28, 2005, NMFS reaffirmed the threatened status of the Central Valley spring-run Chinook salmon ESU, and included the FRFH spring-run Chinook salmon population as part of the Central Valley spring-run Chinook salmon ESU (70 FR 37160).

Section 4(c)(2) of the ESA requires that NMFS review the status of listed species under its authority at least every five years and determine whether any species should be removed from the list or have its listing status changed. In August 2011, NMFS completed a second 5-year status review of the Central Valley spring-run Chinook salmon ESU. Prior to making a determination on whether the listing status of the ESU should be uplisted (i.e., threatened to endangered), downlisted, or remain unchanged, NMFS considered: (1) new scientific information that has become available since the 2005 status review (Good et al. 2005); (2) an updated biological status summary report (Williams et al. 2011) intended to determine whether or not the biological status of spring-run Chinook salmon has changed since the 2005 status review was conducted (referred to as the “viability report”); (3) the current threats to the species; and (4) relevant ongoing and future conservation measures and programs.

Based on a review of the available information, NMFS (2011a) recommended that the Central Valley spring-run Chinook salmon ESU remain classified as a threatened species. NMFS’ review also indicates that the biological status of the ESU has declined since the previous status review in 2005 and, therefore, NMFS recommended that the ESU’s status
be reassessed in 2 to 3 years if it does not respond positively to improvements in environmental conditions and management actions. As part of the 5-year review, NMFS also re-evaluated the status of the FRFH stock and concluded that it still should be considered part of the Central Valley spring-run Chinook salmon ESU.

In addition to Federal regulations, the California Endangered Species Act (CESA, Fish and Game Code Sections 2050 to 2089) establishes various requirements and protections regarding species listed as threatened or endangered under state law. California’s Fish and Game Commission is responsible for maintaining lists of threatened and endangered species under CESA. Spring-run Chinook salmon in the Sacramento River Basin, including the lower Yuba River, was listed as a threatened species under CESA on February 2, 1999.

### 4.2.2 Critical Habitat Designation

Critical habitat was designated for the Central Valley spring-run Chinook salmon ESU on September 2, 2005 (70 FR 52488), and includes stream reaches of the Feather and Yuba rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, and portions of the northern Delta (NMFS 2009a). On the lower Yuba River, critical habitat is designated from the confluence with the Feather River upstream to Englebright Dam. This critical habitat includes the stream channels in the designated stream reaches and their lateral extents, as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series; Bain and Stevenson 1999; 70 FR 52488, September 2, 2005).

#### 4.2.2.1 Primary Constituent Elements

In designating critical habitat, NMFS (2009a) considers the following requirements of the species: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3)
cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, generally, 
(5) habitats that are protected from disturbance or are representative of the historic 
geographical and ecological distributions of a species [see 50 CFR 424.12(b)]. In 
addition to these factors, NMFS also focuses on the key physical and biological features 
within the designated area that are essential to the conservation of the species and that 
may require special management considerations or protection. Specifically, primary 
constituent elements (PCEs) of critical habitat are those physical and biological features 
esential to the conservation of a species for which its designated or proposed critical 
habitat is based on.

Within the range of the spring-run Chinook salmon ESU, the PCEs of the designated 
critical habitat include freshwater spawning sites, freshwater rearing sites, freshwater 
migration corridors, estuarine areas, and nearshore and offshore marine areas. The 
following summary descriptions of the current conditions of the freshwater PCEs for the 
Central Valley spring-run Chinook salmon ESU were taken from NMFS (2009a), with 
the exception of new or updated information regarding current habitat conditions.

**FRESHWATER SPAWNING HABITAT**

Freshwater spawning sites are areas with appropriate water quantity, water quality and 
substrate for successful spawning, egg incubation, and larval development. Spring-run 
Chinook salmon have been reported to spawn in the mainstem Sacramento River between 
Red Bluff Diversion Dam (RBDD) and Keswick Dam, although little spawning activity 
has been reported in recent years. Spring-run Chinook salmon primarily spawn in 
Sacramento River tributaries such as Mill, Deer, and Butte creeks. Operations of Shasta 
and Keswick dams on the mainstem Sacramento River are confounded by the need to 
provide water of suitable temperature for adult winter-run Chinook salmon migration, 
holding, spawning and incubation, as well as for spring-run Chinook salmon embryo 
incubation in the mainstem Sacramento River.

**FRESHWATER REARING HABITAT**

Freshwater rearing sites are areas with: (1) water quantity and floodplain connectivity to 
form and maintain physical habitat conditions and support juvenile growth and mobility;
(2) water quality and forage supporting juvenile development; and (3) habitat complexity characterized by natural cover such as shade, submerged and overhanging LWM, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. The channelized, leved, and rip-rapped river reaches and sloughs that are common in the Sacramento River system typically have low habitat complexity, relatively low production of food organisms, and offer little protection from either fish or avian predators. However, some complex, productive habitats with floodplains remain in the system (e.g., Sacramento River reaches with setback levees (i.e., primarily located upstream of the City of Colusa)) and flood bypasses (i.e., Yolo and Sutter bypasses). Juvenile lifestages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

**FRESHWATER MIGRATION CORRIDORS**

Freshwater migration corridors provide upstream passage for adults to upstream spawning areas, and downstream passage of outmigrant juveniles to estuarine and marine areas. Migratory corridors are downstream of the spawning areas and include the lower reaches of the spawning tributaries, the mainstem of the Sacramento River and the Delta. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (i.e., hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. RBDD, completed in 1964, features a series of 11 gates that, when lowered, provide for gravity diversion of irrigation water from the Sacramento River into the Tehama-Colusa and Corning Canals for potential delivery to the Sacramento Valley National Wildlife Refuge and to approximately 140,000 acres of irrigable lands along the Interstate 5 corridor between Red Bluff and Dunnigan, California (Reclamation 2008b). The RBDD has been a serious impediment to upstream and downstream fish migration, and a significant portion of the Sacramento River spawning habitat for Chinook salmon and steelhead occurs upstream of the dam. Until
recently, the RBDD created an upstream migratory barrier in the mainstem Sacramento River during its May 15 through September 15 “gates in” configuration. In response to the NMFS (2009) BO, the RBDD gates were permanently raised in September 2011 and thus, fish passage conditions have likely improved at the RBDD. The Red Bluff Fish Passage Improvement Project, which included construction of a pumping plant to allow for diversion of water from the Sacramento River without closing the RBDD gates, was completed in 2012 (Tehama-Colusa Canal Authority 2012).

Both the Sacramento River flow, and many juvenile spring-run Chinook salmon, enter the Delta Cross Channel (when the gates are open) and Georgiana Slough, and subsequently the central Delta, especially during periods of increased water export pumping from the Delta. Mortality of juvenile salmon entering the central Delta is higher than for those continuing downstream in the Sacramento River. This difference in mortality could be caused by a combination of factors, including: the longer migration route through the central Delta to the western Delta; exposure to higher water temperatures; higher predation rates; exposure to seasonal agricultural diversions; water quality impairments due to agricultural and municipal discharges; and a more complex channel configuration that makes it more difficult for salmon to successfully migrate to the western Delta and the ocean. In addition, the State and Federal pumps and associated fish facilities increase mortality of juvenile spring-run Chinook salmon through various means, including entrainment into the State and Federal canals, and salvage operations.

**ESTUARINE HABITAT AREAS**

The current condition of the estuarine habitat in the Delta has been substantially degraded from historic conditions. Over 90% of the fringing fresh, brackish, and salt marshes have been lost due to human activities. This loss of the fringing marshes reduces the availability of forage species and eliminates the cycling of nutrients from the marsh vegetation into the water column of the adjoining waterways.

The channels of the Delta have been modified by the raising of levees and armoring of the levee banks with riprap, which has decreased habitat complexity by reducing the incorporation of woody material and vegetative material into the nearshore area,
minimizing and reducing local variations in water depth and velocities, and simplifying
the community structure of the nearshore environment.

Heavy urbanization and industrial actions have lowered water quality and introduced
persistent contaminants to the sediments surrounding points of discharge (i.e., refineries
in Suisun and San Pablo bays, creosote factories in Stockton, etc.)

Delta hydraulics have been modified as a result of federal CVP and state SWP actions.
Within the central and southern Delta, net water movement is towards the pumping
facilities, altering the migratory cues for emigrating fish in these regions. Spring-run
Chinook salmon smolts are drawn to the central and south Delta as they outmigrate, and
are subjected to the indirect effects (e.g., predation, contaminants) and direct effects (e.g.,
salvage, loss) in the Delta and the CVP and SWP fish facilities.

The area of salinity transition, the low salinity zone (LSZ), is an area of high
productivity. Historically, this zone fluctuated in its location in relation to the outflow of
water from the Delta and moved westwards with high Delta inflow (i.e., floods and
spring runoff) and eastwards with reduced summer and fall flows. This variability in the
salinity transition zone has been substantially reduced by the operations of the
CVP/SWP. The CVP/SWP long-term water diversions also have contributed to
reductions in the phytoplankton and zooplankton populations in the Delta, as well as to
alterations in nutrient cycling within the Delta ecosystem.

**NEARSHORE COASTAL MARINE AND OFFSHORE MARINE AREAS**

Spring-run Chinook salmon reside in the Pacific Ocean from one to four years. The first
few months of a salmon’s ocean life has been identified as the period of critical climatic
influences on survival which, in turn, suggests that coastal and estuarine environments
are key areas of biophysical interaction (NMFS 2009). Juvenile salmon grow rapidly as
they feed in the highly productive currents along the continental shelf (Barnhart 1986).

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 and Lindley 2009). 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 (NMFS 2009).

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 as cited in NMFS 2009). Strong upwelling is probably beneficial because it causes greater transport of smolts offshore, beyond major concentrations of inshore predators (Pearcy 1997 as cited in NMFS 2009).

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 (NMFS 2009). The primary issue for the CCE is the onset and length of the upwelling season, that is 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 (NMFS 2009).

4.2.3 Summary of Past and Ongoing Fisheries Studies on the Lower Yuba River

As stated in YCWA (2010), the Yuba River downstream of Englebright Dam is one of the more thoroughly studied rivers in the Central Valley of California. A description of existing information regarding salmonid populations in the lower Yuba River downstream of Englebright Dam is contained in Attachment 1 to YCWA (2010), which is provided in Appendix E of this BA. Appendix E summarizes the available literature for
spring-run Chinook salmon where specifically identified, Chinook salmon in general where runs are not specifically identified, and *O. mykiss*. Much of the referenced information discusses both runs of Chinook salmon and *O. mykiss*, and therefore is presented in its entirety in Appendix E. The appendix describes available field studies and data collection reports, other relevant documents, and ongoing data collection, monitoring and evaluation activities including the Yuba River Accord Monitoring and Evaluation Program (M&E Program) and other data collection and monitoring programs. Appendix E summarily describes 21 available field studies and data collection reports, 20 other relevant documents (e.g., plans, policies, historical accounts and regulatory compliance), 14 ongoing data collection, monitoring and evaluation activities for the M&E Program, and 4 other data collection and monitoring programs.

4.2.4 Historical Abundance and Distribution

Spring-run Chinook salmon were once the most abundant run of salmon in the Central Valley (Campbell and Moyle 1990) and were found in both the Sacramento and San Joaquin drainages. The Central Valley drainage as a whole is estimated to have supported annual runs of spring-run Chinook salmon as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). More than 500,000 spring-run Chinook salmon were reportedly caught in the Sacramento-San Joaquin commercial fishery in 1883 alone (Yoshiyama et al. 1998). Before the construction of Friant Dam (completed in 1942), nearly 50,000 adults were counted in the San Joaquin River (Fry 1961). The San Joaquin populations were essentially extirpated by the 1940s, with only small remnants of the run that persisted through the 1950s in the Merced River (Hallock and Van Woert 1959; Yoshiyama et al. 1998).

Annual run sizes of spring-run Chinook salmon are reported in “GrandTab”, a database administered by CDFW for the Central Valley that includes reported run size estimates from 1960 through 2012, although mainstem Sacramento River estimates are not available for years before 1969 (CDFW 2013). The Central Valley spring-run Chinook salmon ESU has displayed broad fluctuations in adult abundance. Estimates of spring-run Chinook salmon in the Sacramento River and its tributaries (not including the lower
Yuba and Feather rivers because GrandTab does not distinguish between fall-run and spring-run Chinook salmon in-river spawners, and not including the FRFH) have ranged from 1,404 in 1993 to 25,890 in 1982.

The average abundance for the Sacramento River and its tributaries (excluding the lower Yuba and Feather rivers – see above) was 11,646 for the period extending from 1970 through 1979, 14,240 for the period 1980 through 1989, 5,825 for the period 1990 through 1999, and 14,055 for the period 2000 through 2009. Since 1995, spring-run Chinook salmon annual run size estimates have been dominated by Butte Creek returns. Since carcass survey estimates have been available in Butte Creek in 2001 through 2012, Butte Creek returns have averaged 10,874 fish. The estimated spring-run Chinook salmon run size was 18,511 for 2012, of which Butte Creek returns (based on the carcass survey) accounted for 16,140 fish (CDFW 2013).

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, and occupied the middle and upper elevation reaches (1,000 to 6,000 feet) of most streams and rivers with sufficient habitat for over summering adults (Clark 1929). 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% of the original Chinook salmon spawning and holding habitat in the Central Valley drainage is no longer available due to the construction of non-passable dams (Yoshiyama et al. 2001). Adult migrations to the upper reaches of the Sacramento, Feather, and Yuba rivers were eliminated with the construction of major dams during the 1940s, 1950s and 1960s. Naturally spawning populations of spring-run Chinook salmon have been reported to be restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Mill Creek, Feather River, and the Yuba River (CDFG 1998).

Historically, the Yuba River watershed reportedly was one of the most productive habitats for runs of Chinook salmon and steelhead (Yoshiyama et al. 1996). Although it is not possible to estimate the numbers of spawning fish from historical data, CDFG
(1993) suggested that the Yuba River “historically supported up to 15% of the annual run of fall-run Chinook salmon in the Sacramento River system” (Yoshiyama et al. 1996).

By the late 1800s, anadromous fish populations were experiencing significant declines, primarily because of mining activities and resultant extreme sedimentation following flood events (McEwan 2001; Yoshiyama et al. 2001). As an example, the flood of 1861–1862 buried much of the bottomlands along the lower Yuba River under sand deposits averaging two to seven feet deep (Kelley 1989). By 1876 the channel of the lower Yuba River reportedly had become completely filled, and what remained of the adjoining agricultural lands was covered with sand and gravel (Kelley 1989; CDFG 1993) — a marked deterioration of the river as salmon habitat (Yoshiyama et al. 2001).

To control flooding and the downstream movement of sediment, construction of several man-made instream structures on the Yuba River occurred during the early 1900s. A structure referred to as Barrier No. 1, built in 1904 and 1905, was located 1 mile below Parks Bar Bridge near Smartsville and was destroyed by flood waters in March 1907 (Sumner and Smith 1939). This barrier probably hindered salmon upstream movement (Sumner and Smith 1939). In 1906, the California Debris Commission, a partnership between the Federal Government and the State of California, constructed Daguerre Point Dam, specifically to hold back mining debris. In 1910, the Yuba River was diverted over the new dam. This approximately 24-foot high dam retained the debris, but made it difficult for spawning fish to migrate upstream, although salmon reportedly did surmount the dam in occasional years because they were reportedly observed in large numbers in the North Yuba River at Bullards Bar during the early 1920s (Yoshiyama et al. 2001).

Two fishways, one for low water and the other for high water, were constructed at Daguerre Point Dam prior to the floods of 1927-1928 (Clark 1929), when the fish ladders were destroyed, and were not replaced until 1938, leaving a 10-year period when upstream fish passage at Daguerre Point Dam was blocked (CDFG 1991). A fish ladder was constructed at the south end of Daguerre Point Dam in 1938 and was generally ineffective (CDFG 1991), but during the fall of 1938, “several salmon were reported seen below the Colgate Head Dam on the North Fork of the Yuba, 35 miles above Daguerre Point Dam.” (Sumner and Smith 1939).
Upstream of Daguerre Point Dam, the 260-foot-high Englebright Dam was authorized in 1935 to hold back hydraulic mining debris, and was constructed in 1941 by the California Debris Commission. Englebright Dam was not authorized to provide fish passage, therefore it has no fish ladders and blocks anadromous fish access to all areas upstream of the dam (Eilers 2008; PG&E 2008; DWR 2009). The dam restricts anadromous fish to the lower 24 miles of the Yuba River.

There is limited information on the historical population size of spring-run Chinook salmon in the Yuba River. Historical accounts indicate that “large numbers” of Chinook salmon may have been present as far upstream as Downieville on the North Fork Yuba River (Yoshiyama et al. 1996). Due to their presence high in the watershed, Yoshiyama et al. (1996) concluded that these fish were spring-run Chinook salmon.

For the Middle Fork Yuba River, Yoshiyama et al. (2001) concluded that direct information was lacking on historic abundance and distribution of salmon, and they conservatively considered the 10-foot falls located 1.5 miles above the mouth of the Middle Fork Yuba River was the upstream limit of salmon distribution.

Yoshiyama et al. (2001) report that little is known of the original distribution of salmon in the South Fork Yuba River where the Chinook salmon population was severely depressed and upstream access was obstructed by dams when CDFW began surveys in the 1930s. Sumner and Smith (1939) stated that the “South Fork of the Yuba is not considered an angling stream in its 24 miles below the mouth of Poorman Creek, where slickens* (pulverized rock) from the Spanish Mine turns the river a muddy grey.” They also reported that in “Poorman Creek, cyanide poisoning may have done more harm than the slickens... It was evident that some strong poison was entering the stream with the tailings. An occasional heavy dose of cyanide would kill off fish and fish food...” Yoshiyama et al. (2001) consider the cascade, with at least a 12-foot drop, located 0.5 mile below the juncture of Humbug Creek, which was as essentially the historical upstream limit of salmon during most years of natural streamflows.

Clark (1929) reported that the salmon spawning grounds extended from the mouth of the lower Yuba River upstream to the town of Smartsville, but that very few salmon (evidently spring-run) went farther upstream past that point. Sumner and Smith (1940)
report that salmon ascended in considerable numbers up to Bullard’s Bar Dam on the North Fork Yuba River while it was being constructed (1921-1924). In their 1938 survey of Yuba River salmon populations, Sumner and Smith (1940) stated that the height of the dams in the Yuba River blocked all potential salmon and steelhead runs upstream of the barriers (Sumner and Smith 1940). However, Sumner and Smith (1940) describe the ladders as “a rather ineffectual fishway... That few fish have been able to use it...is testified to by the almost universal belief among local residents that at present no fish ever come above the dam.” In addition, the fall-run Chinook salmon run was reportedly destroyed at least temporarily, and many miles of streams rendered unfit for trout (Sumner and Smith 1939).

In 1951, two functional fish ladders were installed by the State of California and it was stated that “With ladders at both ends, the fish have no difficulty negotiating this barrier at any water stage.” (CDFG 1953).

CDFG (1991) reports that a small spring-run Chinook salmon population historically occurred in the lower Yuba River but the run virtually disappeared by 1959, presumably due to the effects of water diversion and hydraulic developments on the river (Fry 1961). As of 1991, a remnant spring-run Chinook salmon population reportedly persisted in the lower Yuba River downstream of Englebright Dam, maintained by fish produced in the lower Yuba River, fish straying from the Feather River, or fish previously and infrequently stocked from the FRFH (CDFG 1991).

In the 1990s, relatively small numbers of Chinook salmon that exhibit spring-run phenotypic characteristics were observed in the lower Yuba River (CDFG 1998). Although precise escapement estimates are not available, the USFWS testified at the 1992 SWRCB lower Yuba River hearing that “…a population of about 1,000 adult spring-run Chinook salmon now exists in the lower Yuba River” (San Francisco Bay RWQCB 2006 as cited in NMFS 2009).

4.2.5 General Life History and Habitat Requirements

This section presents a general overview of lifestage-specific information (e.g., adult immigration and holding, adult spawning, embryo incubation, juvenile rearing and
outmigration) for the Central Valley spring-run Chinook salmon ESU. Then, this section specifically focuses and provides information on lifestage specific temporal and spatial distributions for spring-run Chinook salmon in the lower Yuba River. Recently, the RMT developed representative temporal distributions for specific spring-run Chinook salmon lifestages through review of previously conducted studies, as well as recent and currently ongoing data collection activities of the M&E Program (Table 4-1). The resultant lifestage periodicities encompass the majority of activity for a particular lifestage, and are not intended to be inclusive of every individual in the population (RMT 2010; RMT 2013).

Four distinct runs of Chinook salmon spawn in the Sacramento-San Joaquin River system, with each run named for the season when the majority of the run enters freshwater as adults. The primary characteristic distinguishing spring-run Chinook salmon from the other runs of Chinook salmon is that adult spring-run Chinook salmon enter their natal streams during the spring, and hold in areas downstream of spawning grounds during the summer months until their eggs fully develop and become ready for spawning.

Table 4-1. Lifestage-specific periodicities for spring-run Chinook salmon in the lower Yuba River (Source: RMT 2013).

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4.2.5.1 Adult Immigration and Holding

Adult spring-run Chinook salmon immigration and holding in California’s Central Valley has been reported to occur from mid-February through September (CDFG 1998; Lindley et al. 2004). Spring-run Chinook salmon are known to use the Sacramento River primarily as a migratory corridor to holding and spawning areas located in upstream tributaries. For the mainstem Sacramento River, all of the potential spring-run Chinook salmon holding habitat is located upstream from the Red Bluff Diversion Dam and downstream of Keswick Dam (CDFG 1998).

Suitable water temperatures for adult upstream migration reportedly range between 57°F and 67°F (NMFS 1997). In addition to suitable water temperatures, adequate flows are required to provide migrating adults with olfactory and other cues needed to locate their spawning reaches (CDFG 1998). The primary characteristic distinguishing spring-run Chinook salmon from the other runs of Chinook salmon is that adult spring-run Chinook salmon hold in areas downstream of spawning grounds during the summer months until their eggs fully develop and become ready for spawning. NMFS (1997) states, “Generally, the maximum temperature for adults holding, while eggs are maturing, is about 59-60°F, but adults holding at 55-56°F have substantially better egg viability.”

For the lower Yuba River, adult spring-run Chinook salmon immigration and holding has previously been reported to primarily occur from March through October (Vogel and Marine 1991; YCWA et al. 2007), with upstream migration generally peaking in May (SWRI 2002). The RMT’s examination of preliminary data obtained since the VAKI Riverwatcher infrared and videographic sampling system has been operated (2003 – present) found variable temporal modalities of Chinook salmon ascending the fish ladders at Daguerre Point Dam. The RMT (2013) identified the spring-run Chinook salmon adult immigration and holding period as extending from April through September.

Previously, it has been reported that spring-run Chinook salmon in the lower Yuba River hold over during the summer in the deep pools and cool water downstream of the Narrows I and Narrows II powerhouses, or further downstream in the Narrows Reach (CDFG 1991; SWRCB 2003), where water depths can exceed 40 feet (YCWA et al.)
Congregations of adult Chinook salmon (approximately 30 to 100 fish) have been observed in the outlet pool at the base of the Narrows II Powerhouse, generally during late August or September when the powerhouse is shut down for maintenance. During this time period, the pool becomes clear enough to see the fish (M. Tucker, NMFS, pers. comm. 2003; S. Onken, YCWA, pers. comm. 2004). While it is difficult to visually distinguish spring-run from fall-run Chinook salmon in this situation, the fact that these fish are congregated this far up the river at this time of year indicates that some of them are likely to be spring-run Chinook salmon (NMFS 2007).

Past characterizations of spring-run Chinook salmon distributions from available literature on the lower Yuba River have provided some anecdotal references to behavioral run details (such as migration timing and areas of holding and spawning), but the referenced information has not provided or referenced the basis for these descriptions. Spring-run Chinook salmon have been reported to migrate immediately to areas upstream of the Highway 20 Bridge after entering the lower Yuba River from March through October (Vogel and Marine 1991; YCWA et al. 2007), and then over-summer in deep pools located downstream of the Narrows 1 and 2 powerhouses, or further downstream in the Narrows Reach through the reported spawning period of September through November (CDFG 1991; SWRCB 2003).

The RMT’s (2013) examination of preliminary data obtained since the VAKI Riverwatcher infrared and videographic sampling system has been operated (2003 – present) found variable temporal modalities of Chinook salmon ascending the fish ladders at Daguerre Point Dam. The RMT’s 3-year acoustic telemetry study of adult spring-run Chinook salmon tagged downstream of Daguerre Point Dam during the phenotypic adult upstream migration period has provided new information to better understand adult spring-run Chinook salmon temporal and spatial distributions in the lower Yuba River. The results from the Vaki Riverwatcher monitoring, and particularly from the acoustic telemetry study found past characterizations of temporal and spatial distributions to be largely unsupported, as phenotypic adult spring-run Chinook salmon were observed to exhibit a much more diverse pattern of movement, and holding locations in the lower Yuba River were more expansive than has been previously reported (RMT 2013).
Although some of the acoustically-tagged spring-run Chinook salmon were observed to adhere to other previously reported characterizations, observations from the telemetry study also identified that a large longitudinal extent of the lower Yuba River was occupied by the tagged phenotypic adult spring-run Chinook salmon during immigration and holding periods (Figure 4-1). Figure 4-1 displays all individual fish detections obtained during the RMT’s mobile acoustic tracking surveys conducted from May 2009 until November 2011 (RMT 2013).

Also, temporal migrations to areas upstream of Daguerre Point Dam occurred over an extended period of time (Figure 4-2). The tagged phenotypic adult spring-run Chinook salmon in the lower Yuba River actually migrated upstream of Daguerre Point Dam from May through September, and utilized a broad expanse of the lower Yuba River during the summer holding period, including areas as far downstream as Simpson Lane Bridge (i.e., ~RM 3.2), and as far upstream as the area just below Englebright Dam. A longitudinal analysis of acoustic tag detection data indicated that distributions were non-random, and that the tagged spring-run Chinook salmon were selecting locations for holding.

Figure 4-1. Spatial distribution of all individual acoustically-tagged adult phenotypic spring-run Chinook salmon (SRCS) detections obtained from the mobile tracking surveys conducted during 2009, 2010 and 2011 (Source: RMT 2013).
Figure 4-2. Spatial and temporal distribution of all individual acoustically-tagged adult phenotypic spring-run Chinook salmon detected from the mobile tracking surveys conducted during 2009, 2010 and 2011 in the lower Yuba River (Source: RMT 2013).

The area of the river between Daguerre Point Dam and the Highway 20 Bridge was largely used as a migratory corridor by the tagged adult spring-run Chinook salmon during all three years of the study (RMT 2013). Telemetry data in this area demonstrated relatively brief periods of occupation, characterized by sequential upstream detections as individually-tagged fish migrated through this area. By contrast, frequent and sustained detections were observed from the Highway 20 Bridge upstream to Englebright Dam (RMT 2013).

Examination of individual detection data indicated that tagged phenotypic adult spring-run Chinook salmon that moved upstream of Daguerre Point Dam had generally passed through the Daguerre Point Dam fish ladders by the end of September during all three years (RMT 2013). Acoustic tag detection data were used to discern tagged spring-run Chinook salmon residing in holding areas during June, July and August, and shifting to spawning areas during September into early October. This observation was repeated during all three years of the study, and in all occupied reaches. Telemetry data demonstrated that the majority of tagged phenotypic adult spring-run Chinook salmon that ascended the ladders at Daguerre Point Dam also continued to move farther upstream.
to the Timbuctoo, Narrows, and Englebright Dam reaches during September, coincident
with the initiation of spawning activity (RMT 2013).

YCWA (2013) used the RMT’s 2009-2011 acoustic tagging study data to evaluate
movements of the individual acoustically-tagged spring-run Chinook salmon and
potential relationships between changes in flow. Visual examination of the time series
plots of daily locations of individual acoustically-tagged Chinook salmon and mean daily
flows at the Smartsville Gage showed highly variable behavior among individuals on a
daily basis within and among years. However, several general patterns of fish movement
in relationship to flow are apparent.

- Abrupt upstream movement coinciding with an increase in flow
- Abrupt upstream movement coinciding with a decrease in flow
- Abrupt downstream movement coinciding with a decrease in flow
- Abrupt upstream movement occurring after an increase in flow

YCWA (2013) found that most of the individual movements of acoustically-tagged
spring-run Chinook salmon potentially associated with a change in Smartsville flow were
abrupt upstream movements occurring concurrently with a noticeable decrease in flow.
Additional notable observations included some individuals that abruptly moved upstream
in the days following a reduction in flow.

Observed movements of individual spring-run Chinook salmon identified during 2009
generally occurred within the time period from about mid-May to early September, and
generally occurred over a period ranging from one to nine days. Most of the observed
movements identified during 2010 occurred during early to mid-June, with a few
movements occurring during August, and generally occurred over a period ranging from
about one to seven days. The identified movements during 2011 generally occurred
during late August into early September, and generally occurred over a period ranging
from about one to five days. Because spring-running Chinook salmon immigrated into
the lower Yuba River later in 2011 than during 2009 and 2010, and were not captured
and acoustically-tagged until July, no potential relationships between fish movement and
flow reductions during the spring months could be evaluated for 2011.
More than half (40 out of 60) of the identified movements of Chinook salmon over the three years that were potentially associated with a concurrent change in flow consisted of upstream movements coinciding with a large decrease in flow (measured at the Smartsville Gage). Most of the identified upstream movements occurring coincident to a decrease in flow occurred when flow decreased substantially during a 1 to 2 week period in late August to early September and/or during a 1 to 2 week period during May or June, depending on the year. In other words, the most common potential relationship identified between spring-run Chinook salmon movement and flow was an abrupt and continued movement upstream to the upper reaches during a large reduction in mean daily Smartsville flow (38 to 68% reduction in flow) occurring over about 1 to 2 weeks.

4.2.5.2 Adult Spawning

In the Central Valley, spawning has been reported to primarily occur from September to November, with spawning peaking in mid-September (DWR 2004c; Moyle 2002; Vogel and Marine 1991). Within the ESU, spring-run Chinook salmon spawn in accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Mill Creek, Feather River, and the Yuba River (CDFG 1998).

All of the potential spring-run Chinook salmon spawning habitat in the mainstem Sacramento River is located upstream from the Red Bluff Diversion Dam and downstream of Keswick Dam (CDFG 1998). It has been reported that in some years high water temperatures would prevent spring-run Chinook salmon egg and embryo survival (USFWS 1990 as cited in CDFG 1998). During years of low storage in Shasta Reservoir and under low flow releases, water temperatures exceed 56°F downstream of Keswick Dam during critical months for spring-run Chinook salmon spawning and egg incubation (YCWA et al. 2007).

In general, Central Valley spring-run Chinook salmon have been reported to spawn at the tails of holding pools (Moyle 2002; NMFS 2007). Redd sites are apparently chosen in part by the presence of subsurface flow. Chinook salmon usually seek a mixture of gravel and small cobbles with low silt content to build their redds. Characteristics of spawning habitats that are directly related to flow include water depth and velocity. Chinook
salmon spawning reportedly occurs in water velocities ranging from 1.2 feet/sec to 3.5 feet/sec, and spawning typically occurs at water depths greater than 0.5 feet (YCWA et al. 2007).

For the lower Yuba River, the spring-run Chinook salmon spawning period has been reported to extend from September through November (CDFG 1991; YCWA et al. 2007). Limited reconnaissance-level redd surveys conducted by CDFW since 2000 during late August and September have detected spawning activities beginning during the first or second week of September. They have not detected a bimodal distribution of spawning activities (i.e., a distinct spring-run spawning period followed by a distinct fall-run Chinook salmon spawning period), and instead have detected a slow build-up of spawning activities starting in early September and transitioning into the main fall-run spawning period.

The RMT’s (2013) examination of the 2009, 2010 and 2011 acoustically-tagged spring-run Chinook salmon data revealed a consistent pattern in fish movement. In general, acoustically-tagged spring-run Chinook salmon exhibited an extended holding period, followed by a rapid movement into upstream areas (upper Timbuctoo Reach, Narrows Reach, and Englebright Reach) during September. Then, a period encompassing approximately one week was observed when fish held at one specific location, followed by rapid downstream movement. The approximate one-week period appeared to be indicative of spawning events, which ended by the first week in October. These observations, combined with early redd detections and initial carcasses appearing in the carcass surveys (see below), suggest that the spring-run Chinook salmon spawning period in the lower Yuba River may be of shorter duration than previously reported, extending from September 1 through mid-October (RMT 2013).

The earliest spawning (presumed to be spring-run Chinook salmon) generally occurs in the upper reaches of the highest quality spawning habitat (i.e., below the Narrows pool) and progressively moves downstream throughout the fall-run Chinook salmon spawning season (NMFS 2007). Spring-run Chinook salmon spawning in the lower Yuba River is believed to occur upstream of Daguerre Point Dam. USFWS (2007) collected data from 168 Chinook salmon redds in the lower Yuba River on September 16-17, 2002 and
September 23-26, 2002, considered to be spring-run Chinook salmon redds. The redds were all located above Daguerre Point Dam. During the pilot redd survey conducted from the fall of 2008 through spring of 2009, the RMT (2010a) report that the vast majority (96%) of fresh Chinook salmon redds constructed by the first week of October 2008, potentially representing spring-run Chinook salmon, were observed upstream of Daguerre Point Dam. Similar distributions were observed during the 2010 and 2011 redd surveys, when weekly redd surveys were conducted. About 97 and 96% of the fresh Chinook salmon redds constructed by the first week of October were observed upstream of Daguerre Point Dam during 2009 and 2010, respectively (RMT 2013).

4.2.5.3 Embryo Incubation

The spring-run Chinook salmon embryo incubation period encompasses the time period from egg deposition through hatching, as well as the additional time while alevins remain in the gravel while absorbing their yolk sacs prior to emergence.

The length of time for spring-run Chinook salmon embryos to develop depends largely on water temperatures. In well-oxygenated intragravel environs where water temperatures range from about 41ºF to 55.4ºF embryos hatch in 40 to 60 days and remain in the gravel as alevins for another 4 to 6 weeks, usually after the yolk sac is fully absorbed (NMFS 2009). In Butte and Big Chico creeks, emergence occurs from November through January, and in the colder waters of Mill and Deer creeks, emergence typically occurs from January through as late as May (Moyle 2002).

In the lower Yuba River, the RMT (2013) concluded that spring-run Chinook salmon embryo incubation period generally extends from September through December.

4.2.5.4 Juvenile Rearing and Outmigration

After emerging, Chinook salmon fry tend to seek shallow, nearshore habitat with slow water velocities and move to progressively deeper, faster water as they grow. However, fry may disperse downstream, especially if high-flow events correspond with emergence (Moyle 2002). Spring-run juveniles may emigrate as fry soon after emergence, rear in their natal streams for several months prior to emigration as young-of-the-year, or remain in their natal streams for extended periods and emigrate as yearlings. Information
regarding the duration of rearing and timing of emigration of spring-run Chinook salmon
in the Central Valley is summarized in NMFS (2009), much of which is presented herein.

Upon emergence from the gravel, juvenile spring-run Chinook salmon may reside in
freshwater for 12 to 16 months, but some migrate to the ocean as young-of-the-year fish
in the winter or spring months within eight months of hatching (CALFED 2000). 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).

The timing of juvenile emigration from the spawning and rearing grounds varies among
the tributaries of origin, and can occur during the period extending from October through
April (Vogel and Marine 1991). 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
later in the spring. Some juveniles continue to rear in Butte Creek through the summer
and emigrate as yearlings from October to February, with peak yearling emigration
occurring in November and December (CDFG 1998). 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). In contrast, data
collected on the Feather River suggests that the bulk of juvenile emigration occurs during
November and December (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.

In general, juvenile Chinook salmon have been collected by electrofishing and observed
by snorkeling throughout the lower Yuba River, but with higher abundances above
Daguerre Point Dam (Beak 1989; CDFG 1991; Kozlowski 2004). This may be due to
larger numbers of spawners, greater amounts of more complex, high-quality cover, and
lower densities of predators such as striped bass and American shad, which reportedly are
restricted to areas below the dam (YCWA et al. 2007). During juvenile rearing and
outmigration, salmonids prefer stream margin habitats with sufficient depths and velocities to provide suitable cover and foraging opportunities. Juvenile Chinook salmon reportedly utilize river channel depths ranging from 0.9 feet to 2.0 feet, and most frequently are in water with velocities ranging from 0 feet/sec to 1.3 feet/sec (Raleigh et al. 1986).

Juvenile snorkeling surveys conducted in the lower Yuba River during 2012 indicate that juvenile Chinook salmon in the lower Yuba River initially prefer slower, shallower habitat, and move into faster and deeper water as they grow. RMT (2013) reported that the vast majority of observations of juvenile Chinook salmon in the lower Yuba River occurred in water velocities and depths indicative of slackwater and slow glide mesohabitats. Juvenile Chinook salmon are known to prefer slower water habitats than many other members of Oncorhynchus (Quinn 2005), and have been previously reported to actively seek out slow backwaters, pools, or floodplain habitat for rearing (Sommer et al. 2001; Jeffres et al. 2008). The snorkeling data collected by the RMT during 2012 are generally consistent with other data available for multiple rivers (Bjornn and Reiser 1991). Juvenile Chinook salmon in the 30-50 mm size class tended to occupy shallower habitats than larger (and presumably older) individuals, which is consistent with other observations of salmonids (e.g., Bjornn and Reiser 1991). Similarly, juvenile Chinook salmon showed a clear preference for faster water (up to an average of about 1.8 ft/s) as they grew, consistent with trends found with salmonids in other rivers (Bjornn and Reiser 1991).

Based upon review of available information, the RMT (2010b) recently identified the spring-run Chinook salmon fry rearing period as extending from mid-November through March, the juvenile rearing period extending year-round, and the young-of-year (YOY) emigration period extending from November through mid-July. Associated with the previously described shortened duration of spring-run Chinook salmon spawning, the fry rearing period is estimated to extend from mid-November through mid-February (RMT 2013). Updated characterization of the juvenile (YOY) emigration (i.e., downstream movement) period extends from mid-November through June (RMT 2013).
In the lower Yuba River, CDFW has conducted juvenile salmonid outmigration monitoring by operating rotary screw traps (RSTs) near Hallwood Boulevard, located approximately 6 RM upstream from the city of Marysville. CDFW’s RST monitoring efforts generally extended from fall (October or November) through winter, and either into spring (June) or through the summer (September) annually from 1999 to 2006. The RMT took over operation of the year-round RST effort in the fall of 2006, and continued operations through August 2009 (RMT 2013).

Analyses of CDFW RST data indicate that most Chinook salmon juveniles move downstream past the Hallwood Boulevard location prior to May of each year. For the 5 years of data included in the analyses, 97.5 to 99.2% of the total numbers of juvenile Chinook salmon were captured by May 1 of each year. The percentage of the total juvenile Chinook salmon catch moving downstream past the Hallwood Boulevard location each year ranged from 0.4 to 1.3% during May, and 0 to 1.2% during June (YCWA et al. 2007). During the 2007/2008 sampling period, 95% of all juvenile Chinook salmon were captured by June 2, 2008 (Campos and Massa 2010a). Analysis of the fitted distribution of weekly juvenile Chinook salmon catch at the Hallwood Boulevard RST site from survey year 1999 through 2008 revealed that most emigration occurred from late-December through late-April in each survey year (RMT 2013). Approximately 95% of the observed catch across all years based on the fitted distribution occurred by April 30 (RMT 2013).

Overall, most (about 84%) of the juvenile Chinook salmon were captured at the Hallwood Boulevard RSTs soon after emergence from November through February, with relatively small numbers continuing to be captured through June. Although not numerous, captures of (oversummer) holdover juvenile Chinook salmon ranging from about 70 to 140 mm FL, primarily occurred from October through January with a few individuals captured into March (Massa 2005; Massa and McKibbin 2005). These fish likely reared in the river over the previous summer, representing an extended juvenile rearing strategy characteristic of spring-run Chinook salmon. During the 2007/2008 sampling period, 33 Chinook salmon that met this criterion were observed at the Hallwood Boulevard RST site from mid-December through January. Juvenile Chinook salmon captured during the fall and early winter (October-January) larger than 70 mm are
likely exhibiting an extended rearing strategy in the lower Yuba River (Campos and Massa 2010a).

For the sampling periods extending from 2001 to 2005, CDFW identified specific runs based on sub-samples of lengths of all juvenile Chinook salmon captured in the RSTs by using the length-at-time tables developed by Fisher (1992), as modified by S. Greene (DWR 2003b). Although the veracity of utilization of the length-at-time tables for determining the run type of Chinook salmon in the Yuba River has not been ascertained, based on the examination of run-specific determinations, in the lower Yuba River the vast majority (approximately 94%) of spring-run Chinook salmon were captured as post-emergent fry during November and December, with a relatively small percentage (nearly 6%) of individuals remaining in the lower Yuba River and captured as YOY from January through March. Only 0.6% of the juvenile Chinook salmon identified as spring-run was captured during April, and only 0.1% during May, and none were captured during June (YCWA et al. 2007). The above summary of juvenile Chinook salmon emigration monitoring studies in the Yuba River is most consistent with the temporal trends of spring-run Chinook salmon outmigration reported for Butte and Big Chico creeks (YCWA et al. 2007).

### 4.2.5.5 Smolt Emigration

For the Central Valley, it has been reported that while some spring-run Chinook salmon emigrate from natal streams soon after emergence during the winter and early-spring (NMFS 2004a), some may spend as long as 18 months in freshwater and move downstream as smolts during the first high flows of the winter, which typically occur from November through January (CDFG 1998; USFWS 1995). In the Sacramento River drainage, spring-run Chinook salmon smolt emigration reportedly occurs from October through March (CDFG 1998). In Butte Creek, some juvenile spring-run Chinook salmon rear through the summer and emigrate as yearlings from October to February, with peak yearling emigration occurring in November and December (CDFG 1998). In the Feather River, some spring-run Chinook salmon smolts reportedly emigrate from the Feather River system from October through June (B. Cavallo, DWR, pers. comm. 2004).
Although it has been previously suggested that spring-run Chinook salmon smolt emigration generally occurs from November through June in the lower Yuba River (CALSFD and YCWA 2005; CDFG 1998; SWRI 2002), recent (1999-2005), CDFW monitoring data indicate that the vast majority of spring-run Chinook salmon emigrate as post-emergent fry during November and December. There were some captures of (over-summer) holdover juvenile Chinook salmon ranging from about 70 to 140 mm FL, which primarily occurred from October through January with a few individuals captured into March (Massa 2005; Massa and McKibbin 2005). These fish likely reared in the river over the previous summer, representing an extended juvenile rearing strategy characteristic of spring-run Chinook salmon. During the 2007/2008 sampling period, 33 Chinook salmon that met this criterion were observed at the Hallwood Boulevard RST site from mid-December through January. Juvenile Chinook salmon captured during the fall and early winter (October-January) larger than 70 mm are likely exhibiting an extended rearing strategy in the lower Yuba River (Campos and Massa 2010a).

Based upon review of available information, the RMT (2013) recently identified the spring-run Chinook salmon smolt (yearling+) outmigration period as extending from October through mid-May.

4.2.5.6 Lifestage-Specific Water Temperature Suitabilities

During November 2010, the RMT prepared a technical memorandum (RMT 2010b) to review the appropriateness of the water temperature regime associated with implementation of the Yuba Accord using previously available data and information, updated in consideration of recent and ongoing monitoring activities conducted by the RMT since the pilot programs were initiated in 2006. The RMT’s objectives for that memorandum were to review and update the lifestage periodicities of target species in the lower Yuba River, identify the appropriate thermal regime for target fish species taking into account individual species and lifestage water temperature requirements, identify water temperature index values, assess the probability of occurrence that those water temperature index values would be achieved with implementation of the Yuba Accord, and to evaluate whether alternative water temperature regimes are warranted.
Since November 2010, additional water temperature monitoring and life history investigations of anadromous salmonids in the lower Yuba River have been conducted by the RMT. An update to the water temperature suitability evaluation in RMT (2010) was recently conducted by RMT (2013). The water temperature suitability evaluation conducted for this BA incorporates additional water temperature monitoring data from what was presented in RMT (2013).

Through review of previously conducted studies, as well as recent and currently ongoing data collection activities of the M&E Program, the RMT (2013) developed the following representative lifestage-specific periodicities and primary locations for water temperature suitability evaluations. The locations used for water temperature evaluations correspond to Smartsville, Daguerre Point Dam, and Marysville.

- Adult Immigration and Holding (April through September) – Smartsville, Daguerre Point Dam, and Marysville
- Spawning (September through mid-October) – Smartsville
- Embryo Incubation (September through December) – Smartsville
- Juvenile Rearing and Outmigration (Year-round) – Daguerre Point Dam and Marysville
- Smolt (Yearling+) Emigration (October through mid-May) – Daguerre Point Dam and Marysville

Lifestage-specific water temperature index values used as evaluation guidelines for spring-run Chinook salmon were developed based on the information described in Attachment A to RMT (2010b), as well as additional updated information provided in Bratovich et al. (2012). These documents present the results of literature reviews that were conducted to: (1) interpret the literature on the effects of water temperature on the various lifestages of Chinook salmon and steelhead; (2) consider the effects of short-term and long-term exposure to constant or fluctuating temperatures; and (3) establish water temperature index (WTI) values to be used as guidelines for evaluation. Specifically, the RMT (2013) evaluation adopted the approach established by Bratovich et al. (2012) which uses the lifestage and species-specific upper tolerance WTI values. These WTI
values were not meant to be significance thresholds, but instead provide a mechanism by which to compare the suitability of the water temperature regimes associated with implementation of the Yuba Accord. Spring-run Chinook salmon lifestage-specific WTI values are provided in Table 4-2. The lifestages and periodicities presented in Table 4-2 differ from those presented in Table 4-1 due to specific lifestages that have the same or distinct upper tolerable WTI values.

Table 4-2. Spring-run Chinook salmon lifestage-specific upper tolerance WTI values.

<table>
<thead>
<tr>
<th>Lifestage</th>
<th>Upper Tolerance WTI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jan</td>
</tr>
<tr>
<td>Adult Migration</td>
<td>68°F</td>
</tr>
<tr>
<td>Adult Holding</td>
<td>65°F</td>
</tr>
<tr>
<td>Spawning</td>
<td>58°F</td>
</tr>
<tr>
<td>Embryo Incubation</td>
<td>58°F</td>
</tr>
<tr>
<td>Juvenile Rearing and Downstream Movement</td>
<td>65°F</td>
</tr>
<tr>
<td>Smolt (Yearling+) Emigration</td>
<td>68°F</td>
</tr>
</tbody>
</table>

Recent water temperature monitoring data in the lower Yuba River are available for the period extending from 2006 into June 2013, during which time operations have complied with the Yuba Accord. In general, the lowest water temperatures in the lower Yuba River are observed during January and February, and water temperatures steadily increase until mid-June or July, remain at relatively high values through September and steadily decrease thereafter. The coldest water temperatures are observed upstream at the Smartsville Gage, intermediate water temperatures occur at Daguerre Point Dam, and the warmest temperatures are observed downstream at the Marysville Gage for most months of the year. The least amount of spatial variation in water temperature is observed during late fall through winter months (i.e., late November through February), when water temperatures are similar at the three monitoring locations.

Figure 4-3 displays daily water temperature monitoring results from October 2006 through late June 2013 at the Smartsville, Daguerre Point Dam, and Marysville water temperature gages, superimposed with spring-run Chinook salmon lifestage-specific...
Figure 4-3. Monitored lower Yuba River water temperatures and spring-run Chinook salmon upper tolerance WTI values.

upper tolerance WTI values. Water temperatures at all three gages during the period evaluated are always below the upper tolerance WTI values for smolt (yearling+), outmigration, juvenile rearing and outmigrati on, and adult immigration and holding. The upper tolerance spawning and embryo incubation WTI value is never exceeded at Smartsville, which is the only location evaluated for spring-run Chinook salmon spawning and embryo incubation.

4.2.6 Limiting Factors, Threats and Stressors

Limiting factors and threats supporting the listing of the Central Valley spring-run Chinook salmon ESU are presented in two documents. The first is titled “Factors for Decline: A Supplement to the Notice of Determination for West Coast Steelhead” (NMFS 1996). That report concluded that all of the factors identified in section 4(a)(1) of the ESA have played roles in the decline of steelhead and other salmonids, including Chinook salmon. The report identifies destruction and modification of habitat, overutilization of fish for commercial and recreational purposes, and natural and human-made factors as being the primary reasons for the declines of west coast steelhead and other salmonids including Chinook salmon. The second document is a supplement to the
document referred to above. This document is titled ‘‘Factors Contributing to the Decline of West Coast Chinook Salmon: An Addendum to the 1996 West Coast Steelhead Factors for Decline Report’’ (NMFS 1998a).

At the ESU level, more recent descriptions of limiting factors, threats and stressors are provided in the CVP/SWP OCAP BA (Reclamation 2008), the CVP/SWP OCAP BO (NMFS 2009a), and the Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead (NMFS Draft Recovery Plan) (NMFS 2009). In addition to the ESU-level discussions, limiting factors, threats and stressors specifically addressing spring-run Chinook salmon in the lower Yuba River are discussed in the NMFS Draft Recovery Plan (NMFS 2009). These documents are incorporated by reference into this BA, and brief summaries of limiting factors, threats and stressors to spring-run Chinook salmon at the ESU level, and in the lower Yuba River specifically, are provided below. These brief summaries provide additional detail, explanation or clarification of limiting factors, threats and stressors in the lower Yuba River.

4.2.6.1 ESU

According to the NMFS Draft Recovery Plan (NMFS 2009), threats to Central Valley spring-run Chinook salmon are in three broad categories: (1) loss of historical spawning habitat; (2) degradation of remaining habitat; and (3) threats to the genetic integrity of the wild spawning populations from the FRFH spring-run Chinook salmon production program. As stated in the NMFS (2009), the Central Valley spring-run Chinook salmon 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 long-term climate change also may adversely affect spring-run Chinook salmon and their recovery. The 2009 NMFS OCAP BO (2009a), summarized below, identified the factors that have lead to the current status of the species to be habitat blockage, water development and diversion dams, water conveyance and flood control, land use activities, water quality,
hatchery operations and practices, over-utilization (e.g., ocean commercial and sport harvest, inland sport harvest), disease and predation, environmental variation (e.g., natural environmental cycles, ocean productivity, global climate change), and non-native invasive species.

**Habitat Blockage**

Hydropower, flood control, and water supply dams of the CVP, SWP, and other municipal and private entities have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. As a result of migrational barriers, spring-run Chinook salmon (as well as winter-run Chinook salmon and steelhead) populations have been confined to lower elevation mainstems that historically only were used by these species for migration and rearing. Population abundances have declined in these streams due to decreased quantity, quality, and spatial distribution of spawning and rearing habitat (Lindley et al. 2009). Higher temperatures at these lower elevations during late-summer and fall are also a major stressor to adult and juvenile salmonids.

Juvenile downstream migration patterns have been altered by the presence of dams. Juvenile spring-run Chinook salmon (as well as winter-run) on the mainstem Sacramento River generally outmigrate earlier than they did historically because they are hatched considerably farther downstream and now have less distance to travel. Therefore, smolts in the Sacramento River under present conditions must rear for a longer period of time in order to reach sizes comparable to those of smolts that historically reared in upstream reaches above the dams. However, for several months of the year, habitat conditions in the mainstem Sacramento River do not provide the necessary features for listed anadromous fish species, especially for an extended period of time.

**Water Development**

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have altered the natural hydrologic cycles on which juvenile and adult salmonids historically based their migration patterns upon (NMFS 2009a). As much as 60% of the natural historical inflow to Central Valley watersheds and the Delta has been diverted for human uses. Dams have contributed to lower flows, higher water
temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and LWM. More uniform flows year round have resulted in diminished natural channel formation, altered food web processes, and slower regeneration of riparian vegetation.

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands exist throughout the Central Valley. Thousands of small and medium-size water diversions exist along the Sacramento River, its tributaries and the Delta. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions have the potential to entrain many lifestages of aquatic species, including juvenile salmonids.

The Anderson-Cottonwood Irrigation District (ACID) operates a diversion dam across the Sacramento River about 5 miles downstream of Keswick Dam, which is one of the three largest diversions on the Sacramento River. Operated from April through October, the installation and removal of the diversion dam flashboards requires close coordination between Reclamation and ACID. Because substantial reductions (limited to 15% in a 24-hour period and 2.5% in any 1 hour) in Keswick Dam releases are necessary to install or remove the flashboards, the ACID diversion dam operations have the potential to impact various lifestages of Chinook salmon (e.g., redd dewatering, juvenile stranding and exposure to elevated water temperatures). Redd dewatering primarily affects spring- and fall-run Chinook salmon during October. Although flow reductions are usually of a short-term duration (i.e., lasting less than 8 hours), these short-term flow reductions may cause mortality through desiccation of incubating eggs and loss of stranded juveniles.

Located 59 miles downstream of Keswick Dam, RBDD is owned and operated by Reclamation. Historically, RBDD impeded adult salmonid passage throughout its May 15 through September 15 “gates in” period. Although there are fish ladders at the right and left banks, and a temporary ladder in the middle of the dam, they were not very efficient at passing fish because it was difficult for fish to locate the entrances to the ladders. Water released from RBDD flows through a small opening under each of the 11 gates in the dam cause turbulent flows that confused fish and keep them from finding the ladders. The effects resulting from upstream migrational delays at RBDD ranged from
delayed but eventually successful spawning, to pre-spawn mortality and the complete loss of spawning potential in that fraction of the population. The fish ladders are not designed to allow a sufficient amount of flow through them to attract adult salmonids, and previous studies have shown that salmon could be delayed up to 20 days in passing the dam. These delays had the potential to reduce the fitness of adults that expend their energy reserves fighting the flows beneath the gates, and increase the chance of pre-spawn mortality. Passage delays of a few days up to a week were believed to prevent timely movement of adult spring-run Chinook salmon upstream to enter the lower reaches of Sacramento River tributaries (e.g., Cottonwood Creek, Cow Creek) above the RBDD, which dry up or warm up during the spring. These passage delays prevented adult spring-run Chinook salmon from accessing summer holding pools in the upper reaches of these tributaries. As previously discussed, the RBDD gates were permanently raised in September 2011 and, thus, many of the historical migration-related stressors associated with this location have likely been eliminated due to the improved fish passage conditions.

Outmigrant juvenile salmonids in the Delta have been subjected to adverse environmental conditions created by water export operations at the CVP and SWP facilities. Specifically, juvenile salmonid survival has been reduced by: (1) water diversions from the mainstem Sacramento River into the Central Delta through the Delta Cross Channel (DCC); (2) upstream or reverse flows of water in the lower San Joaquin River and southern Delta waterways; (3) entrainment at the CVP/SWP export facilities and associated problems at Clifton Court Forebay; and (4) increased exposure to introduced, non-native predators such as striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*), and sunfishes (*Centrarchidae spp.*) within the waterways of the Delta.

**WATER CONVEYANCE AND FLOOD CONTROL**

More than 1,600 miles of levee construction in the Central Valley has constricted river channels, disconnected floodplains from active river channels, reduced riparian habitat, and reduced natural channel function, particularly in lower reaches of the Sacramento River and the Delta (NMFS 2009a). The development of the water conveyance system in
the Delta also has resulted in the construction of armored, rip-rapped levees on more than 1,100 miles of channels and diversions to increase channel elevations and flow capacity of the channels (Mount 1995 as cited in NMFS 2009a).

Levee development in the Central Valley has affected anadromous salmonid spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitats. Many of the levees use angular rock (riprap) to armor the banks from erosive forces. The effects of channelization and rip-rapping include the alteration of river hydraulics and vegetative cover along the banks as a result of changes in bank configuration and structural features (Stillwater Sciences 2006 as cited in NMFS 2009a). These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000; Schmetterling et al. 2001 as cited in NMFS 2009a; Garland et al. 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than those that occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and to escape from fast currents, deep water, and predators (Stillwater Sciences 2006 as cited in NMFS 2009a). In addition, the armoring and revetment of stream banks tend to narrow rivers, reducing the amount of habitat per unit channel length (Sweeney et al. 2004). As a result of river narrowing, benthic habitat decreases and the number of macroinvertebrates (e.g., stoneflies, mayflies) per unit channel length decreases, affecting salmonid food supply.

LWM is a functionally important component of many streams (NMFS 1996). LWM influences stream morphology by affecting channel pattern, position, and geometry, as well as pool formation (Keller and Swanson 1979; Bilby 1984; Robison and Beschta 1990). Reduction of wood in the stream channel, either from past or present activities, generally reduces pool quantity and quality, alters stream shading which can affect water temperature regimes and nutrient input, and can eliminate critical stream habitat needed for both vertebrate and invertebrate populations. Removal of vegetation also can destabilize marginally stable slopes by increasing the subsurface water load, lowering
root strength, and altering water flow patterns in the slope. During the 1960s and early 1970s, it was common practice among California fishery management agencies to remove LWM thought to be a barrier to fish migration (NMFS 1996). However, it is now recognized that too much LWM was removed from streams in past decades, resulting in a loss of salmonid habitat. The large scale removal of LWM prior to 1980 is believed to have had major, long-term adverse effects on juvenile salmonid rearing habitat in northern California (NMFS 1996). Aquatic habitat areas that were subjected to the removal of LWM are still limited in the recovery of salmonid stocks, and NMFS (2009) expects that this limitation could persist for 50 to 100 years.

**LAND USE ACTIVITIES**

Land use activities continue to have large-scale impacts on salmonid habitat in the Central Valley. According to Lindley et al. (2009), “Degradation and simplification of freshwater and estuary habitats over a century and a half of development have changed the Central Valley Chinook salmon complex from a highly diverse collection of numerous wild populations to one dominated by fall Chinook salmon from four large hatcheries.”

Until about 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation extending outward for 4 or 5 miles (California Resources Agency 1989). Starting with the gold rush, vast riparian forests were cleared for building materials, fuel, and to open land for farming along the banks of the river. The clearing of the riparian forests also removed a vital source of snags and driftwood in the Sacramento River Basin. The removal of in-river snags and obstructions for navigational safety has further reduced the presence of LWM in the Sacramento River and the Delta (see LWM discussion above). The degradation and fragmentation of riparian habitat continued with extensive flood control and bank protection projects, together with the conversion of the fertile riparian lands to agriculture. By 1979, riparian habitat along the Sacramento River diminished to about 2% (i.e., 11,000 to 12,000 acres) of historic levels (McGill and Price 1987).

Land use activities associated with road construction, urban development, logging, mining, agriculture, and recreation have significantly altered fish habitat quantity and quality through the alteration of streambank and channel morphology, alteration of
ambient water temperatures, degradation of water quality, elimination of spawning and
rearing habitat, fragmentation of available habitats, elimination of downstream
recruitment of LWM, and removal of riparian vegetation, resulting in increased
streambank erosion (Meehan 1991 as cited in NMFS 2009a). Urban stormwater and
agricultural runoff may be contaminated with herbicides and pesticides, petroleum
products, sediment, etc. Agricultural practices in the Central Valley have eliminated
large trees and logs and other woody debris that would otherwise be recruited into the
stream channel (NMFS 1998a).

Increased sedimentation resulting from agricultural and urban practices is one of the
primary causes of salmonid habitat degradation in the Central Valley (NMFS 1996).
Sedimentation can adversely affect salmonids during all freshwater lifestages by clogging
or abrading gill surfaces, adhering to eggs, hampering fry emergence (Phillips and
Campbell 1961 as cited in NMFS 2009a), burying eggs or alevins, scouring and filling in
pools and riffles, reducing primary productivity and photosynthesis activity (Cordone and
Kelley 1961), and affecting intergravel permeability and DO levels. Excessive
sedimentation over time can cause substrates to become embedded, which reduces
successful salmonid spawning and egg and fry survival (Waters 1995 as cited in
NMFS 2009a).

River channel dredging to enhance inland maritime trade and to provide raw material for
levee construction also has altered the natural hydrology and function of the Central
Valley rivers. Since the mid-1800s, the Corps and others have straightened and
artificially deepened river channels to enhance shipping commerce, consequently
reducing the natural river meander and the formation of pool and riffle segments. In the
early 1900s, the Sacramento Flood Control Project ushered in large scale Corps actions
for reclamation and flood control purposes along the Sacramento River and in the Delta.
The creation of levees and the deep shipping channels reduced the natural tendency of the
Sacramento River to create floodplains along its banks during seasonal inundation
periods (e.g., spring snow melt). The annual inundations provided necessary juvenile
rearing and foraging habitat that became available in conjunction with seasonal flooding
processes. The armored riprapped levee banks and active maintenance actions of
Reclamation Districts precluded the establishment of ecologically important riparian
vegetation, introduction of valuable LWM from these riparian corridors, and the
productive intertidal mudflats characteristic of the undisturbed Delta habitat.

Since the 1850s, reclamation of wetlands for urban and agricultural development has
resulted in the cumulative loss of tidal marsh habitat downstream (79%) and upstream
(94%) of Chipps Island (Conomos et al. 1985; Nichols et al. 1986; Wright and Phillips
1988 as cited in NMFS 2009a; Monroe et al. 1992 as cited in NMFS 2009a; Goals
Project 1999). Little of the extensive tracts of wetland marshes that existed prior to 1850
along the Central Valley river systems and within the natural flood basins exist today.
Most wetland and marsh areas have been “reclaimed” for agricultural purposes, leaving
only small remnant patches of available habitat. In the Delta, juvenile salmonids are
exposed to increased water temperatures during the late spring and summer due to the
loss of riparian shading and thermal inputs from municipal, industrial, and agricultural
discharges. Studies by DWR on water quality in the Delta over the last 30 years show a
steady decline in food resources available for juvenile salmonids, as well as an increase
in the clarity of the water due to a reduction in phytoplankton and zooplankton. These
conditions are believed to have contributed to increased juvenile Chinook salmon and
steelhead mortality as fish move through the Delta.

**WATER QUALITY**

Over the past 150 years, the water quality of the Delta has been adversely affected by
increased water temperatures, decreased DO levels, and increased turbidity and
contaminant loads, which have degraded the quality of the aquatic habitat for the rearing
and migration of salmonids. Historic and ongoing point and nonpoint source discharges
impact surface waters, and portions of major rivers and the Delta are impaired, to some
degree, by discharges from agriculture, mines, urban areas and industries (California
RWQCB 1998). Pollutants include effluents from wastewater treatment plants and
chemical discharges (e.g., dioxin from San Francisco Bay petroleum refineries) (McEwan
and Jackson 1996). Agricultural drain water, another possible source of contaminants,
can contribute up to 30% of the total inflow into the Sacramento River during drier
conditions (Reclamation 2008a).
According to NMFS (2009a), the California RWQCB (1998; 2001) has identified the Delta as an impaired waterbody having elevated levels of chlorpyrifos, dichlorodiphenyltrichlor (i.e. DDT), diazinon, mercury, Group A pesticides (e.g., aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan and toxaphene), organic enrichment, as well as low DO. In general, water degradation or contamination can lead to either acute toxicity, resulting in death when concentrations are sufficiently elevated, or more typically, when concentrations are lower, to chronic or sublethal effects that reduce the physical health of the organism, and lessens its survival over an extended period of time. Mortality may become a secondary effect due to compromised physiology or behavioral changes that lessen the organism's ability to carry out its normal activities. For listed species, these effects may occur directly to the listed fish or to its prey base, which reduces the forage base available to the listed species.

In the aquatic environment, most anthropogenic chemicals and waste materials, including toxic organic and inorganic chemicals eventually accumulate in sediment (Ingersoll 1995 as cited in NMFS 2009a). Direct exposure to contaminated sediments may cause deleterious effects if a fish swims through a plume of the re-suspended sediments or rests on contaminated substrate and absorbs the toxic compounds via dermal contact, ingestion, or uptake across the gills. Although sediment contaminant levels can be significantly higher than the overlying water column concentrations (EPA 1994), the more likely means of exposure is through the food chain when fish feed on organisms that are contaminated with toxic compounds. Prey species become contaminated either by feeding on the detritus associated with the sediments or dwelling in the sediment itself. Therefore, the degree of exposure to the salmonids depends on their trophic level and the amount of contaminated forage base consumed. Salmonid biological responses to contaminated sediments are similar to those resulting from waterborne exposures once a contaminant has entered the body of the fish.

**Hatchery Operations and Practices**

CDFW is currently operating 10 salmon and steelhead hatchery facilities in California. Eight of these 10 facilities (i.e., Iron Gate, Trinity River, Warm Springs, Feather River,
Nimbus, Mokelumne River, and Merced River Hatcherries and the Coyote Valley Fish Facility) were constructed below dams on major rivers as mitigation for loss of access to anadromous fish habitat upstream of the dams. The Thermalito Annex, which is not located below a dam, supports the mitigation and enhancement programs that include Chinook and coho salmon for the FRFH.

Five hatcheries currently produce Chinook salmon in the Central Valley, and four of these also produce steelhead. Releasing large numbers of hatchery fish can pose a threat to wild Chinook salmon and steelhead stocks through genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs in the Central Valley are primarily caused by straying of hatchery fish and the subsequent interbreeding of hatchery fish with wild fish. In the Central Valley, practices such as transferring eggs between hatcheries and trucking smolts to distant sites for release contribute to elevated straying levels (USDOI 1999, as cited in NMFS 2009a).

Hatchery practices as well as spatial and temporal overlaps of habitat use and spawning activity between spring- and fall-run Chinook salmon have led to the hybridization and homogenization of some subpopulations (CDFG 1998). As early as the 1960s, Slater (1963) observed that spring-run and early fall-run were competing for spawning sites in the Sacramento River below Keswick Dam, and speculated that the two runs may have hybridized. Spring-run Chinook salmon from the FRFH have been documented as straying throughout the Central Valley for many years (CDFG 1998), and may have contributed to hybridization. In the Feather River, the lack of physical separation has led to hybridization of spring- and fall-run Chinook salmon.

The relatively low number of spawners needed to sustain a hatchery population can result in high harvest-to-escapements ratios in waters where fishing regulations are set according to hatchery population. This can lead to over-exploitation and reduction in the size of wild populations existing in the same system as hatchery populations due to incidental by-catch (McEwan 2001).
Hatcheries also can have some positive effects on salmonid populations. Spring-run Chinook salmon produced in the FRFH are considered part of the spring-run Chinook salmon ESU. Artificial propagation has been shown to be effective in bolstering the numbers of naturally spawning fish in the short term under specific scenarios. Artificial propagation programs can also aid in conserving genetic resources and guarding against catastrophic loss of naturally spawned populations at critically low abundance levels (IMST 2001, as cited in NMFS 2004).

OVERUTILIZATION

OCEAN COMMERCIAL AND SPORT HARVEST

Extensive ocean recreational and commercial troll fisheries for Chinook salmon exist along the Northern and Central California coast, and an inland recreational fishery exists in the Central Valley for Chinook salmon and steelhead. The Central Valley Index (CVI) is an annual index of abundance of all Central Valley Chinook salmon stocks combined, and is defined as the calendar year sum of ocean fishery Chinook harvests in the area south of Point Arena, California (where 85% of Central Valley Chinook salmon are caught), plus the Central Valley adult Chinook spawning escapement (Lindley et al. 2009). Since 1991, the PFMC’s Salmon Technical Team (comprised of scientists from NMFS, USFWS, and state fisheries agencies from OR, WA, and CA) has used a linear regression of the CVI on the previous year’s Central Valley age-2 return to forecast the CVI (BDCP 2009). The CVI harvest rate index is an annual index of the ocean harvest rate on all Central Valley Chinook stocks combined, and is defined as the ocean harvest landed south of Point Arena, California, divided by the CVI (Lindley et al. 2009).

There are no Pacific Coast Salmon Fisheries Management Plan (FMP) objectives in place specifically regulating the harvest of spring-run Chinook salmon, except that the FMP will manage ocean fisheries consistent with NMFS ESA consultation standards (BDCP 2009). The current FMP harvest constraints on winter-run Chinook salmon serve as proxy for Central Valley spring-run Chinook salmon (BDCP 2009). Spring-run Chinook salmon CVI harvest rate index ranged from 0.55 to nearly 0.80 between 1970 and 1995, when harvest rates were adjusted for the protection of winter-run Chinook salmon (NMFS 2003). The decline in the CVI harvest rate index to 0.27 in 2001 as a result of
high fall-run Chinook salmon escapement also resulted in reductions to the authorized harvesting of spring-run Chinook salmon (NMFS 2003).

FRFH spring-run Chinook salmon provide indices of harvest of natural spring-run. Maturing age-3 and age-4 spring-run Chinook salmon are vulnerable to the early portion of the recreational and commercial season, whereas fall-run Chinook salmon are exposed to an entire harvest season (BDCP 2009). Inferences drawn from coded-wire tag recoveries indicate that 44% of the spring-run Chinook salmon are taken prior to May 1, the start of the commercial fishing season (BDCP 2009). Ocean fisheries have affected the age structure of spring-run Chinook salmon through targeting large fish for many years and reducing the numbers of 4- and 5-year-old fish (CDFG 1998). As a result of very low returns to the Central Valley in 2007, there was a complete closure of the commercial and recreational ocean Chinook salmon fishery in 2008 and 2009. Due to improved ocean salmon numbers, a severely restricted commercial season and short recreational season opened in 2010 (Bacher 2011). On April 13, 2011, the Pacific Fishery Management Council (PFMC) adopted a set of ocean salmon seasons that provides both recreational and commercial opportunities during the 2011 fishing season. PFMC (2011) reports that “Greatly improved abundance of Sacramento River fall-run Chinook salmon will fuel the first substantial ocean salmon fisheries off California and Oregon since 2007. Fisheries south of Cape Falcon are supported by Sacramento River fall Chinook. In 2008 and 2009, poor Sacramento returns led to the largest ocean salmon fishery closure on record. The abundance forecast of Sacramento River fall Chinook in 2011 is 730,000, far above the number needed for optimum spawning this fall (122,000-180,000 fish).”

INLAND SPORT HARVEST

Historically in California, almost half of the river sport fishing effort has occurred in the Sacramento-San Joaquin River system, particularly upstream from the city of Sacramento (Emmett et al. 1991). In-river recreational fisheries historically have taken spring-run Chinook salmon throughout the species’ range. During the summer, adult spring-run Chinook salmon are targeted by anglers when the fish congregate and hold in large pools. Poaching also occurs at fish ladders, and other areas where adults congregate. However,
the significance of poaching on the adult population is unknown (NMFS 2009a).
Specific regulations for the protection of spring-run Chinook salmon in Mill, Deer, Butte, and Big Chico creeks and the lower Yuba River have been added to the CDFW regulations.

**DISEASE AND PREDATION**

Salmonids are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment (NMFS 1996, 1996a, 1998a), and infectious disease is one of many factors that influence adult and juvenile salmonid survival. Specific diseases such as bacterial kidney disease, Ceratomyxosis shasta, columnaris, furunculosis, infectious hematopoietic necrosis, redmouth and black spot disease, whirling disease, and erythrocytic inclusion body syndrome are known, among others, to affect Chinook salmon and steelhead (NMFS 1996; 1996a; 1998a). Little current or historical information exists to quantify changes in infection levels and mortality rates attributable to these diseases; however, studies have shown that wild fish tend to be less susceptible to pathogens than are hatchery-reared fish (NMFS 2009a). Nevertheless, wild salmonids may contract diseases that are spread through the water column (i.e., waterborne pathogens) as well as through interbreeding with infected hatchery fish. The stress of being released into the wild from a controlled hatchery environment frequently causes latent infections to convert into a more pathological state, and increases the potential of transmission from hatchery reared fish to wild stocks within the same waters.

As described in NMFS (2005a), accelerated predation is also a significant factor affecting critical habitat for spring-run Chinook salmon. Although predation is a natural component of spring-run Chinook salmon life ecology, the rate of predation likely has greatly increased through the introduction of non-native predatory species such as striped bass (*Marone saxatilis*) and largemouth bass (*Micrapterus salmoides*), and through the alteration of natural flow regimes and the development of structures that attract predators, including dams, bank revetment, bridges, diversions, piers, and wharfs (Stevens 1961; Vogel et al. 1988 as cited in NMFS 2009; Garcia 1989 as cited in Reclamation 2008; Decato 1978 as cited in Reclamation 2008). The USFWS found that more predatory fish
were found at rock revetment bank protection sites between Chico Landing and Red
Bluff than at sites with naturally eroding banks (Michny and Hampton 1984). On the
mainstem Sacramento River, high rates of predation are known to occur at RBDD, ACID,
GCID, and at south Delta water diversion structures (CDFG 1998). From October 1976
to November 1993, CDFW conducted ten mark/recapture experiments at the SWP's
Clifton Court Forebay to estimate prescreen losses using hatchery-reared juvenile
Chinook salmon. Pre-screen losses ranged from 69 to 99%. Predation from striped bass
is thought to be the primary cause of the loss (CDFG 1998; Gingras 1997).

Predation on juvenile salmonids has increased as a result of water development activities,
which have created ideal habitats for predators and non-native invasive species. As
juvenile salmonids pass the Sacramento River system dams, fish are subject to conditions
that can disorient them, making them highly susceptible to predation by fish or birds.
Striped bass and Sacramento pikeminnow (*Ptychocheilus grandis*), a species native to the
Sacramento River Basin that co-evolved with anadromous salmonids, congregate below
dams and prey on juvenile salmon in the tail waters. Tucker et al. (1998) reported that:
(1) striped bass exhibit a strong preference for juvenile salmonids; (2) during the summer
months, juvenile salmonids increased to 66% of the total weight of Sacramento
pikeminnow stomach contents; and (3) the percent frequency of occurrence for juvenile
salmonids nearly equaled other fish species in the stomach contents of the predatory fish.
Additionally, Tucker et al. (2003) showed the temporal distribution for these two
predatory species in the RBDD area were directly related to RBDD operations (i.e.,
predators congregated when the dam gates were in, and dispersed when the dam gates
were removed).

Other locations in the Central Valley where predation is of concern include flood
bypasses, post-release sites for salmonids salvaged at the CVP and SWP Fish Facilities,
and the Suisun Marsh Salinity Control Gates (SMSCG). The dominant predator species
at the SMSCG was striped bass, and the remains of juvenile Chinook salmon were
identified in their stomach contents (Edwards et al. 1996; Tillman et al. 1996; NMFS
1997a). Striped bass and pikeminnow predation on salmon at salvage release sites in the
Delta and lower Sacramento River has been documented (Orsi 1967; Pickard et al. 1982).
However, accurate predation rates at these sites are difficult to determine. From October
1976 to November 1993, CDFW conducted 10 mark/recapture studies at the SWP’s Clifton Court Forebay to estimate pre-screen losses using hatchery-reared juvenile Chinook salmon. Pre-screen losses ranged from 69 to 99%, and predation by striped bass is thought to be the primary cause of the loss (Gingras 1997). More recent studies by DWR (2008) have verified this level of predation also exists for steelhead smolts within Clifton Court Forebay, indicating that these predators were efficient at removing salmonids over a wide range of body sizes.

Avian predation on fish contributes to the loss of migrating juvenile salmonids (NMFS 2009a). Fish-eating birds (e.g., great blue herons, black-crowned night herons, gulls, osprey) in the Central Valley have high metabolic rates and require large quantities of food relative to their body size. Mammals can also be an important source of predation on salmonids within the California Central Valley. These animals, especially river otters, are capable of removing large numbers of salmon and trout from the aquatic habitat (Dolloff 1993 as cited in NMFS 2009a). Mammals have the potential to consume large numbers of salmonids, but generally scavenge post-spawned salmon. In the marine environment, Southern Resident killer whales target Chinook salmon as their preferred prey (96% of prey consumed during spring, summer and fall, from long-term study of resident killer whale diet; Ford and Ellis 2006).

**ENVIRONMENTAL VARIATION**

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. Global climate change is playing an increasingly important role in scientific and policy debates related to effective water management. The most considerable impacts of climate change on water resources in the United States are believed to occur in the mid-latitudes of the West, where the runoff cycle is largely determined by snow accumulation and subsequent melt patterns. Evidence is continuing to accumulate to indicate global climate change will have a
marked effect on water resources in California. Numerous peer-reviewed scientific articles on climate and water issues in California have been published to date, with many more in preparation, addressing a range of considerations from proposed improvements in the downscaling of general circulation models to understanding how reservoir operations might be adapted to new conditions (Kiparsky and Gleick 2003).

NMFS (2009) states that the potential effects of long-term climate change may adversely affect spring-run Chinook salmon and steelhead, and the recovery of both species. Current climate change information suggests that the Central Valley climate will become warmer, a challenging prospect for Chinook salmon and steelhead – both of which are coldwater fish at the southern end of their distribution. According to NMFS (2009a), early marine survival for juvenile salmon is a critical phase in their survival and development into adults. The correlation between various environmental indices that track ocean conditions and salmon productivity in the Pacific Ocean, both on a broad and local scale, provides an indication of how climate-related factors influence salmon survival in the ocean. Consistent with the approach taken in recent NMFS BOs (NMFS 2011; NMFS 2010; NMFS 2010a; NMFS 2010b), the discussion below describes the potential climate-related threats anticipated to affect the status of listed species, including inter-annual climatic variations (e.g. El Niño and La Niña), the Wells Ocean Productivity Index, and longer term cycles in ocean conditions pertinent to salmonid survival (e.g., Pacific Decadal Oscillation).

**NATURAL ENVIRONMENTAL CYCLES**

Natural climate variability in freshwater and marine environments has the potential to substantially affect salmonid abundance, particularly during early lifestages (NMFS 2008). Sources of variability include inter-annual climatic variations (e.g., El Niño and La Niña), longer-term cycles in ocean conditions (e.g., Pacific Decadal Oscillation, Mantua et al. 1997), and ongoing global climate change. Climate variability can affect ocean productivity in the marine environment, as well as water storage (e.g., snow pack) and in-stream flow in the freshwater environment. Early lifestage growth and survival of salmon can be negatively affected when climate variability results in conditions that hinder ocean productivity (e.g., Scheuerell and Williams 2005) and water storage (e.g.,
Independent Scientific Advisory Board 2007) in marine and freshwater systems, respectively.

Fisheries scientists have shown that ocean climate varies strongly at decadal scales (e.g., Beamish 1993; Beamish and Bouillon 1993; Graham 1994; Miller et al. 1994; Hare and Francis 1995; Mantua et al. 1997; Mueter et al. 2002). In particular, the identification of the Pacific Decadal Oscillation (PDO) (Mantua et al. 1997) has led to the belief that decadal-scale variation may be cyclical, and thus predictable (Lindley et al. 2007). Evidence also suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare et al. 1999 as cited in NMFS 2009a; Mantua and Hare 2002). In addition, large-scale climatic regime shifts, such as the El Niño condition, appear to change productivity levels over large expanses of the Pacific Ocean. A further confounding effect is the fluctuation between drought and wet conditions in the basins of the American west. During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years, which reduced inflows to watersheds up and down the west coast.

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

A key factor affecting many West Coast stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is
presumed that survival of Chinook salmon in the ocean is driven largely by events occurring between ocean entry and recruitment to a sub-adult lifestage. The freshwater life history traits and habitat requirements of juvenile winter-run and fall-run Chinook salmon are similar. Therefore, the unusual and poor ocean conditions that caused the drastic decline in returning fall-run Chinook salmon populations coast-wide in 2007 (Varanasi and Bartoo 2008) are suspected to have also caused the observed decrease in the winter-run Chinook salmon spawning population in 2007 (Oppenheim 2008 as cited in NMFS 2009a). Lindley et al. (2009) reviewed the possible causes for the decline in Sacramento River fall-run Chinook salmon in 2007 and 2008 for which reliable data were available. They concluded that a broad body of evidence suggested that anomalous conditions in the coastal ocean in 2005 and 2006 resulted in unusually poor survival of the 2004 and 2005 broods of fall-run Chinook salmon. However, Lindley et al. (2009) recognize that the rapid and likely temporary deterioration in ocean conditions acted on top of a long-term, steady degradation of the freshwater and estuarine environment.

As suggested by Rudnick and Davis (2003) and Hsieh et al. (2005), apparent regime shifts need not be cyclical or predictable, but rather may be the expression of a stochastic process. If this interpretation is correct, then we should expect future ocean climate conditions to be different than those observed over the past few decades (Lindley et al. 2007).

Lindley et al. (2007) further state that Central Valley salmonid ESUs and DPSs are capable of surviving the kinds of climate extremes observed over the past few thousand years if they have functional habitats, because these lineages are on order of a thousand years old or older. There is growing concern, however, that the future climate will be unlike that seen before, due to global warming in response to anthropogenic greenhouse gas emissions (Lindley et al. 2007).

**Ocean Productivity**

The time when juvenile salmonids enter the marine environment marks a critical point in their life history. Studies have shown the greatest rates of growth and energy accumulation for Chinook salmon occur during the first 1 to 3 months after they enter the ocean (Francis and Mantua 2003 as cited in NMFS 2009a; MacFarlane et al. 2008 as
cited in NMFS 2009a). Emigration periods and ocean entry can vary substantially among, and even within, runs in the Central Valley. Winter-run Chinook salmon typically rear in freshwater for 5 to 9 months and exhibit a peak emigration period in March and April. Spring-run Chinook salmon emigration is more variable and can occur in December or January (soon after emergence as fry), or from October through March (after rearing for a year or more in freshwater; Reclamation 2008). In contrast to Chinook salmon, steelhead tend to rear in freshwater environments longer (anywhere from 1 to 3 years) and their period of ocean entry can span many months. Juvenile steelhead presence at Chipps Island has been documented between at least October and July (Reclamation 2008). While still acknowledging this variability in emigration patterns, a general statement can be made that Chinook salmon typically rear in freshwater environments for less than a year and enter the marine environment as sub-yearlings in late spring to early summer (NMFS 2009a). Similarly, although steelhead life histories are more elastic, they typically enter the ocean in approximately the same time frame. The general timing pattern of ocean entry is commonly attributed to evolutionary adaptations that allow salmonids to take advantage of highly productive ocean conditions that typically occur off the California coast beginning in spring and extending into the fall (MacFarlane et al. 2008 as cited in NMFS 2009a). Therefore, the conditions that juvenile salmonids encounter when they enter the ocean can play an important role in their early marine survival and eventual development into adults.

Variations in salmon marine survival correspond with periods of cold and warm ocean conditions, with cold regimes being generally favorable for salmon survival and warm regimes unfavorable (Behrenfeld et al. 2006; Wells et al. 2006). Peterson et al. (2006) provide evidence that growth and survival rates of salmon in the California Current System (CCS) off the Pacific Northwest can be linked to fluctuations in ocean conditions. The CCS extends up to 1000 km offshore from Oregon to Baja California and encompasses a southward meandering surface current, a pole-ward undercurrent and surface countercurrents that exhibit high biological productivity, diverse regional characteristics, and intricate eddy motions that have mystified oceanographers for decades.
An evaluation of conditions in the CCS since the late 1970s reveals that a generally warm, unproductive regime persisted until the late 1990s. This regime was followed by a period of high variability that began with colder, more productive conditions lasting from 1999 to 2002. In general, salmon populations increased substantially during this period. However, the brief cold cycle was immediately succeeded by a 4-year period of predominantly warm ocean conditions beginning in late 2002, which appeared to negatively impact salmon populations in the CCS (Peterson et al. 2006). These regime shifts follow a more or less linear pattern beginning with the amount and timing of nutrients provided by upwelling and passing “up” the food chain from plankton to forage fish and eventually, salmon. There are also indications that these same regime shifts affect the migration patterns of larger animals that prey on salmon (e.g., Pacific hake, sea birds) resulting in a “top-down” effect as well (Peterson et al. 2006).

Peterson et al. (2006) evaluated three sets of ecosystem indicators to identify ecological properties associated with warm and cold ocean conditions and determine how those conditions can affect salmon survival. The three sets of ecosystem indicators include: (1) large-scale oceanic and atmospheric conditions [specifically, the PDO and the Multivariate ENSO Index]; (2) local observations of physical and biological ocean conditions off northern Oregon (e.g., upwelling, water temperature, plankton species compositions, etc.); and (3) biological sampling of juvenile salmon, plankton, forage fish, and Pacific hake (which prey on salmon). When used collectively, this information can provide a general assessment of ocean conditions in the northern California Current that pertain to multi-year warm or cold phases. It can also be used to develop a qualitative evaluation for a particular year of the effect these ocean conditions have on juvenile salmon when they enter the marine environment and the potential impact to returning adults in subsequent years (NMFS 2009a).

The generally warmer ocean conditions in the California Current that began to prevail in late 2002 have resulted in coastal ocean temperatures remaining 1°C to 2°C above normal through 2005. A review of the previously mentioned indicators for 2005 revealed that almost all ecosystem indices were characteristic of poor ocean conditions and reduced salmon survival (NMFS 2009a). For instance, in addition to the high sea surface temperatures, the spring transition, which marks the beginning of the upwelling season
and typically occurs between March and June, was very late, postponing upwelling until mid-July. In addition, the plankton species present during that time were the smaller organisms with lower lipid contents associated with warmer water, as opposed to the larger, lipid-rich organisms believed to be essential for salmon growth and survival throughout the winter. The number of juvenile salmon collected during trawl surveys was also lower than any other year previously sampled since 1998 (Peterson et al. 2006). Furthermore, although conditions in 2006 appeared to have improved somewhat over those observed in 2005 (e.g., sea surface temperature was cooler, the spring transition occurred earlier, and coastal upwelling was more pronounced), not all parameters were necessarily “good.” In fact, many of the indicators were either “intermediate” (e.g., PDO, juvenile Chinook salmon presence in trawl surveys) or “poor” (e.g., copepod biodiversity, Peterson et al. 2006).

Peterson et al. (2006) shows the transition to colder ocean conditions, which began in 2007 and persisted through 2008. For juvenile salmon that entered the ocean in 2008, ocean indicators suggested a highly favorable marine environment (NMFS 2009a). After remaining neutral through much of 2007, PDO values became negative (indicating a cold California Current) in late 2007 and remained negative through at least August 2008, when sea surface temperatures also remained cold. Because coastal upwelling was initiated early and the larger, energy-rich, coldwater plankton species were present in large numbers during 2007 and 2008, ocean conditions in the broader California Current appear to have been favorable for salmon survival in 2007 and to a greater extent in 2008. These ecosystem indicators can be used to provide an understanding of ocean conditions, and their relative impact on marine survival of juvenile salmon, throughout the broader, northern portion of the California Current. However, they may not provide an accurate assessment of the conditions observed on a more local scale off the California coast.

Wells et al. (2008) developed a multivariate environmental index that can be used to assess ocean productivity on a finer scale for the central California region. This index (also referred to as the Wells Ocean Productivity Index) has also tracked the Northern Oscillation Index, which can be used to understand general ocean conditions in the North Pacific Ocean. The divergence of these two indices in 2005 and 2006 provided evidence that ocean conditions were worse off the California coast than they were in the broader
North Pacific region. The Wells et al. (2008) index incorporates 13 oceanographic
variables and indices and has correlated well with the productivity of zooplankton,
juvenile shortbelly rockfish, and common murre production along the California coast
(MacFarlane et al. 2008 as cited in NMFS 2009a). In addition to its use as an indicator of
general ocean productivity, the index may also relate to salmon dynamics due to their
heavy reliance on krill and rockfish as prey items during early and later lifestages. For
instance, not only did the extremely low index values in 2005 and 2006 correlate well
with the extremely low productivity of salmon off the central California coast in those
years, but the index also appears to have correlated well with maturation and mortality
rates of adult salmon from 1990-2006 in that region (Wells and Mohr 2008 as cited in
NMFS 2009a).

Available information suggests ocean conditions in 2007 and 2008 improved
substantially over those observed in 2005 and 2006. The spring transition, which marks
the beginning of the upwelling season and typically occurs between March and June, was
earlier in 2007 and 2008, relative to 2005 and 2006. An early spring transition is often
indicative of greater productivity throughout the spring and summer seasons (Wells and
Mohr 2008, Peterson et al. 2006). Coastal upwelling, the process by which cool, nutrient
rich waters are brought to the surface (perhaps the most important parameter with respect
to plankton productivity), was also above average in 2007 and 2008. Moreover, coastal
sea surface temperature and sea level height (representative of the strength of the
California current and southern transport) values were also characteristic of improved
ocean productivity (Wells and Mohr 2008). Thus, contrary to the poor ocean conditions
observed in the spring of 2005 and 2006, the Wells et al. (2008) index parameters
indicate spring ocean conditions have been generally favorable for salmon survival off

In contrast to the relatively “good” ocean conditions that occurred in the spring, the Wells
et al. (2008) index values for the summer of 2007 and 2008 were poor in general, and
similar to those observed in 2005 and 2006. Summer sea surface temperature followed a
similar pattern in both 2007 and 2008, starting out cool in June, and then rising to well
above average in July before dropping back down to average in August (Wells and Mohr
2008). The strong upwelling values observed in the spring of 2007 and 2008 were not
maintained throughout the summer, and instead dropped to either at or below those
observed in 2005 and 2006. Finally, sea level height and spring curl values (a
mathematical representation of the vertical component of wind shear which represents the
rotation of the vector field), which are negatively correlated with ocean productivity,
were both poor (Wells and Mohr 2008). Therefore, during the spring of 2007 and 2008,
ocean conditions off California were indicative of a productive marine environment
favorable for ocean salmon survival (and much improved over 2005 and 2006). However,
those conditions did not persist throughout the year, as Wells et al. (2008) index values
observed in the summer of 2007 and 2008 were similar to those experienced in the
summer of 2005 and 2006, two years marked by extremely low productivity of salmon
off the central California coast.

Changes in the state of the California Current since spring 2009 reflected a transition
from cool La Niña conditions into and through a short-lived relatively weak El Niño
event (Bjorkstedt et al. 2010). Weaker than normal upwelling and several extended
relaxation events contributed to warming over much of the California Current during
summer 2009, especially in the north. Moderation of La Niña conditions in the California
Current coincided with the development of El Niño conditions in the equatorial Pacific,
yet manifested well in advance of any evidence for direct effects of El Niño on the
California Current. Responses to El Niño in fall 2009 and winter 2009–2010 appear to
have varied substantially with latitude - conditions off southern California returned to
near climatological values with the decline of La Niña, and did not indicate any
subsequent response to El Niño, yet the northern California Current warmed substantially
following the decline of La Niña and was strongly affected by intense downwelling
upwelling off central and southern California resumed unusually early and strongly for a
spring following an El Niño, but recovery from El Niño in early 2010 appears to be less
robust in the northern California Current. Thus, despite dynamic changes in the overall
state of the California Current, 2009–2010 continued the recent pattern of strong regional
variability across the California Current (Bjorkstedt et al. 2010).

Responses to this climate sequence exhibited some consistent patterns across the
California Current, but regional differences noted in recent State of the California Current
reports appear to have persisted along the west coast of North America (Goericke et al. 2007; McClatchie et al. 2009). The transition from La Nina conditions appears to have unfolded well in advance of the arrival of direct effects of El Nino in the California Current in late 2009. Cool conditions related to the 2007–2008 La Nina abated in summer 2009, and, in general terms, hydrographic and ecological conditions from southern California north approached climatological values during summer 2009 (Bjorkstedt et al. 2010).

Warmer than usual conditions had already developed off Baja California in 2008 and persisted into the current year, but showed similar directional responses to climate variability as did regions to the north (Bjorkstedt et al. 2010). Overall, changes in the state of the California Current during 2009 coincided with the decay of La Nina conditions in the tropical Pacific Ocean. In the context of the general pattern of transition from La Nina to El Nino, differences between the northern and southern regions of the California Current are readily apparent. Off southern California, the general trend was for mean hydrographic, chemical, and biological properties of the system to return to long-term average conditions during summer 2009. In contrast, the northern California Current experienced anomalous warming of coastal waters and associated ecosystem responses, presumably as a consequence of anomalously weak and intermittent upwelling during 2009. Likewise, regional differences and similarities are apparent from late fall 2009 through spring 2010, the period during which El Nino conditions propagated into the California Current and subsequently diminished. Off southern California, the arrival of El Nino was clearly indicated by anomalously high sea level, but responses to El Nino were limited to changes in isopycnal depth—presumably related to the passage of poleward-propagating Kelvin waves and their lingering consequences (Bjorkstedt et al. 2010).

Coastal waters off Oregon and northern California were affected by unusually strong downwelling during winter 2009–2010. In neither case, however, was there any evidence for intrusion of unusual water masses such as had been observed during the strong 1997–1998 El Nino. Relatively strong positive anomalies in temperature and salinity off southern Baja California suggest that the 2009–2010 El Nino influenced the southern extent of the California Current, but these changes appear to have been a consequence of local circulation patterns rather than anomalous poleward flows (Bjorkstedt et al. 2010).
Copepod assemblages observed at mid-shelf stations off northern California and Oregon continued to show marked seasonal variation, with high abundances developing over the summer and into the fall and subsequently declining over the winter (Bjorkstedt et al. 2010). Total abundance of copepods over the shelf appears to have been lower or later in developing in summer 2009 than in 2008 in sampled areas of the northern California Current. Patterns in assemblage structure, as indicated by the abundance of species particular biogeographic affinities (e.g., southern (warm) v. northern (cold), neritic v. oceanic; Hooff and Peterson 2006), show a substantial degree of coherence since 2008, particularly at stations north of Cape Mendocino. Compared to winter 2009, the composition of copepod assemblages off Oregon and northern California shifted strongly towards being dominated by southern and oceanic species by winter 2010. Southern taxa were abundant off Bodega Bay in late 2008, coincident with warm temperatures, but largely disappeared from mid-shelf waters in early 2009, possibly as a consequence of intense transport. Although warm water and reduced flows were observed in summer 2009 off Bodega, total copepod abundance did not reach high abundances and southern taxa did not assume a dominant place in the assemblage until winter 2010 (Bjorkstedt et al. 2010).

Catches of juvenile salmonids in pelagic surface trawl surveys were unusually low during September 2009 (Bjorkstedt et al. 2010). The fewest juvenile coho salmon (Oncorhynchus kisutch; 2 compared to maximum catch of 158 in 1999) and sub-yearling Chinook salmon (O. tschawytscha; 2 versus 465 in 2001) were caught since the beginning of the time series in 1998. Overall spring 2009 appeared to be relatively good for salmon marine survival but oceanographic conditions appear to have deteriorated for salmon by late summer 2009 (Bjorkstedt et al. 2010).

In 2008 and 2009, poor Sacramento returns, primarily supported by Sacramento River fall-run Chinook salmon, led to the largest fishery closure on record. In 2009, adult spawning escapement for Sacramento River fall Chinook failed to meet the escapement goal (122,000-180,000 adults) for the third year in a row, leading to the formal declaration of an overfishing concern (although fishing is not considered one of the major causes of the stock’s decline). The forecast for the index of ocean abundance in 2010 was 245,500 adults, which provided adequate numbers for limited fisheries (PFMC 2011).
Ecosystem observations offer further suggestion of regional variation in responses to El Nino, but it must be noted that such comparisons are limited by disparity in available data sets (Bjorkstedt et al. 2010). Off southern California, estimates of nutrient concentrations, chlorophyll a standing stock, primary productivity, and zooplankton displacement volumes returned to “normal” levels, and did not show evidence for any decline associated with El Nino. In contrast, anomalies in chlorophyll a concentration shifted from positive to negative off Baja California, especially north of Point Eugenia, despite the lack of concomitantly strong changes in hydrographic conditions. Responses at higher trophic levels are much more difficult to connect to simple indices of climate variability, but provide insight to the potential magnitude of ecosystem responses to conditions leading into spring 2009 and the consequences of the 2009–2010 El Nino relative to previous El Ninos. Positive shifts in indices of abundance for the juvenile groundfish assemblage off central California and breeding success of Cassin’s Auklet in 2009 are consistent with the persistence of cool conditions into spring 2009. Interestingly, the pelagic juvenile groundfish assemblage did not appear to collapse in 2010, suggesting that El Nino conditions did not substantially diminish productivity available to these taxa during critical lifestages during winter and early spring. In contrast, juvenile salmonids at sea in the northern region of the California Current appear to have fared poorly during the warmer than usual conditions of summer and fall 2009. Changes in the copepod assemblage off Oregon were consistent with warmer conditions that do not favor salmon production (Peterson and Schwing 2003; Peterson et al. 2010).

In summary, the significant changes in the state of the California Current during 2009 and early 2010 appear to have been more closely associated with diminishment of La Nina conditions than direct effects of El Nino (Bjorkstedt et al. 2010). The signature of the 2009–2010 El Nino throughout much of the California Current was substantially weaker than that of the strong 1997–1998 El Nino when influxes of more tropical waters were observed throughout the California Current. While the 2009–2010 El Nino is perhaps most comparable to the mild 2002–2003 El Nino, direct comparisons between the two events are confounded by the interaction of the 2002–2003 El Nino with a coincident intrusion of subarctic water that affected much of the California Current (Venrick et al. 2003). The more dramatic changes observed during 2009–2010 in the
northern California Current might reflect responses to atmospheric forcing favoring coastal warming absent countervailing subarctic influences. Because a transition to moderate La Nina conditions was forecast for summer 2010, the past year might represent a temporary interruption of an otherwise cool period in the California Current (Bjorkstedt et al. 2010).

NMFS (2009a) suggests that early marine survival for juvenile salmon is a critical phase in their survival and development into adults. The correlation between various environmental indices that track ocean conditions and salmon productivity in the Pacific Ocean, both on a broad and local scale, provides an indication of the role they play in salmon survival in the ocean. Moreover, when discussing the potential extinctions of salmon populations, Francis and Mantua (2003) state that climate patterns would not likely be the sole cause but could certainly increase the risk of extinction when combined with other factors, especially in ecosystems under stress from humans. Thus, the efforts to try and gain a greater understanding of the role ocean conditions play in salmon productivity will continue to provide valuable information that can be incorporated into the management of these species and should continue to be pursued. However, the highly variable nature of these environmental factors makes it very difficult, if not impossible, to accurately predict what they will be like in the future. Because the potential for poor ocean conditions exists in any given year, and because there is no way for salmon managers to control these factors, any deleterious effects endured by salmonids in the freshwater environment can only exacerbate the problem of an inhospitable marine environment (NMFS 2009a).

**GLOBAL CLIMATE CHANGE**

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, 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. Regarding climate change impacts already being observed, the
Sierra Nevada Alliance (2008) reports that seven of the largest Sierra glaciers have retreated by 30 to 70% in the past 100 years. Changes observed over the past several decades also have shown that the earth is warming, and scientific evidence suggests that increasing greenhouse gas emissions are changing the earth’s climate (Moser et al. 2009). Accumulating greenhouse gas concentrations in the earth’s atmosphere have been linked to global warming, and projected future trends of increasing atmospheric greenhouse gas concentrations suggest global warming will continue (National Research Council 2001). 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 (NMFS 2009).

Global climate change has the potential to impact numerous environmental resources in California through potential, though uncertain, impacts related to future air temperatures and precipitation patterns, and the resulting implications to stream runoff rate and timing, water temperatures, reservoir operations, and sea levels. Although current models are broadly consistent in predicting increases in probable global air temperatures and increasing levels of greenhouse gasses resulting from human activities, there are considerable uncertainties about precipitation estimates. For example, many regional modeling analyses conducted for the western United States indicate that overall precipitation will increase, but uncertainties remain due to differences among larger-scale General Circulation Models (GCMs) (Kiparsky and Gleick 2003). Some researchers believe that climate warming might push the storm track on the West Coast further north, which would result in drier conditions in California. At the same time, relatively newer GCMs, including those used in the National Water Assessment, predict increases in California precipitation (DWR 2005). Similarly, two popular climate models, including HadCM2 developed by the U.K. Hadley Center and PCM developed by the U.S. National Center for Atmospheric Research, also predict very different future scenarios. The HadCM2 predicts wetter conditions while the PCM predicts drier conditions (Brekke et al. 2004).

While much variation exists in projections related to future precipitation patterns, all available climate models predict a warming trend resulting from the influence of rising
levels of greenhouse gasses in the atmosphere (Barnett et al. 2005). The potential effects of a warmer climate on the seasonality of runoff from snowmelt in the Central Valley have been well-studied and results suggest that melt runoff will likely shift from spring and summer to earlier periods in the water year (Vanrheenen et al. 2001). Presently, snow accumulation in the Sierra Nevada acts as a natural reservoir for California by delaying runoff from winter months when precipitation is high (Kiparsky and Gleick 2003). However, compared to present water resources development, Null et al. (2010) report that watersheds in the Northern Sierra Nevada are most vulnerable to decreased mean annual flow, southern-central watersheds are most susceptible to runoff timing changes, and the central portion of the range is most affected by longer periods with low flow conditions. Despite the uncertainties about future changes in precipitation rates, it is generally believed that higher temperatures will lead to changes in snowfall and snowmelt dynamics. Higher atmospheric temperatures will likely increase the ratio of rain to snow, shorten and delay the onset of the snowfall season, and accelerate the rate of spring snowmelt, which would lead to more rapid and earlier seasonal runoff relative to current conditions (Kiparsky and Gleick 2003). Studies suggest that the spring stream flow maximum could occur about one month earlier by 2050 (Barnett et al. 2005).

If air temperatures in California rise significantly, it will become increasingly difficult to maintain appropriate water temperatures in order to manage coldwater fisheries, including salmonids. A reduction in snowmelt and increased evaporation could lead to decreases in reservoir levels and, perhaps more importantly, coldwater pool reserves (California Energy Commission 2003). As a result, increasing air temperatures, particularly during the summer, lead to rising water temperatures in rivers and streams, which increase stress on coldwater fish. Projected temperatures for the 2020s and 2040s under a higher emissions scenario suggest that the habitat for these fish is likely to decrease dramatically (Mote et al. 2008; Salathé 2005; Keleher and Rahel 1996; McCullough et al. 2001). Reduced summer flows and warmer water temperatures will create less favorable instream habitat conditions for coldwater fish species.

In the Central Valley, by 2100 mean summer temperatures 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 (NMFS 2009). 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).

Under the expected warming of around 5°C, substantial amounts of habitat would be lost, with significant amounts of habitat remaining primarily in the Feather and Yuba rivers, and remnants of habitat in the upper Sacramento, McCloud, and Pit rivers, Battle and Mill creeks, and the Stanislaus River (Lindley et al. 2007). Under the less likely but still possible scenario of an 8°C warming, spring-run Chinook salmon habitat would be found only in the upper-most reaches of the north fork Feather River, Battle Creek, and Mill Creek. This simple analysis suggests that Central Valley salmonids are vulnerable to warming, but more research is needed to evaluate the details of how warming would influence individual populations and subbasins.

As summarized by Lindley et al. (2007), climate change may pose new threats to Central Valley salmonids by reducing the quantity and quality of freshwater habitat. Under the worst case scenario, spring-run Chinook salmon may be driven extinct by warming in this century, while the best-case scenario may allow them to persist in some streams, although prediction of the future status of Central Valley salmonids associated with long-term climate change is fraught with uncertainty.

By contrast to the conditions for other Central Valley floor rivers, climate change may not be likely to have such impacts on salmonids in the lower Yuba River downstream of Englebright Reservoir (YCWA 2010a). Presently, the lower Yuba River is one of the few Central Valley tributaries that consistently has suitable water temperatures for salmonids throughout the year. Lower Yuba River water temperatures generally remain below 58°F year-round at the Smartsville Gage (downstream of Englebright Dam), and below 60°F year-round at Daguerre Point Dam (YCWA et al. 2007). At Marysville, water
temperatures generally remain below 60°F from October through May, and below 65°F from June through September (YCWA et al. 2007).

According to YCWA (2010), because of specific physical and hydrologic factors, the lower Yuba River is expected to continue to provide the most suitable water temperature conditions for anadromous salmonids of all Central Valley floor rivers, even if there are long-term climate changes. This is because New Bullards Bar Reservoir is a deep, steep-sloped reservoir with ample coldwater pool reserves. Throughout the period of operations of New Bullards Bar Reservoir (1969 through present), which encompasses the most extreme critically dry year on record (1977), the coldwater pool in New Bullards Bar Reservoir never was depleted. Since 1993, coldwater pool availability in New Bullards Bar Reservoir has been sufficient to accommodate year-round utilization of the reservoir’s lower level outlets to provide cold water to the lower Yuba River. Even if climate conditions change, New Bullards Bar Reservoir still will have a very substantial coldwater pool each year that will continue to be available to provide sustained, relatively cold flows of water into the lower Yuba River during the late spring, summer and fall of each year (YCWA 2010).

**Ocean Acidification**

Ocean acidification has been called a “sister” or co-equal problem to climate change because it is caused by the same human-caused production of large amounts of CO₂. Its impacts are additional to, and may exacerbate, the effects of climate change (Alaska Marine Conservation Council 2011).

Seawater pH is a critical variable in marine systems. Today’s surface ocean water is slightly alkaline, with a pH ranging from 7.5 to 8.5 and it is saturated with calcium carbonate, a very important organic molecule for organisms like corals, mollusks and crustaceans that make shells. As CO₂ reacts with the seawater, it lowers the pH and releases hydrogen ions. These ions bind strongly with carbonate, preventing it from forming the important calcium carbonate molecules. If the pH of the global oceans drops 0.4 by the end of the century as predicted, the levels of calcium carbonate available for use by marine organisms will decrease by 50% (Alaska Marine Conservation Council 2011).
Ocean acidification is likely to alter the biodiversity of the world’s marine ecosystems and may affect the total productivity of the oceans. Previously it was thought that these changes would take centuries, but new findings indicate that an increasingly acidic environment could cause problems in high-latitude marine ecosystems within just a few decades (Alaska Marine Conservation Council 2011).

Currently, the oceans’ surface water layers have sufficient amounts of calcium carbonate for organisms to use (known as saturated conditions). This calcium carbonate rich layer is deeper in warmer regions and closer to the surface in colder regions. Because calcium carbonate is less stable in colder waters, marine life in the polar oceans will be affected by calcium carbonate loss first. A study published in Nature by 27 U.S. and international scientists stated, “Some polar and sub-polar waters will become under-saturated [at twice the pre-industrial level of CO2, 560 ppm], probably within the next 50 years” (Orr et al. 2005). Under-saturated refers to conditions in which the seawater has some calcium carbonate remaining, but it does not have enough available for the organisms to build strong shells (Alaska Marine Conservation Council 2011).

Research has shown that lowered ocean pH will affect the processes by which animals such as corals, mollusks and crustaceans make their support structures. Because these organisms depend on calcium carbonate, increasing acidity threatens their survival. At higher levels of acidity (lower pH levels), any organism that forms a shell through calcification — from clams to pteropods — could be adversely affected. These species use the naturally occurring carbonate minerals calcite and aragonite for the calcification process.

Pteropods are small planktonic mollusks that are at the bottom of the food chain and because of their dependence on calcium carbonate, they will be one of the first casualties of increasing acidity in Alaska's marine waters. In recent experiments exposing live pteropods to the conditions predicted by “business-as-usual” carbon emission scenarios – the pteropod shells showed evidence of dissolution and damage within only 48 hours. Pteropods are a key food source for salmon and other species (Alaska Marine Conservation Council 2011). Increased research into ocean acidification caused by the saturation of water with carbon dioxide suggests that a 10% decline in pteropod
production can lead to a 20% reduction in the body weight of mature salmon (Climate Solutions 2011). A decrease in these mineral levels to food web base species like pteropods, also known as sea butterflies, which make up 45% of the diet for juvenile pink salmon, can cause cascading waves of disruption up the food chain (Climate Solutions 2011).

**Non-Native Invasive Species**

Non-native invasive species are of concern throughout the ESU and DPSs and can result in numerous deleterious effects to native species. For example, introduction of non-native invasive species can alter the natural food webs that existed prior to their introduction, as illustrated by the Asiatic freshwater clams *Corbicula fluminea* and *Potamocorbula amurensis* in the Delta. Cohen and Moyle (2004) report that the arrival of these two clam species disrupted the normal benthic community structure, and depressed phytoplankton levels in the Delta due to the highly efficient filter feeding of the introduced clams. Declines in phytoplankton levels have consequently resulted in reduced populations of zooplankton that feed upon them, thereby reducing the forage base available to salmonids transiting through the Delta and the San Francisco estuary on their ocean migrations. The lack of forage base can adversely affect the health and physiological condition of salmonids as they migrate to the Pacific Ocean.

Attempts to control non-native invasive plant species also can adversely affect the health and habitat suitability of salmonids within affected water systems, through either direct exposure to toxic chemicals or reductions in DO levels associated with the decomposition of vegetative matter in the water. As an example, control programs for the invasive water hyacinth and *Egeria densa* plants in the Delta must balance the toxicity of the herbicides applied to control the plants against the probability of exposure to listed salmonids during herbicide application period.

### 4.2.6.2 Lower Yuba River

The phenotypic lower Yuba River spring-run Chinook salmon population is exposed and subject to the myriad of limiting factors, threats and stressors described above for the Central Valley ESU. Lower Yuba River phenotypic spring-run Chinook salmon generally
spend a few months (with some individuals remaining up to several months, or a year) in the lower Yuba River prior to migrating downstream through the lower Feather River, the lower Sacramento River, the Delta, and San Francisco Bay to the Pacific Ocean, where they spend from two to four years growing and maturing. Following their ocean residency, these fish then undertake an upstream migration through this same system, and are again exposed to the associated limiting factors, threats and stressors, prior to spending a few additional months in the lower Yuba River holding and subsequently spawning.

Three separate efforts have been undertaken over the past few years to identify, characterize and prioritize limiting factors (i.e., “stressors”) for anadromous salmonids (including spring-run Chinook salmon) in the lower Yuba River. The Lower Yuba River Fisheries Technical Working Group, a multi-party stakeholder group including the Corps and YCWA, established a process to rank stressors as part of the “Draft Implementation Plan for Lower Yuba River Anadromous Fish Habitat Restoration” (CALFED and YCWA 2005). The Yuba Accord Technical Team built upon these efforts and utilized a stressor analysis in the development of the Yuba Accord minimum flow requirements (i.e., “flow schedules”) (YCWA et al. 2007).

Most recently, NMFS (2009) conducted a comprehensive assessment of stressors affecting spring-run Chinook salmon both within the lower Yuba River, and affecting lower Yuba River populations as they migrate downstream (as juveniles) and upstream (as adults) through the lower Feather River, the lower Sacramento River, and the Bay-Delta system.

As stated by NMFS (2009), stressor matrices, which structured hierarchically related tiers in order to prioritize stressors, were developed. After all of the variables in the matrix were identified and weighted, stressors within the matrices were sorted in descending order (from the highest to the lowest biological impact). Although the resultant sorted matrices provide a pseudo-quantitative means of comparatively ranking individual stressors, to avoid attributing unwarranted specificity to the prioritized stressor list, it was distributed into four separate quartiles (“Very High”, “High”, “Medium”, and “Low”).
The ranking and quartile characterization of stressors were organized such that stressors affecting the individual life stages also could be ascertained.

According to NMFS (2009a), for the lower Yuba River population of spring-run Chinook salmon, the number of stressors according to the categories of “Very High”, “High”, “Medium”, and “Low” that occur in the lower Yuba River or occur out of basin are presented below by life stage (Table 4-3).

Table 4-3. The number of stressors according to the categories of “Very High”, “High”, “Medium”, and “Low” that occur in the lower Yuba River, or occur out-of-basin, by life stage for the lower Yuba River population of spring-run Chinook salmon (Source: NMFS 2009a).

<table>
<thead>
<tr>
<th>Lifestage</th>
<th>Location</th>
<th>Stressor Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Very High</td>
</tr>
<tr>
<td>Adult Immigration and Holding</td>
<td>Lower Yuba River</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Out of Basin</td>
<td>1</td>
</tr>
<tr>
<td>Spawning</td>
<td>Lower Yuba River</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Out of Basin</td>
<td>N/A*</td>
</tr>
<tr>
<td>Embryo Incubation</td>
<td>Lower Yuba River</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Out of Basin</td>
<td>N/A</td>
</tr>
<tr>
<td>Juvenile Rearing and Outmigration</td>
<td>Lower Yuba River</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Out of Basin</td>
<td>12</td>
</tr>
</tbody>
</table>

* Not Applicable. These lifestages for this population only occur in the lower Yuba River.

As shown by the numbers in Table 4-3, of the total number of 94 stressors affecting all identified lifestages of the lower Yuba River populations of spring-run Chinook salmon, 31 are within the lower Yuba River and 63 are out-of-basin. Because spawning and incubation occurs only in the lower Yuba River, all of the stressors associated with these lifestages occur in the lower Yuba River. Therefore, for the adult immigration and holding, and the juvenile rearing and outmigration lifestages combined, a total of 49 “Very High” and “High” stressors were identified, with 15 of those occurring in the lower Yuba River and 34 occurring out-of-basin.
The NMFS (2009) Draft Recovery Plan states that “The lower Yuba River, below Englebright Dam, is characterized as having a high potential to support a viable independent population of spring-run Chinook salmon, primarily because: (1) flow and water temperature conditions are generally suitable to support all lifestage requirements; (2) the river does not have a hatchery on it; (3) spawning habitat availability is believed not to be limiting; and (4) high habitat restoration potential”.

The NMFS (2009) Draft Recovery Plan further states that “For currently occupied habitats below Englebright Dam, it is unlikely that habitats can be restored to pre-dam conditions, but many of the processes and conditions that are necessary to support a viable independent population of spring-run Chinook salmon can be improved with provision of appropriate instream flow regimes, water temperatures, and habitat availability. Continued implementation of the Yuba Accord is expected to address these factors and considerably improve conditions in the lower Yuba River.”

**PASSAGE IMPEDIMENTS/BARRIERS**

Englebright Dam was not designed for fish passage and presents an impassable barrier to the upstream migration of anadromous salmonids, and marks the upstream extent of currently accessible spring-run Chinook salmon habitat in the lower Yuba River, whereas Daguerre Point Dam presents an impediment to upstream migration.

Englebright Dam, built in 1941 to retain hydraulic mining debris from the Yuba River watershed, blocks upstream migration of fish in the lower Yuba River and, in particular, blocks the migration of steelhead and spring-run Chinook salmon to their historic spawning grounds (NMFS 2002).

Daguerre Point Dam has been reported to be an impediment to upstream migration of adult salmon and steelhead under certain conditions. Factors contributing to impeded adult spring-run Chinook salmon upstream passage have been suggested to include inadequate attraction flows to the ladders, proximity and orientation of the ladder entrances to the spillway, periodic obstruction of the ladders by sediment and woody debris, and other fish ladder physical design issues.
Sheet flow across the dam’s spillway, particularly during high-flow periods, may obscure ladder entrances and, thus, makes it difficult for immigrating adult salmonids to find the entrances (NMFS 2007a). For example, fall-run Chinook salmon have been observed attempting to leap over the dam, demonstrating that these fish may have difficulty in finding the fish ladder entrances (Corps 2000). This phenomenon may particularly affect spring-run Chinook salmon, because peak spring-run adult Chinook salmon upstream migration occurs primarily during the relatively high-flow periods of spring through early summer. Since 2001, wooden flashboards have been periodically affixed to the crest of the dam during low flow periods to aid in directing the flows towards the fish ladder entrances. Fish passage monitoring data from 2006 indicates that the installation of the flashboards resulted in an immediate and dramatic increase in the passage of salmon up the ladders, and is thought to have improved the ability of salmon to locate and enter the ladders (NMFS 2007a).

Both the north and south fish ladders at Daguerre Point Dam, particularly the north ladder, historically tended to clog with woody debris and sediment, which had the potential to block passage or substantially reduce attraction flows at the ladder entrances. Additionally: (1) the north and south ladders’ exits are close to the spillway, potentially resulting in adult fish exiting the ladder being immediately swept by flow back over the dam; (2) sediment accumulates at the upstream exits of the fish ladders, reducing the unimpeded passage from the ladders to the main channel, and may cause potential “fall-back” into the ladders; and (3) fish could jump out of the upper bays of the fishway, resulting in direct mortality. Many of the past issues associated with woody debris accumulation have either been eliminated or minimized since locking metal grates were installed over the unscreened bays on the north and south fish ladders during 2011.

The RMT (2013) examined passage of adult Chinook upstream of Daguerre Point Dam and corresponding flow data during eight years of available data. Chinook salmon passage was observed over a variety of flow conditions, including ascending or descending flows, as well as during extended periods of stable flows. Flow thresholds prohibiting passage of Chinook salmon through the ladders at Daguerre Point Dam were not apparent in the data (RMT 2013).
Phenotypic spring-run Chinook salmon (those entering the lower Yuba River during spring months) may remain in the lower Yuba River in areas downstream (and proximate) to Daguerre Point Dam for extended periods of time during the spring and summer. It is uncertain whether, or to what extent, the duration of residency in the large pool located downstream of Daguerre Point Dam is associated with upstream passage impediment and delay, or volitional habitat utilization prior to spawning in upstream areas. However, RMT (2013) reported that temporal migrations of adult phenotypic spring-run Chinook salmon to areas upstream of Daguerre Point Dam occurred over an extended period of time. The tagged spring-run Chinook salmon in the lower Yuba River actually migrated upstream of Daguerre Point Dam from May through September, and utilized a broad expanse of the lower Yuba River during the phenotypic summer holding period, including areas as far downstream as Simpson Lane Bridge (i.e., ~RM 1.8), and as far upstream as the area just below Englebright Dam. A longitudinal analysis of acoustic tag detection data indicated that distributions were non-random, and that the tagged spring-run Chinook salmon were selecting locations for holding (RMT 2013).

NMFS (2007) suggested that delays resulting from adult spring-run Chinook salmon adult passage impediments could weaken fish by requiring additional use of fat stores prior to spawning, and potentially could result in reduced spawning success (i.e., production) from reduced resistance to disease, increased pre-spawning mortality, and reduced egg viability. However, these statements suggesting biological effects associated with fish passage issues at Daguerre Point Dam are not supported by studies or referenced literature. For example, the RMT (2010b) included evaluation of water temperatures at Daguerre Point Dam during the spring-run Chinook salmon adult upstream immigration and holding lifestage, which addressed considerations regarding both water temperature effects to pre-spawning adults and egg viability. They concluded that during this lifestage, characterized as extending from April through August, water temperatures [modeled] at Daguerre Point Dam are suitable and remain below the reported optimum water temperature index value of 60°F at least 97% of the time over all water year types during these months. Thus, it is unlikely that this represents a significant source of mortality to spring-run Chinook salmon. Moreover, actual data
monitored since the Yuba Accord has been implemented (October 2006 to June 2013) demonstrates that water temperatures at Daguerre Point Dam actually remained at about or below 60°F during the adult immigration and holding period each of the six years (RMT 2013).

As reported by NMFS (2007), Daguerre Point Dam may adversely affect outmigration success of juvenile salmon and steelhead. During downstream migration, juvenile Chinook salmon and steelhead may be disoriented or injured as they plunge over the spillway, increasing their exposure and vulnerability to predators in the large pool at the base of the dam (NMFS 2007).

**Harvest/Angling Impacts**

Fishing for Chinook salmon on the lower Yuba River is regulated by CDFW. Although harvest/angler impacts were previously listed as a stressor, the magnitude of this potential stressor has been reduced associated with changes in fishing regulations over time. Angling regulations on the lower Yuba River are intended to protect sensitive species, in particular spring-run Chinook salmon (and wild steelhead). CDFW angling regulations 2013-2014 (CDFW 2013a) state that the lower Yuba River from its confluence with the lower Feather River up to Englebright Dam is closed year-round to salmon fishing, and no take or possession of salmon is allowed.

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

Although these regulations are intended to specifically protect spring-run Chinook salmon, anglers can potentially harass, harm and kill listed species (spring-run Chinook salmon and wild steelhead) through incidental actions while targeting non-listed species. Examples of potential angler impacts may include, but are not necessarily limited to, angler harvest, physical disturbance of salmonid redds, hooking and catch-and-release stress or mortality, including that which results from incidental hooking (CALFED and YCWA 2005).
**POACHING**

Whether poaching represents a stressor, or the extent to which spring-run Chinook salmon are targeted for poaching in the lower Yuba River is unknown.

Poaching of adult Chinook salmon at the fish ladders and at the base of Daguerre Point Dam has been previously reported in several documents. Poaching has been previously reported as a “chronic problem” (Falxa 1994 as cited in CALFED and YCWA 2005). The spring-run Chinook salmon status report (CDFG 1998) stated that poaching was an “ongoing problem” at Daguerre Point Dam. Poaching of salmon has been reported as a “long-standing problem” on the Yuba River, particularly at Daguerre Point Dam (John Nelson, CDFG, pers. comm., November 2000, as cited in NMFS 2005a). The Corps (2001) and NMFS (2009) both refer to poaching of adult salmon at the Daguerre Point Dam.

Although these previous reports refer in some fashion to poaching within the fish ladders and immediately downstream of Daguerre Point Dam as issues, the only actual account of documented poaching was provided by Nelson (2009). In his declaration, Nelson (2009) stated that during his tenure at CDFW (which extended until 2006) he personally observed people fishing illegally in the ladders, and further observed gear around the ladders used for poaching. It is not clear regarding the time period to which he was referring, although it may have been referring to the period prior to 2000 (see reference in previous paragraph).

The VAKI Riverwatcher infrared and videographic sampling system began operations in 2003. CDFW monitored these operations at Daguerre Point Dam seasonally from 2003 through 2005. Since 2006 (with implementation of the Yuba Accord Pilot Programs (2006 – 2007) and the Yuba Accord in 2008), PSMFC staff have monitored the system at Daguerre Point Dam on a nearly daily basis, year-round, through the present. Over this 8-year period, neither CDFW nor PSMFC staff have reported poaching in the ladders, or immediately downstream of Daguerre Point Dam. Thus, although poaching has been reported as a stressor, it is unclear whether, or to what extent, it impacts the spring-run Chinook salmon population in the lower Yuba River. According to Sprague (2011), the amount of poaching from the fish ladders has not been quantified, and there does not
appear to be data on the amount of poaching, so the extent of the problem is not well understood.

Moreover, it is unclear whether these previous reports of poaching were directed toward spring-run or fall-run Chinook salmon. While data are not available as to the fish species targeted, poachers likely target the fish that are readily available. The greatest numbers of poached fish probably would be fall-run Chinook salmon because they congregate below the dam in large numbers under the low-flow, clear-water conditions of October and November (Corps 2001). According to NMFS (2002), fall-run Chinook salmon are most likely to be subject to poaching because they are the largest salmonid population in the lower Yuba River. Nevertheless, spring-run Chinook salmon also may be affected because they may be present in the lower Yuba River during the periods of the highest recreational use (NMFS 2002).

As early as 2001, the Corps (2001) suggested that although poaching is likely very limited, fencing or screening of the ladder could further reduce or eliminate any poaching. Nelson (2009) suggested that one measure that could reduce poaching would be to place grates over the top of the ladders to restrict poacher access. He further suggested that grates had been installed on other fish ladders to prevent poaching, such as on the Woodbridge Irrigation District Dam fish ladders located on the Mokelumne River near Woodbridge, California. However, Sprague (2011) stated that grates are not recommended, due to the multiple sharp edges and the potential for resultant fish injury. He further suggested that solid covers could be used, but consideration should be given to the potential for how to avoid pressurizing the fish ladders during high flow events. As a temporary solution addressing the potential for fish to jump out of the ladder (and potential poaching within the fish ladders), in 2011 the Corps installed plywood boards over the upper bays at the south ladder at Daguerre Point Dam. As previously discussed, the July 25, 2011 Interim Remedy Order issued by the Court ordered the Corps to install locking metal grates over all but the lower eight bays of the fish ladders at Daguerre Point Dam by September 14, 2011. In response to the Interim Remedy Order issued by the Court on July 25, 2011, during the summer of 2011 the Corps proceeded with installation of locking metal grates on all 33 unscreened bays. Due to concerns expressed by both NMFS and CDFW, the Court then reconsidered the requirement to put grates over the
bays on the lowermost section of the south fish ladder at Daguerre Point Dam. Consequently, grates were not installed over the lower eight bays of the south fish ladder at Daguerre Point Dam.

**Physical Habitat Alteration (Including Waterway 13)**

According to NMFS (2009), the stressor associated with physical habitat alteration specifically addressed the issue of return flows and attraction of anadromous salmonids into the Yuba Goldfields through Waterway 13. Various efforts have been undertaken to prevent anadromous salmonids from entering the Goldfields via Waterway 13. In May 2005, heavy rains and subsequent flooding breached the structure at the east (upstream facing) end. Subsequently, funded by USFWS, the earthen “plug” was replaced with a "leaky-dike" barrier intended to serve as an exclusion device for upstream migrating adult salmonids (AFRP 2010). The Corps does not have any operations or maintenance responsibilities for the earthen “plug” and Waterway 13, nor has it issued any permits or licenses for it. Nonetheless, until a more permanent solution is implemented, ongoing issues associated with attraction of upstream migrating adult salmonids into Waterway 13 are considered to remain a stressor to spring-run Chinook salmon. For additional information on Waterway 13, see Chapter 5 – Environmental Baseline.

In addition to Waterway 13 issues, physical habitat alteration stressors include Lake Wildwood operations and resultant Deer Creek flow fluctuations (according to the SWRCB’s Revised Decision 1644, Lake Wildwood is operated by the Lake Wildwood Association — a gated community in Penn Valley, California). This stressor refers to the potential for stranding or isolation events to occur in Deer Creek, near its confluence with the lower Yuba River. Observational evidence suggests that, in the past, adult Chinook salmon entered Deer Creek during relatively high flow periods, presumably for holding or spawning purposes, only to subsequently become stranded in the creek when flows receded due to changes in Lake Wildwood operations. Stranding may delay or prevent adult Chinook salmon from spawning, or cause decreased spawning success due to increased energy expenditure or stress due to delayed spawning (CALFED and YCWA 2005).
The Sierra Streams Institute (SSI) is in the process of implementing the Deer Creek Spawning Bed Enhancement Project, which is located on a tributary to the lower Yuba River. From September 4-7, 2012, 250 tons of spawning gravel (~180 cubic yards) was placed in the creek. Chinook salmon redd surveys were conducted after the initial placement to document the number and characteristics of salmon redds created in Deer Creek during the 2012 spawning season. On November 27, 2012, more than 51 salmon redds were observed in Deer Creek, compared to 15 redds in 2011, and 9 redds in 2003 (SSI 2013). Approximately 75% of spawning activity during 2012 occurred in the newly created spawning areas, with the remaining spawning activity occurring in locations where spawning was observed in 2011. Gravel transport also was monitored to understand the effects of higher stream flows on gravel movement, and to evaluate transport of spawning gravels in Deer Creek. Tracer gravel surveys were conducted during February, March, and April 2013. Based on these and other visual observations of substrate deposition in Deer Creek, SSI (2013) report that it is likely that some of the placed gravels remain in Deer Creek providing spawning habitat, and that some of the gravels were mobilized downstream into the Yuba River to provide habitat for anadromous salmonids. To supplement existing available spawning habitat, SSI planned to place an additional 250 tons of spawning gravel in Deer Creek from September 3-13, 2013.

Physical habitat alteration stressors also address habitat complexity and diversity. The concepts of habitat complexity and diversity pertinent to the lower Yuba River were described by CALFED and YCWA (2005), as discussed below.

Habitat complexity and diversity refer to the quality of instream physical habitat including, but not necessarily limited to, the following physical habitat characteristics:

- Escape cover
- Feeding cover
- Allochthonous material contribution
- Alternating point-bar sequences
- Pool-to-riffle ratios
- Sinuosity
- Instream object cover
- Overhanging riparian vegetation
The physical structure of rivers plays a significant role in determining the suitability of aquatic habitats for juvenile salmonids, as well as for other organisms upon which salmonids depend for food. These structural elements are created through complex interactions among natural geomorphic features, the power of flowing water, sediment delivery and movement, and riparian vegetation, which provides bank stability and inputs of large woody debris (Spence et al. 1996). The geomorphic conditions caused by hydraulic and dredge mining since the mid-1800s, and the construction of Englebright Dam, which affects the transport of nutrients, fine and course sediments and, to a lesser degree, woody material from upstream sources to the lower river, continue to limit habitat complexity and diversity in the lower Yuba River.

LWM creates both micro- and macro-habitat heterogeneity by forming pools, back eddies and side channels and by creating channel sinuosity and hydraulic complexity. This habitat complexity provides juvenile salmonids numerous refugia from predators and water velocity, and provides efficient locations from which to feed. LWM also functions to retain coarse sediments and organic matter in addition to providing substrate for numerous aquatic invertebrates (Spence et al. 1996).

In the lower Yuba River, mature riparian vegetation is scattered intermittently, leaving much of the banks devoid of LWM and unshaded – affecting components that are essential to the health and survival of the freshwater lifestages of salmonids (NMFS 2002). Although the ability of the lower Yuba River to support riparian vegetation has been substantially reduced by the historic impacts from mining activities, the dynamic nature of the river channel results in periodic creation of high-value shaded riverine aquatic (SRA) cover for fish and wildlife (Beak 1989).

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

**LOSS OF RIPARIAN HABITAT AND INSTREAM COVER**

**RIPARIAN VEGETATION**

As stated in CALFED and YCWA (2005), riparian vegetation, an important habitat component for anadromous fish, is known to provide: (1) bank stabilization and sediment load reduction; (2) shade that results in lower instream water temperatures; (3) overhead cover; (4) streamside habitat for aquatic and terrestrial insects, which are important food sources for rearing juvenile fishes; (5) a source of instream cover in the form of woody material; and (6) allochthonous nutrient input.

SRA cover generally occurs in the lower Yuba River as scattered, short strips of low-growing woody species (e.g., *Salix sp.*.) adjacent to the shoreline. Beak (1989) reported that the most extensive and continuous segments of SRA cover occur along bars where [then] recent channel migrations or avulsions had cut new channels through relatively large, dense stands of riparian vegetation. SRA cover consists of instream object cover and overhanging cover. Instream object cover provides structure, which promotes hydraulic complexity, diversity and microhabitats for juvenile salmonids, as well as escape cover from predators. The extent and quality of suitable rearing habitat and cover, including SRA, generally has a strong effect on juvenile salmonid production in rivers (Healey 1991 as cited in CALFED and YCWA 2005).

Since completion of New Bullards Bar Reservoir, the riparian community (in the lower Yuba River) has expanded under summer and fall streamflow conditions that have generally been higher than those that previously occurred (SWRCB 2003). However, the riparian habitat is not pristine. NMFS (2005b) reports …“The deposition of hydraulic mining debris, subsequent dredge mining, and loss/confinement of the active river corridor and floodplain of the lower Yuba River which started in the mid-1800’s and continues to a lesser extent today, has eliminated much of the riparian vegetation along the lower Yuba River. In addition, the large quantities of cobble and gravel that remained generally provided poor conditions for re-establishment and growth of riparian
vegetation. Construction of Englebright Dam also inhibited regeneration of riparian vegetation by preventing the transport of any new fine sediment, woody debris, and nutrients from upstream sources to the lower river. Subsequently, mature riparian vegetation is sparse and intermittent along the lower Yuba River, leaving much of the bank areas unshaded and lacking in large woody debris. This loss of riparian cover has greatly diminished the value of the habitat in this area.”

Where hydrologic conditions are supportive, riparian and wetland vegetative communities are found adjacent to the lower Yuba River and on the river sides of retaining levees. These communities are dynamic and have changed over the years as the river meanders. The plant communities along the river are a combination of remnant Central Valley riparian forests, foothill oak/pine woodlands, agricultural grasslands, and orchards (Beak 1989).

According to CALFED and YCWA (2005), the lower Yuba River, especially in the vicinity of Daguerre Point Dam and the Yuba Goldfields, is largely devoid of sufficient riparian vegetation to derive the benefits (to anadromous salmonids) discussed above (Figure 4-4).

In 2012, YCWA conducted a riparian habitat study in the Yuba River from Englebright Dam to the confluence with the Feather River (see Technical Memorandum 6-2 in YCWA 2013). Field efforts included descriptive observations of woody and riparian vegetation, cottonwood inventory and coring, and a large woody material (LWM) survey. The study was performed by establishing eight LWM study sites and seven riparian habitat study sites. One LWM study site was established within each of eight distinct reaches (i.e., Marysville, Hallwood, Daguerre Point Dam, Dry Creek, Parks Bar, Timbuctoo Bend, Narrows, and Englebright Dam). Riparian habitat sites were established in the same locations as the LWM study sites, with the exception of the Marysville study site. Riparian information regarding the Marysville Reach was developed, but no analysis was performed because of backwater effects of the Feather River.

The RMT contracted Watershed Sciences Inc. to use existing LiDAR to produce a map of riparian vegetation stands by type. The resulting data was subject to a field validation
and briefly summarized in WSI (2010) and the data were also utilized in YCWA’s Riparian Study Technical Memorandum 6-2 (YCWA 2013).

Based on field observations, YCWA (2013) reported that all reaches supported woody species in various lifestages - mature trees, recruits, and seedlings were observed within all reaches. Where individuals or groups of trees were less vigorous, beaver (Castor canadensis) activity was the main cause, although some trees in the Marysville Reach appeared to be damaged by human camping.

The structure and composition of riparian vegetation was largely associated with four landforms. Cobble-dominated banks primarily supported bands of willow shrubs with scattered hardwood trees. Areas with saturated soils or sands supported the most complex riparian areas and tended to be associated with backwater ponds. Scarps and levees supported lines of mature cottonwood and other hardwood species, typically with a simple understory of Himalayan blackberry or blue elderberry shrubs. Bedrock
dominated reaches had limited riparian complexity and supported mostly willow shrubs and cottonwoods (YCWA 2013).

Based on analysis of the mapping data, RMT (2013) reported that the majority of the woody species present in the river valley include, in order of most to least number of individuals: various willow species (*Salix* sp. and *Cephalanthus occidentalis*); Fremont cottonwood (*Populus fremontii*) (i.e., cottonwoods); blue elderberry (*Sambucus nigra* ssp. *caerulea*); black walnut (*Juglans hindsii*); Western sycamore (*Platanus racemosa*); Oregon ash (*Fraxinus latifolia*); white alder (*Alnus rhombifolia*); tree of heaven (*Ailanthus altissima*); and grey pine (*Pinus sabiniana*). Willow species could not be differentiated by species using remote sensing information. Willow on the lower Yuba River are dominated by dusky sandbar willow (*Salix melanopsis*) and narrow leaf willow (*Salix exigua*), and relative dominance of the two species shifts respectively in the downstream direction (WSI 2010). Other species occurring are arundo willow (*Salix lasiolepsis*), Goodings willow (*Salix goodingii*) and red willow (*Salix laevigata*). Goodings and red willow comprise 6.4% of the willow according to a limited field validation survey (WSI 2010).

Cottonwoods are one of the most abundant woody species in the study area, and the most likely source of locally-derived large instream woody material due to rapid growth rates and size of individual stems commonly exceeding 2 feet in diameter and 50 feet in length. Cottonwoods exist in all life stages including as mature trees, recruits, or saplings, and as seedlings. Cottonwoods are more abundant in downstream areas of the study area relative to upstream. Cottonwoods are distributed laterally across the valley floor. Of the estimated 18,540 cottonwood individuals/stands, 12% are within the bankfull channel (flows of 5,000 cfs or less), and 39% are within the floodway inundation zone (flows between 5,000 and 21,100 cfs). However, recruitment patterns of cottonwood have not been analyzed with respect to time or with any more detail regarding channel location (YCWA 2013).

A total of 97 cottonwood trees were cored to estimate age. Age estimates ranged from 11 to 87 years. The cottonwood tree age analysis resulted in age estimates that place the year of establishment for trees in a range of years from ±7 to 16 years, which is too wide
to allow for linking the establishment of trees to any year’s specific conditions (YCWA 2013).

YCWA conducted a historical aerial photograph analysis to describe changes over time to total vegetation delineated within the valley walls, riparian vegetation delineated within 50 feet of the active river channel, and channel alignment (see Technical Memorandum 6-2 in YCWA 2013). To determine the cumulative change over time in total vegetative cover and riparian vegetation cover for the Marysville, Timbuctoo Bend, Narrows, and Englebright Dam study sites, YCWA compared the aerial photographs from 1937 and 2010.

Cumulative changes in vegetative cover in the Englebright Dam and Narrows study sites decreased. For the remaining study sites, including Marysville, Hallwood, Daguerre Point Dam, Dry Creek, Parks Bar, and Timbuctoo Bend study sites, the cumulative change in vegetative cover increased. The least amount of vegetation change over time was observed in the Englebright Dam, Narrows and Marysville sites. The Dry Creek, Daguerre Point Dam and Hallwood sites had the greatest vegetated area, and YCWA identified those sites as the most dynamic (i.e., both decreased in vegetative cover through 1970 and then increased through 2010).

Cumulative changes in riparian vegetation cover in the Englebright Dam and Narrows study sites decreased with very little detectable change for the Narrows study site. For the remaining study sites, the cumulative change in riparian vegetation cover increased. The observed changes for the Englebright Dam, Narrows and Marysville study sites were very small. For the Dry Creek and Parks Bar study sites, the greatest changes were observed, with dramatic increases in riparian vegetation cover. The magnitude of change of riparian vegetation between photoset years (in a stepwise comparison) was greater than that seen in the cumulative riparian vegetation cover change.

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2 Total vegetation is inclusive of riparian vegetation.

3 Cumulative change describes the changes to observable area for either total vegetation or riparian vegetation from the earliest photo date to the most recent photo date.
**INSTREAM WOODY MATERIAL**

Instream woody material provides escape cover and relief from high current velocities for juvenile salmonids and other fishes. LWM also contributes to the contribution of invertebrate food sources, and micro-habitat complexity for juvenile salmonids (NMFS 2007). Snorkeling observations in the lower Yuba River have indicated that juvenile Chinook salmon had a strong preference for near-shore habitats with instream woody material (JSA 1992).

There is currently a lack of consensus regarding the amount of instream woody material occurring in the lower Yuba River (Corps 2012d). It has been suggested (CALFED and YCWA 2005) that the presence of Englebright Dam has resulted in decreased recruitment of LWM to the lower Yuba River, although no surveys or studies were cited to support these statements. Some woody material may not reach the lower Yuba River due to collecting on the shoreline and sinking in Englebright Reservoir (Corps 2012d). However, Englebright Dam does not functionally block woody material from reaching the lower Yuba River because there is no woody material removal program implemented for Englebright Reservoir, and accumulated woody material therefore spills over the dam during uncontrolled flood events (R. Olsen, Corps, pers. comm. 2011, as cited in Corps 2012d).

About 8.7 miles of the lower Yuba River downstream of Englebright Dam, distributed among study sites per reach, were surveyed and evaluated for pieces of wood (YCWA 2013). The number of pieces of wood was relatively similar above and below Daguerre Point Dam (i.e., about 5,100 and 5,750 pieces, respectively). Woody material was generally found in bands of willow (*Salix* sp.) shrubs near the wetted edge, dispersed across open cobble bars, and stranded above normal high-flow indicators. Most of the woody material was diffuse and located on floodplains and high floodplains, with only about a quarter of the material in heavy concentrations (YCWA 2013).

Most (77-96%) pieces of wood found in each reach were smaller than 25 feet in length and smaller than 24 inches in diameter, which is the definition of large woody material (LWM). These pieces would be typically floated by flood flows and trapped within
willows and alders above the 21,100 cfs line, which is defined as the flow delineating the floodway boundary (YCWA 2013).

Instream woody material was not evenly distributed throughout the reaches. For the smaller size classes (i.e., shorter than 50 feet, less than 24 inches in diameter), the greatest abundance of pieces was found in the Hallwood or Daguerre Point Dam reaches, with lower abundances above and below these reaches (YCWA 2013).

The largest size classes of LWM (i.e., longer than 50 feet and greater than 24 inches in diameter) were rare or uncommon (i.e., fewer than 20 pieces total) with no discernible distribution. Pieces of this larger size class were counted as “key pieces”, as were any pieces exceeding 25 inches in diameter and 25 feet in length and showing any morphological influence (e.g., trapping sediment or altering flow patterns). A total of 15 key pieces of LWM were found in all study sites, including six in the Marysville study site. Few of the key pieces were found in the active channel or exhibiting channel forming processes (YCWA 2013).

**LOSS OF NATURAL RIVER MORPHOLOGY AND FUNCTION**

According to NMFS (2009), “Loss of Natural River Morphology and Function” is the result of river channelization and confinement, which leads to a decrease in riverine habitat complexity, and thus, a decrease in the quantity and quality of juvenile rearing habitat. Additionally, this primary stressor category includes the effect that dams have on the aquatic invertebrate species composition and distribution, which may have an effect on the quality and quantity of food resources available to juvenile salmonids.

According to NMFS (2009), attenuated peak flows and controlled flow regimes have altered the lower Yuba River’s geomorphology and have affected the natural meandering of the river downstream of Englebright Dam.

As reported by RMT (2013), preliminary evaluation of available data collected to date related to Yuba River fluvial geomorphology indicates that the Yuba River downstream of Englebright Dam has complex river morphological characteristics. Evaluation of the morphological units in the Yuba River as part of the spatial structure analyses indicates that, in general, the sequence and organization of morphological units is non-random,
indicating that the channel has been self-sustaining of sufficient duration to establish an ordered spatial structure (RMT 2013).

The Yuba River downstream of Englebright Dam exhibits lateral variability in its form-process associations (RMT 2013). In the Yuba River, morphological unit organization highlights the complexity of the channel geomorphology, as well as the complex and diverse suite of morphological units. The complexity in the landforms creates diversity in the flow hydraulics which, in turn, contributes to a diversity of habitat types available for all riverine lifestages of anadromous salmonids in the Yuba River downstream of Englebright Dam (RMT 2013).

In the lower Yuba River, anadromous salmonids spawn in mean substrate sizes ranging from about 50 to 150 mm, and most of the lower Yuba River from Englebright Dam to the confluence with the Feather River is characterized by average substrate particle sizes within this size range (RMT 2013). The exceptions are sand/silt areas near the confluence with the Feather River, and the boulder/bedrock regions in the upper sections of Timbuctoo Bend and most of the Englebright Dam Reach. However, gravel augmentation funded by the Corps in the Englebright Dam Reach over the past several years has spurred spawning activity and Chinook salmon redd construction in this reach. The net result is an increase in the spatial distribution of spawning habitat availability in the river, particularly for early spawning (presumably spring-run) Chinook salmon (RMT 2013).

**LOSS OF FLOODPLAIN HABITAT**

NMFS (2009) listed the loss of floodplain habitat in the lower Yuba River as one of the key stressors affecting anadromous salmonids (including spring-run Chinook salmon). NMFS (2009) stated …“Historically, the Yuba River was connected to vast floodplains and included a complex network of channels, backwaters and woody material. The legacy of hydraulic and dredger mining is still evident on the lower Yuba River where, for much of the river, dredger piles confine the river to an unnaturally narrow channel. The consequences of this unusual and artificial geomorphic condition include reduced floodplain and riparian habitat and resultant limitations in fish habitat, particularly for rearing juvenile salmonids.”
NMFS (2009) further stated that in the lower Yuba River, controlled flows and decreases in peak flows has reduced the frequency of floodplain inundation resulting in a separation of the river channel from its natural floodplain. Within the Yuba Goldfields area (RM 8–14), confinement of the river by massive deposits of cobble and gravel derived from hydraulic and dredge mining activities resulted in a relatively simple river corridor dominated by a single main channel and large cobble-dominated bars, with little riparian and floodplain habitat (DWR and PG&E 2010).

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

As reported by RMT (2013), despite some flow regulation, the channel and floodplain in the lower Yuba River are highly connected, with floods spilling out onto the floodplain more frequently than commonly occurs for unregulated semiarid rivers. Some locations exhibit overbank flow well below 5,000 cfs, while others require somewhat more than that. In any given year, there is an 82% chance the river will spill out of its bankfull channel and a 40% chance that the floodway will be fully inundated. These results demonstrate that floodplain inundation occurs with a relatively high frequency in the lower Yuba River compared to other Central Valley streams which, in turn, contributes to a diversity in habitats available for anadromous salmonids (RMT 2013).

RMT (2013) conducted a flood-frequency analysis of the annual peak discharges recorded at the USGS stream gage near Marysville (#11421000) that showed average annual return periods of 1.25 years and 2.5 years for the bankfull and flood discharges, respectively. Bankfull flows for similar rivers are generally assumed to occur with return periods of 1.5-2 years. The fact that the lower Yuba River is less than this implies that
the channel is naturally undersized relative to generalized expectations and flows spill into the floodplain at a more frequent rate (RMT 2013).

**ENTRAINMENT**

According to NMFS (2009), entrainment of juvenile salmonids remains a stressor in the lower Yuba River. Entrainment represents a suite of potential negative impacts to juvenile fish that may occur while, or after, the fish encounter a diversion facility in operation. For instance, entrainment impacts may include the non-volitional recruitment of juveniles past a diversion facility and/or screening structure, or impingement upon diversion screens and physical damage to fish caused by diversion activities. It has been suggested that as juvenile salmonids pass Daguerre Point Dam, physical injury may occur as they pass over the dam or through its fish ladders (SWRI 2002).

Water diversions in the lower Yuba River generally begin in the early spring and extend through the fall. As a result, potential threats to juvenile salmonids occur at the Hallwood-Cordua and South Yuba/Brophy diversions (NMFS 2009). The relatively recent fish screen constructed at the Hallwood-Cordua diversion is considered a notable improvement over the previous design, and is believed to reduce the amount of fry and juvenile entrainment at the diversion. The new diversion fish screen is believed to reduce loss rates of emigrating fall-run Chinook salmon at this location. However, predation losses of emigrating fry and juvenile fall-run Chinook salmon may remain a limiting factor at this location. In addition, the configuration of the current return pipe and flows through the pipe may also be a limiting factor (CALFED and YCWA 2005).

As previously described, the South Yuba/Brophy system diverts water through an excavated channel from the south bank of the lower Yuba River in the vicinity of Daguerre Point Dam. The water is then subsequently diverted through a porous rock dike that is intended to exclude fish. The current design of this rock structure does not meet current NMFS or CDFW juvenile fish screen criteria (SWRI 2002), and additional issues regarding predation in the diversion channel and the rate of water bypassing the rock gabion and returning to the lower Yuba River through the diversion channel have been raised as potential stressors.
Predation can occur in three forms: (1) natural; (2) predation resulting from a relative increase in predator habitat and opportunity near major structures and diversions; and (3) predation resulting from minimal escape cover and habitat complexity for prey species (CALFED and YCWA 2005). For the purpose of stressor identification in this BA, predation includes the predation associated with increases in predator habitat and predation opportunities for piscivorous species created by major structures and diversions, and predation resulting from limited amounts of prey escape cover in the lower Yuba River.

The extent of predation on juvenile Chinook salmon in the lower Yuba River is not well documented (NMFS 2009). Although predation is a natural component of salmonid ecology, the rate of predation of salmonids in the lower Yuba River has potentially increased through the introduction of non-native predatory species such as striped bass (Morone saxatilis), largemouth bass (Micropterus salmoides) and American shad (Alosa sapidissima) and through the alteration of natural flow regimes and the development of structures that attract predators (NMFS 2009).

Predatory fish are known to congregate around structures in the water including dams, diversions and bridges, where their foraging efficiency is improved by shadows, turbulence and boundary edges (CDFG 1998). Thus, juvenile salmonids can also be adversely affected by Daguerre Point Dam on their downstream migration. Daguerre Point Dam creates a large plunge pool at its base, which provides ambush habitat for predatory fish in an area where emigrating juvenile salmonids may be disoriented after plunging over the face of the dam into the deep pool below (NMFS 2002). The introduced predatory striped bass and American shad have been observed in this pool (CALFED and YCWA 2005). In addition to introduced predatory species, several native fish species also prey on juvenile salmonids in the lower Yuba River, including Sacramento pikeminnow, hardhead and large juvenile and adult rainbow trout/steelhead (CALFED and YCWA 2005). It has been suggested that the rate of predation of juvenile salmonids passing over dams in general, and Daguerre Point Dam in particular, may be
unnaturally high (NMFS 2007), although specific studies addressing this suggestion have not been conducted.

In addition to the suggestion of increased rates of predation resulting from disorientation of juveniles passing over Daguerre Point Dam into the downstream plunge pool, it also has been suggested that unnaturally high predation rates may also occur in the diversion channel associated with the South Yuba/Brophy diversion (NMFS 2007). Other structure-related predation issues include the potential for increased rates of predation of juvenile salmonids: (1) in the entryway of the Hallwood-Cordua diversion canal upstream of the fish screen; and (2) at the point of return of fish from the bypass pipe of the Hallwood-Cordua diversion canal into the lower Yuba River.

**HATCHERY EFFECTS**

Although no fish hatcheries are located on the lower Yuba River, and the river continues to support a persistent population of spring-run Chinook salmon that spawn downstream of Englebright Dam, the genetic integrity of the fish expressing the phenotypic characteristics of spring-run Chinook salmon is presently uncertain. CDFG (1998) suggested that spring-run Chinook salmon populations may be hybridized to some degree with fall-run Chinook salmon due to lack of spatial separation of spawning habitat. Also, the observation of adipose fin clips on adult Chinook salmon passing upstream through the VAKI system at Daguerre Point Dam during the spring demonstrates that hatchery straying into the lower Yuba River has and continues to occur, most likely from the FRFH (NMFS 2009; RMT 2013).

**FEATHER RIVER FISH HATCHERY GENETIC CONSIDERATIONS**

Spring-run Chinook salmon from the FRFH were planted in the lower Yuba River during 1980 (CDFG 1991). In addition, it is possible that some hatchery-reared juvenile Chinook salmon from the FRFH may move into the lower Yuba River in search of rearing habitat. Some competition for resources with naturally spawned spring-run Chinook salmon could occur as a result (YCWA et al. 2007). The remainder of this discussion pertains to hatchery effects associated with the straying of adult Chinook salmon into the lower Yuba River.
The FRFH is the only hatchery in the Central Valley that currently produces spring-run Chinook salmon. The FRFH was constructed in 1967 to compensate for anadromous salmonid spawning habitat lost with construction of the Oroville Dam. The FRFH has a goal of releasing 2,000,000 spring-run Chinook salmon smolts annually (DWR 2004c).

From 1962 to 1966, spring-run Chinook salmon were trapped and trucked above Oroville Dam. Beginning in 1967, spring-run Chinook salmon were collected for artificial propagation at FRFH as the construction of Oroville Dam was completed. The program is funded by the DWR and managed by CDFW (NMFS 2004).

The program was founded with local native stock collected at the FRFH. Early attempts to over-summer spring-run at the hatchery resulted in high mortality and the decision to allow the run to hold in the river until September 1. Prior to 2004, FRFH hatchery staff differentiated spring-run Chinook salmon from fall-run Chinook salmon by opening the ladder to the hatchery on September 1 (NMFS 2009). 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 as cited in NMFS 2009). This practice led to considerable hybridization between spring- and fall-run Chinook salmon (DWR 2004c). Since 2004, the FRFH fish ladder remains open during the spring months, closing on June 30, and those fish ascending the ladder are marked with an external floy tag and returned to the river. This practice allows FRFH staff to identify those previously marked fish as spring-run when they re-enter the ladder in September. Only floy-tagged fish are spawned with floy-tagged fish in the month of September. No other fish are spawned during this time, as part of an effort to prevent hybridization with fall-run, and to introduce a temporal separation between stocks in the hatchery. During the FRFH spring-run spawning season, all heads from adipose fin-clipped fish are taken and sent to CDFW’s laboratory in Santa Rosa for tag extraction and decoding. The tag information will be used to test the hypothesis that early spring-run spawners will produce progeny that maintain that run fidelity.

Regardless of recent improved FRFH practices, previous practices appear to have resulted in hybridization between “spring-run” and “fall-run” Chinook salmon. The following discussion was taken from Garza et al. (2008).
Evaluation of the FRFH “spring-run” stock found that it is genetically most similar to the FRFH fall-run stock, as indicated both by clustering on the phylogeographic trees and by comparison of the [standardized variance in allele frequencies between the sample years] (F\textsubscript{ST}) values, and is nested within the fall-run group of populations in all analyses (Garza et al. 2008). F\textsubscript{ST} values between the FRFH “spring-run” and naturally-spawned spring-run are in the low end of the range of values for fall-run populations to spring-run populations, but not the lowest. In addition, they are the essentially the same as those of FRFH fall-run to spring-run populations. This demonstrates convincingly that the FRFH “spring-run” stock is dominated by fall-run ancestry. However, Garza et al. (2008) also found very slight, but significant, differentiation between the two FRFH stocks, which is concordant with the results of Hedgecock et al. (unpublished study as cited in Garza et al. 2008) on these stocks. In addition, Garza et al. (2008) found a strong signal of linkage (gametic phase) disequilibrium, absent in all other population samples, in the FRFH “spring-run” stock. Garza et al. (2008) interpreted this as evidence that the FRFH "spring" run retains remnants of the phenotype and ancestry of the Feather River spring-run Chinook salmon that existed prior to the dam and hatchery (as opposed to representing a hatchery selection-created and maintained phenotypic variant), but that has been heavily introgressed by fall-run Chinook salmon through some combination of hatchery practices and natural hybridization, induced by habitat concentration due to lack of access to spring-run Chinook salmon habitat above the dam. This suggests that it may be possible to preserve some additional component of the ancestral Central Valley spring-run Chinook salmon genomic variation through careful management of this stock that can contribute to the recovery of the ESA-listed Central Valley spring-run Chinook salmon ESU, although it will not be possible to reconstitute a “pure” spring-run stock from these fish.

The FRFH spring-run Chinook salmon population is part of the Central Valley spring-run Chinook salmon ESU (70 FR 37160). At the time of issuance of the final rule regarding the listing status of the Central Valley ESU of spring-run Chinook salmon, NMFS (70 FR 37160) recognized that naturally spawning spring-run Chinook in the Feather River are genetically similar to the FRFH spring-run Chinook stock, and that the hatchery stock shows evidence of introgression with Central Valley fall-run Chinook salmon. NMFS
also stated that FRFH stock should be included in the ESU because the FRFH spring-run Chinook salmon stock may play an important role in the recovery of spring-run Chinook salmon in the Feather River Basin, as efforts progress to restore natural spring-run populations in the Feather and Yuba Rivers (70 FR 37160).

Although the FRFH spring-run Chinook salmon population is part of the Central Valley spring-run Chinook salmon ESU, concern has been expressed that straying of FRFH fish into the lower Yuba River may represent an adverse impact due to the potential influence of previous hatchery management practices on the genetic integrity of FRFH spring-run Chinook salmon.

**Straying into the Lower Yuba River**

The RMT (2013) reported that substantially higher amounts of straying of adipose fin-clipped Chinook salmon into the lower Yuba River occur than that which was previously believed. Although no quantitative analyses or data were presented, NMFS (2007) stated that some hatchery fish stray into the lower Yuba River and that these fish likely come from the FRFH.

Some information indicating the extent to which adipose-clipped Chinook salmon originating from the FRFH return to the lower Yuba River is available from coded wire tag analysis. During the October through December 2010 carcass survey period in the lower Yuba River, the RMT collected heads from fresh Chinook salmon carcasses with adipose fin clips, and sent the heads to the CDFW coded wire tag (CWT) interpretive center. In April of 2011, the results of the interpretation of the CWTs became available. Of the 333 Chinook salmon heads sent to the CDFW interpretive center, 11 did not contain a CWT, 8 were fall-run Chinook salmon from the Coleman National Fish Hatchery, 2 were from the RST captured and tagged juveniles in the lower Yuba River, 1 was a naturally-spawned fall-run Chinook salmon from the Feather River, 1 was a fall-run Chinook salmon from the Mokelumne River Hatchery, and 310 were Chinook salmon from the FRFH (234 spring-run and 76 fall-run Chinook salmon). Thus, for all CWT hatchery-origin fish returning to the Yuba River from out-of-basin sources, 97% were from the FRFH. However, this information does not indicate the percentage of hatchery contribution from the FRFH to the phenotypic spring-run Chinook salmon run
in the lower Yuba River, because, among other reasons, all of these heads were collected
during the fall and represent a mixture of phenotypic spring- and fall-run Chinook salmon
spawning in the lower Yuba River (RMT 2013).

Additional information that can be used to assess the amount of straying of FRFH
Chinook salmon into the lower Yuba River is provided from VAKI Riverwatcher data
collected from 2004 through 2011 (RMT 2013). The estimated numbers of adipose fin-
clipped spring-run Chinook salmon that passed upstream of Daguerre Point Dam from
2004 through 2011 that were derived from the VAKI Riverwatcher data are an indicator
of the minimum number of Chinook salmon of hatchery origin (most likely of FRFH
origin) that strayed into the lower Yuba River. The following discussion of adipose fin-
clipped spring-run Chinook salmon is from RMT (2013). Discussion of the procedure
utilized by the RMT (2013) to first differentiate phenotypic spring-run from phenotypic
fall-run Chinook salmon is provided in Section 4.2.7.2, below.

Because the VAKI Riverwatcher systems located at both the north and south ladder of
Daguerre Point Dam can record both silhouettes and electronic images of each fish
passage event, the systems were able to differentiate Chinook salmon with adipose fins
clipped or absent from Chinook salmon with their adipose fins intact. Thus, annual series
of daily counts of Chinook salmon with adipose fins clipped (i.e., ad-clipped fish) and
with adipose fins intact (i.e., not ad-clipped fish) that passed upstream of Daguerre Point
Dam from March 1, 2004 through February 29, 2012 were obtained. The estimated
numbers of spring-run Chinook salmon of hatchery (i.e., ad-clipped fish) and potentially
non-hatchery origin (i.e., not ad-clipped fish) passing upstream of Daguerre Point Dam
for the last eight years of available VAKI Riverwatcher data are presented in Table 4-4.

**RELATIONSHIPS BETWEEN SPRING-RUN CHINOOK SALMON STRAYING INTO THE LOWER YUBA RIVER
AND ATTRACTION FLOWS AND WATER TEMPERATURES**

As reported by RMT (2013), to evaluate the influence of “attraction” flows and water
temperatures on the straying of adipose fin-clipped adult phenotypic spring-run Chinook
salmon into the lower Yuba River, variables related to flows and water temperatures in
the lower Yuba River and the lower Feather River were developed and statistically
related to the weekly proportions of adipose fin-clipped phenotypic spring-run Chinook
Table 4-4. Estimated numbers of Chinook salmon, ad-clipped and not ad-clipped phenotypic spring-run Chinook salmon that passed upstream of Daguerre Point Dam annually from 2004 through 2011 (Source: RMT 2013).

<table>
<thead>
<tr>
<th>Year</th>
<th>Demarcation Date</th>
<th>All Chinook Salmon</th>
<th>Spring-run Chinook Salmon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>Ad-Clipped</td>
</tr>
<tr>
<td>2004</td>
<td>8/1/04</td>
<td>5,927</td>
<td>738</td>
</tr>
<tr>
<td>2005</td>
<td>8/24/05</td>
<td>11,374</td>
<td>3,592</td>
</tr>
<tr>
<td>2006</td>
<td>9/6/06</td>
<td>5,203</td>
<td>1,326</td>
</tr>
<tr>
<td>2007</td>
<td>9/4/07</td>
<td>1,394</td>
<td>372</td>
</tr>
<tr>
<td>2008</td>
<td>8/10/08</td>
<td>2,533</td>
<td>521</td>
</tr>
<tr>
<td>2009</td>
<td>7/9/09</td>
<td>5,378</td>
<td>723</td>
</tr>
<tr>
<td>2010</td>
<td>7/6/10</td>
<td>6,469</td>
<td>2,886</td>
</tr>
<tr>
<td>2011</td>
<td>9/7/11</td>
<td>7,785</td>
<td>1,159</td>
</tr>
</tbody>
</table>

Chinook salmon (relative to all spring-run Chinook salmon) passing upstream of Daguerre Point Dam during each of the 8 years when annual VAKI Riverwatcher counts at Daguerre Point Dam are available. Details of this analytical evaluation are provided in RMT (2013).

Results of the RMT (2013) analysis suggest that there is a moderately strong ($R^2 = 0.72$) and highly significant ($P < 0.000001$) relationship between the percentage of adipose fin-clipped spring-run Chinook salmon contribution to the weekly spring-run Chinook salmon total counts at Daguerre Point Dam and the attraction flow and water temperature indices four weeks prior. The attraction flow index explained 20.4% of the data variability, the attraction water temperature index explained 27.5% of the variability, and the interaction term explained 24.4% of the variability in the proportion of adipose fin-clipped phenotypic spring-run Chinook salmon passing Daguerre Point Dam weekly (RMT 2013). Figure 4-5 displays the 3-D response surface produced by the fitted logistic model.

The analysis described above showed that an estimated 72% of the variation in the proportion of adipose fin-clipped phenotypic spring-run Chinook salmon passing upstream of Daguerre Point Dam can be accounted for by the ratio of lower Yuba River flow relative to lower Feather River flow, and the ratio of lower Yuba River water temperature relative to lower Feather River water temperature, four weeks prior to the
Figure 4-5. Relationship of the weekly percentage of adipose fin-clipped contribution to the weekly phenotypic spring-run Chinook salmon count at Daguerre Point Dam as a function of the weekly attraction flow and water temperature indices calculated four weeks prior to the week of passage at Daguerre Point Dam (Source: RMT 2013).

time of passage at Daguerre Point Dam. In other words, the higher the Yuba River flows relative to Feather River flows, combined with the lower the Yuba River water temperatures relative to Feather River water temperatures, the higher the percentage of fin-clipped Chinook salmon passing upstream of Daguerre Point Dam four weeks later (RMT 2013).

As described in RMT (2013), the acoustically-tagged phenotypic spring-run Chinook salmon spent variable and extended periods of time holding below Daguerre Point Dam after being tagged and prior to passing upstream of Daguerre Point Dam, with a range of 0 to 116 days. Based on all 67 acoustically-tagged spring-run Chinook salmon that passed upstream of Daguerre Point Dam, the average holding time before passing upstream of Daguerre Point Dam was about 50 days. For the phenotypic acoustically-tagged spring-run Chinook salmon that passed upstream of Daguerre Point Dam by the
annual spring-run Chinook salmon demarcation date for each year, the average holding
periods before passing upstream of Daguerre Point Dam were approximately 51, 41, and
57 days during 2009, 2010 and 2011, respectively. Therefore, it would be expected that
attraction of adipose fin-clipped fish to the lower Yuba River associated with flows and
water temperatures in the lower Yuba River relative to the lower Feather River would
occur at least several weeks prior to passage of phenotypic spring-run Chinook salmon
upstream of Daguerre Point Dam (RMT 2013).

While the variation in the proportion of adipose fin-clipped phenotypic spring-run
Chinook salmon passing Daguerre Point Dam was best explained with ratios of flows and
water temperatures in the lower Yuba and Feather rivers four weeks prior to passage at
Daguerre Point Dam, the acoustically-tagged individuals exhibited a somewhat longer
duration of holding on average. However, due to the relatively small sample size of
acoustically-tagged spring-run Chinook salmon passing upstream of Daguerre Point Dam
(N=67), the short duration of the study, and based on the highly variable holding duration
(i.e., 0-116 days), the average holding time calculated for the acoustically-tagged spring-
run Chinook salmon is considered to be a general approximation of holding duration
downstream of Daguerre Point Dam (RMT 2013). Therefore, consideration of holding
duration downstream of Daguerre Point Dam supports the observation that the ratios of
flows and water temperatures in the lower Yuba River relative to the lower Feather River
four weeks prior to passage of spring-run Chinook salmon at Daguerre Point Dam may be
influencing the attraction of adipose fin-clipped spring-run Chinook salmon of FRFH-
origin into the lower Yuba River (RMT 2013).

**LOWER YUBA RIVER GENETIC CONSIDERATIONS**

Spring-run Chinook salmon historically acquired and maintained genetic integrity
through reproductive (spatial-temporal) isolation from other Central Valley Chinook
salmon runs. However, construction of dams has prevented access to headwater areas
and much of this historical reproductive isolation has been compromised, resulting in
intermixed life history traits in many remaining habitats (YCWA 2010).

Between 1900 and 1941, debris dams constructed on the lower Yuba River by the
California Debris Commission to retain hydraulic mining debris, now owned and
operated by the Corps, completely or partially blocked the migration of Chinook salmon and steelhead to historic spawning and rearing habitats (CDFG 1991a; Wooster and Wickwire 1970; Yoshiyama et al. 1996). Englebright Dam (constructed in 1941) completely blocks spawning runs of Chinook salmon and steelhead, and is the upstream limit of fish migration. Fry (1961) reported that a small spring-run Chinook salmon population historically occurred in the lower Yuba River, but the run virtually disappeared by 1959.

Since the completion of New Bullards Bar Reservoir in 1970 by YCWA, higher, colder flows in the lower Yuba River have improved conditions for over-summering and spawning of spring-run Chinook salmon in the lower Yuba River (YCWA et al. 2007). As of 1991, a remnant spring-run Chinook salmon population reportedly persisted in the lower Yuba River downstream of Englebright Dam maintained by fish produced in the lower Yuba River, fish straying from the Feather River, or fish previously and infrequently stocked from the FRFH (CDFG 1991). In the 1990s, relatively small numbers of Chinook salmon that exhibit spring-run phenotypic characteristics were reported to have been observed in the lower Yuba River (CDFG 1998). Although precise escapement estimates are not available, the USFWS testified at the 1992 SWRCB lower Yuba River hearing that “…a population of about 1,000 adult spring-run Chinook salmon now exists in the lower Yuba River” (San Francisco Bay RWQCB 2006).

If spring-run Chinook salmon were extirpated from the lower Yuba River in 1959 (Fry 1961) and, as reported by CDFG (1991), a population of spring-run Chinook salmon became reestablished since the 1970s due to improved habitat conditions and fish straying from the Feather River or stocked and straying from the FRFH, then it is likely that spring-run Chinook salmon on the lower Yuba river do not represent a “pure” ancestral genome.

There also is concern that the existing spring-run Chinook salmon population has interbred with fall-run Chinook salmon and, as a result, it is a hybrid species and not a true spring-run species (Corps 2001). In addition to the effects of hatchery straying, an additional issue regarding the genetic integrity of phenotypic spring-run Chinook salmon in the lower Yuba River pertains to the loss or reduction of reproductive isolation.
Spring-run Chinook salmon acquired and maintained genetic integrity through spatial-temporal isolation from other Central Valley Chinook salmon runs. Historically, spring-run Chinook salmon were temporally isolated from winter-run, and largely isolated in both time and space from the fall-run. Much of this historical spatial-temporal integrity has broken down, resulting in intermixed life history traits in many remaining habitats. Consequently, the present self-sustaining, persistent populations of spring-run Chinook salmon in the upper Sacramento, lower Yuba, and lower Feather rivers may be hybridized to some degree with fall-run Chinook salmon (YCWA et. al 2007).

Englebright Dam is a complete migration barrier to anadromous fish, precluding migration of Chinook salmon to historical holding and spawning areas upstream of the dam. Consequently, both fall-run and spring-run Chinook salmon are restricted to areas below the dam. Because the spawn timing overlaps between the two runs and they potentially interbreed, genetic swamping of the relatively smaller numbers of spring-run Chinook salmon by more abundant fall-run fish could occur (DWR and PG&E 2010).

The presence of Englebright Dam has necessitated that spring-run Chinook salmon spawn in areas that were believed to formerly represent fall-run Chinook salmon spawning areas. Although the lower Yuba River continues to support a persistent population of spring-run Chinook salmon that now are restricted to spawning downstream of Englebright Dam, the genetic integrity of the fish expressing the phenotypic characteristics of spring-run Chinook salmon is presently uncertain. For example, CDFG (1998) suggests that spring-run populations may be hybridized to some degree with fall-run populations due to lack of spatial separation of spawning habitat for the two runs of Chinook salmon in the lower Yuba River.

In the report titled *Salmonid Hatchery Inventory and Effects Evaluation* (NMFS 2004), through an analysis of Yuba River Chinook salmon tissues, NMFS genetically linked the spring-run and fall-run populations, which exhibit a merged run timing similar to that found in the Feather River.

In conclusion, available information indicates that: (1) the phenotypic spring-run Chinook salmon in the lower Yuba River actually represents hybridization between spring- and fall-run Chinook salmon in the lower Yuba River, and hybridization with
Feather River stocks including the FRFH spring-run Chinook salmon stock, which itself represents a hybridization between Feather River fall- and spring-run Chinook salmon populations; and (2) straying from FRFH origin “spring-run” Chinook salmon into the lower Yuba River occurs, and that this rate of straying is associated with the relative proportion of lower Yuba River flows and water temperatures to lower Feather River flows and water temperatures (“attraction flows and water temperatures”); and (3) the FRFH spring-run Chinook salmon is included in the ESU, in part because of the important role this stock may play in the recovery of spring-run Chinook salmon in the Feather River Basin, including the Yuba River (70 FR 37160). Although straying of FRFH “spring-run” Chinook salmon into the lower Yuba River has oftentimes been suggested to represent an adverse impact on lower Yuba River spring-run Chinook salmon stocks, it is questionable whether the phenotypic spring-run Chinook salmon in the lower Yuba River represents an independent population. The RMT (2013) recently reported that data obtained through the course of implementing the RMT’s M&E Program demonstrate that phenotypically “spring-running” Chinook salmon in the lower Yuba River do not represent an independent population – rather, they represent an introgressive hybridization of the larger Feather-Yuba river regional population.

JUVENILE STRANDING AND REDD DEWATERING

In the California State Water Resources Control Board’s (SWRCB) 2001 Decision (D)-1644, the SWRCB directed YCWA to submit a plan that described the scope and duration of future flow fluctuation studies to verify that Chinook salmon and steelhead redds are being adequately protected from dewatering with implementation of D-1644 criteria (YCWA 1992). The monitoring and evaluation plan contained the following objectives (JSA 2003):

- Determine the potential magnitude of redd dewatering in relation to the timing and magnitude of flow fluctuations and reductions
- Determine the potential magnitude of fry stranding in relation to the timing, magnitude, and rate of flow fluctuations and reductions
- Evaluate the effectiveness of the D-1644 flow fluctuation and reduction criteria in protecting redds and fry
Recommend additional measures to protect redds and fry from flow fluctuations and reductions if warranted

The studies combined habitat mapping, field surveys, and information on the timing and distribution of fry rearing in the Yuba River to evaluate the effectiveness of D-1644 flow fluctuation and reduction criteria in protecting Chinook salmon and steelhead fry. Two studies were conducted and summarized in the 2007 and 2008 Lower Yuba River Redd Dewatering and Fry Stranding Annual Report (JSA 2008) to the SWRCB, and results from an additional study were reported in a progress report in 2010 (ICF Jones & Stokes 2010). A preliminary draft report providing the results of all survey activities conducted during 2007 through 2011 was produced in 2012 (ICF Jones & Stokes 2012), although additional evaluation and reporting of the data is ongoing.

The first Lower Yuba River Redd Dewatering and Fry Stranding Study was conducted in April 2007 to evaluate bar and off-channel stranding of juvenile salmonids associated with a flow reduction of 1,300-900 cfs at Smartsville at a ramping rate of 100 cfs per hour. Bar stranding was again evaluated in June with a temporary flow reduction of 1,600-1,300 cfs at a rate of 100 cfs per hour. Snorkel surveys were conducted between Rose Bar, located ~2.5 miles downstream of Englebright Dam, and the Highway 20 Bridge, located ~5.7 miles downstream of Englebright Dam.

During the April 5, 2007 drawdown, field crews observed eight stranded salmon fry in the interstitial spaces of substrates on bar slopes (perpendicular to shoreline) ranging from 0.5 to 5.5% in slope. No stranded fish were observed during surveys conducted on June 18, 2007. The presence of both juvenile Chinook salmon and *O. mykiss* were confirmed in shallow, near-shore areas adjacent to the study sites, suggesting that the risk of bar stranding is greatly reduced by June. Following the April 5, 2007 flow reductions, juvenile salmon were found in 16 of the 24 disconnected off-channel sites (ICF Jones & Stokes 2012). Most of the fish that had become isolated in off-channel sites were 30-50 mm fry. Out of the 16 sites where isolation of fry was observed, 70% of the fish were found in the four largest sites, which accounted for nearly 60% of the total wetted area that had become disconnected from the main river. According to ICF Jones & Stokes (2012), these four sites were unique in that they were all associated with man-made
features within or adjacent to the main river channel (e.g., diversion channels, ponds and
bridge piers).

An updated *Lower Yuba River Redd Dewatering and Fry Stranding Study* was
subsequently conducted from May 29, 2008 through June 4, 2008 with a scheduled flow
reduction on June 1, 2008. A total of seven stranded trout fry ranging between 30-35 mm
were observed in the interstitial spaces of substrates on bar slopes ranging from 2.0 to
5.7% in slope.

Juvenile salmon were found isolated in seven of the 12 off-channel sites that had become
disconnected from the main river by the June 1, 2008 event. One site accounted for only
about 7% of the total wetted area that had been disconnected from the main river, but
nearly 80% of the total number of juvenile salmon that had been isolated by the June 1,
2008 event. A total of 13 steelhead fry were found isolated in 2 of the 12 off-channel
sites that had become disconnected from the main river by the June 1, 2008 event.
Nearly all of these fish were 30-50 mm fry that had been isolated in a single backwater
pool adjacent to the main river in the Timbuctoo Reach (ICF Jones & Stokes 2012).

JSA (2008) suggested that the preliminary findings indicated that juvenile *O. mykiss* fry
may be less vulnerable to off-channel stranding than juvenile Chinook salmon because of
their more restricted distribution and inability to access off-channel areas under late
spring flow conditions. Long-term monitoring of several isolated off-channel sites
confirmed that some sites can support juvenile salmonids for long periods and even
produce favorable summer rearing conditions.

A 2010 study was conducted from June 21, 2010 through July 1, 2010, with a scheduled
flow reduction between June 28 and June 30 from approximately 4,000 cfs to 3,200 cfs as
measured at the Smartsville Gage. As reported by ICF Jones & Stokes (2010), fish
stranding surveys were conducted on June 21, 22, and 23 to identify potential stranding
areas and document habitat conditions and fish presence before the flow reduction, and
were repeated on June 29, June 30, and July 1 to document the incidence of fish stranding
and habitat conditions after the flow reduction.

After the June flow reduction, a total of six juvenile salmon and 46 juvenile trout was
observed in seven of the 26 off-channel sites that had become fully or nearly
disconnected (≤0.1 foot deep) from the main river. Most of the stranded fish were juvenile trout 30-70 mm in length that had become isolated in five off-channel sites above Daguerre Point Dam. Below Daguerre Point Dam, observations of stranded fish were limited to six juvenile salmon and two juvenile trout at two study sites (ICF Jones & Stokes 2010).

Hydrologic and operating conditions in January and February 2011 provided the first opportunity to evaluate the effect of a winter flow reduction on the incidence of bar stranding. A series of three successive flow reductions were evaluated. Following a 3-week period of relatively stable flows, Englebright Dam releases were reduced from 3,000-2,600 cfs on January 31, 2,600-2,200 cfs on February 7, and 2,200-2,000 cfs on February 11.

The first event was a 400-cfs flow reduction (3,000–2,600 cfs) conducted from 8:00 AM to 10:00 AM at a target rate of 200 cfs per hour on January 31, 2011. This event resulted in a 2.1–2.5 inch drop in water surface elevation and a rate of change of 0.6–0.8 inch per hour at the three study sites. Field crews searched a total of 764 square feet of dewatered shoreline and found a total of 20 stranded salmon fry (30-40 mm long) and six stranded steelhead (50-90 mm long) (ICF Jones & Stokes 2012).

During the second event on February 7, 2011, flows were again reduced by 400 cfs (2,600–2,200 cfs) from 8:00 AM to 10:00 AM, but at a target rate of 100 cfs per hour. This event resulted in a 1.8–2.1 inch drop in water surface elevation and a rate of change of 0.4–0.5 inch per hour at the three study sites. Field crews searched a total of 560 square feet of dewatered shoreline and found a total of 10 stranded salmon fry (30-40 mm long) and no steelhead (ICF Jones & Stokes 2012).

During the third event on February 11, 2011, flows were reduced by 200 cfs (2,200–2,000 cfs) from 2:00 AM to 4:00 AM at a target rate of 100 cfs per hour. This event resulted in a 0.8–1.3 inch drop in water surface elevation and a rate of change of 0.4–0.7 inch per hour at the three study sites. Field crews searched a total of 248 square feet of dewatered shoreline and found a total of four stranded salmon fry (30-40 mm long) and no steelhead (ICF Jones & Stokes 2012).
4.2.7 Viability of Central Valley Spring-run Chinook Salmon

The “Viable Salmonid Population” (VSP) concept was developed by McElhany et al. (2000) to facilitate establishment of Evolutionarily Significant Unit (ESU)-level delisting goals and to assist in recovery planning by identifying key parameters related to population viability. Four key parameters were identified by McElhany et al. (2000) as the key to evaluating population viability status: (1) abundance; (2) productivity; (3) diversity; and (4) spatial structure. McElhany et al. (2000) interchangeably use the term population growth rate (i.e., productivity over the entire life cycle) and productivity. Good et al. (2007) used the term productivity when describing this VSP parameter, which also is the term used for this parameter in this BA. The following discussion regarding the four population viability population parameters was taken directly from NMFS (2009).

Abundance is an important determinant of risk, both by itself and in relationship to other factors (McElhany et al. 2000). Small populations are at a greater risk for extinction than larger populations because risks that affect the population dynamics operate differently on small populations than in large populations. A variety of risks are associated with the dynamics of small populations, including directional effects (i.e., density dependence - compensatory and depensatory), and random effects (i.e., demographic stochasticity, environmental stochasticity, and catastrophic events).

The parameter of productivity and factors that affect productivity provide information on how well a population is “performing” in the habitats it occupies during the life cycle (McElhany et al. 2000). Productivity and related attributes are indicators of a population’s performance in response to its environment and environmental change and variability. Intrinsic productivity (the maximum production expected for a population sufficiently small relative to its resource supply not to experience density dependence), the intensity of density dependence, and stage-specific productivity (productivity realized over a particular part of the life cycle) are useful in assessing productivity of a population.

Diversity refers to the distribution of traits within and among populations, and these traits range in scale from DNA sequence variation at single genes to complex life-history traits.
(McElhany et al. 2000). Traits can be completely genetic or vary due to a combination of genetics and environmental factors. Diversity in traits is an important parameter because: (1) diversity allows a species to use a wide array of environments; (2) diversity protects a species against short-term spatial and temporal changes in its environment; and (3) genetic diversity provides the raw material for surviving long-term environmental changes (McElhany et al. 2000). Some of the varying traits include run timing, spawning timing, age structure, outmigration timing, etc. Straying and gene flow strongly influence patterns of diversity within and among populations (McElhany et al. 2000).

Spatial structure reflects how abundance is distributed among available or potentially available habitats, and how it can affect overall extinction risk and evolutionary processes that may alter a population’s ability to respond to environmental change. A population’s spatial structure encompasses the geographic distribution of that population, as well as the processes that generate or affect that distribution (McElhany et al. 2000). A population’s spatial structure depends fundamentally on habitat quality, spatial configuration, and dynamics as well as the dispersal characteristics of individuals in the population. Potentially suitable but unused habitat is an indication of the potential for population growth.

### 4.2.7.1 ESU

To determine the current viability of the spring-run Chinook salmon ESU, NMFS (2009a) used the historical population structure of spring-run Chinook salmon presented in Lindley et al. (2007) and the concept of VSP for evaluating populations described by McElhany et al. (2000). Lindley et al. (2004) identified 26 historical populations within the spring-run ESU; 19 were independent populations, and 7 were dependent populations. Of the 19 independent populations of spring-run that occurred historically, only three remain, in Deer, Mill, and Butte creeks. Extant dependent populations occur in Battle, Antelope, Big Chico, Clear, Beegum, and Thomes creeks, as well as in the Yuba River, the Feather River below Oroville Dam, and in the mainstem Sacramento River below Keswick Dam (NMFS 2009a).

Lindley et al. (2007) provide criteria to assess the level of risk of extinction of Pacific salmonids based on population size, recent population decline, occurrences of
catastrophes within the last 10 years that could cause sudden shifts from a low risk state to a higher one, and the impacts of hatchery influence. Although these criteria were developed for application to specific populations, insight to the viability of the spring-run Chinook salmon ESU can be obtained by examining population trends within the context of these criteria.

**Viable Salmonid Population (VSP) Parameters and Application**

**Abundance**

According to NMFS (2009a), spring-run Chinook salmon in the Central Valley declined drastically in the mid- to late 1980s before stabilizing at very low levels in the early to mid-1990s. Since the late 1990s, there does not appear to be a trend in basin-wide abundance (NMFS 2009a). Since NMFS presented these data, additional abundance estimates are available for the spring-run Chinook salmon ESU.

Central Valley-wide spring-run Chinook salmon abundance estimates are available through GrandTab (CDFW 2013). Since 1983, in-river estimates for the lower Feather River have not been included in the system-wide estimates, although FRFH estimates are provided separately. Additionally, spring-run Chinook salmon are not estimated in GrandTab for the lower Yuba River, and all lower Yuba River Chinook salmon escapement estimates are reported as fall-run Chinook salmon. For the Sacramento River system (not including the FRFH or the lower Yuba River) since 1983, spring-run Chinook salmon run size estimates have ranged from a high of 24,903 in 1998 to a low of 1,404 in 1993. For the past five years (2008 - 2012), the abundance of in-river spawning Central Valley spring-run Chinook salmon has steadily declined from a high of 11,927 in 2008 to a low of 2,962 in 2010, before increasing to 5,439 in 2011 and 18,511 in 2012.

The spring-run Chinook salmon run size estimate for the Sacramento River system (not including the FRFH or the lower Yuba River) over the past three consecutive years for which data are available averaged 8,971 fish (i.e., 2,962 fish in 2010, 5,439 fish in 2011, and 18,511 fish in 2012).
PRODUCTIVITY

The spring-run Chinook salmon run size estimate for the Sacramento River system (not including the FRFH or the lower Yuba River) over the past three consecutive years totaled 26,912 fish, thereby exceeding both the minimum total escapement value of 2,500 (Lindley et al. 2007), as well as the mean value of 833 fish per year identified by NMFS (2011a).

From 1983 through 2012, the annual contribution of spring-run Chinook salmon from the FRFH to the total annual run size in the Sacramento River system has ranged from a high of 76.9% (4,672 fish) in 1993 to a low of 5.6% (1,433 fish) in 1986. As an indicator of the FRFH influence on spring-run Chinook salmon in the Sacramento River system, the average annual percent contribution of FRFH spring-run Chinook salmon relative to the total annual run in the Sacramento River system was 31.2% over the entire 30-year period (1983-2012), and was 20.7% over the last 10 years (2003-2012). The percent contribution of FRFH to the total population of Central Valley spring-run Chinook salmon does not represent straying per se. The guidelines presented in Figure 1 in Lindley et al. (2007) present extinction risk levels corresponding to different amount, duration and source of hatchery strays, taking into consideration whether hatchery strays are from within the ESU, the diversity group, and from a “best management practices” hatchery. These criteria indicate a high extinction risk if hatchery straying represents more than 20% hatchery contribution for one generation or more than 10% for four generations from a hatchery within a given diversity group, or more than 50% hatchery contribution for one generation or more than 15% for four generations from a best management practices hatchery within a given diversity group. Although not technically representing straying, the average contribution of spring-run Chinook salmon from the FRFH to the total annual run size in the Sacramento River system has been 26.4% over the most recent generation, 21.6% over the two most recent generations, 19.8% over the three most recent generations, and 19.9% over the four most recent generations assuming a three-year life cycle. According to NMFS (2011a), recent anomalous conditions in the coastal ocean, along with consecutive dry years affecting inland freshwater conditions, have contributed to statewide escapement declines.
**SPATIAL STRUCTURE**

Lindley et al. (2007) indicated that of the 19 independent populations of spring-run that occurred historically, only three (Butte, Mill, and Deer creeks) remain, and their current distribution makes the spring-run ESU vulnerable to catastrophic disturbance (e.g., disease outbreaks, toxic spills, or volcanic eruptions). Butte, Mill, and Deer Creeks all occur in the same biogeographic region (diversity group), whereas historically, independent spring-run populations were distributed throughout the Central Valley among at least three diversity groups (i.e., the Basalt and Porous Lava Diversity Group, the Northern Sierra Nevada Diversity Group, and the Southern Sierra Nevada Diversity Group). In addition, dependent spring-run populations historically persisted in the Northwestern California Diversity Group (Lindley et al. 2004). Currently, there are dependent populations of spring-run Chinook salmon in the Big Chico, Antelope, Clear, Thomes, Battle, and Beegum creeks, and in the Sacramento, Feather, and Yuba rivers (Lindley et al. 2007).

Spring-run Chinook salmon have been reported more frequently in several upper Central Valley creeks, but the sustainability of these runs is still unknown (NMFS 2004). In 2004, NMFS reported that Butte Creek spring-run cohorts had recently utilized all available habitat in the creek, so the population cannot expand further. It is unknown if individuals have opportunistically migrated to other systems. The spatial structure of the Central Valley spring-run Chinook salmon ESU has been reduced with the extirpation of all San Joaquin River Basin spring-run populations (NMFS 2004).

**DIVERSITY**

As discussed in NMFS (2009a), diversity, both genetic and behavioral, provides a species the opportunity to track environmental changes. As a species’ abundance decreases, and spatial structure of the ESU is reduced, a species has less flexibility to track changes in the environment. Spring-run Chinook salmon reserve some genetic and behavioral variation in that in any given year, at least two cohorts are in the marine environment and, therefore, are not exposed to the same environmental stressors as their freshwater cohorts (NMFS 2009a).
Genetic analysis of natural and hatchery spring-run Chinook salmon stocks in the Central Valley reveal that the southern Cascades spring-run population complex has retained its genetic integrity (NMFS 2004). However, although spring-run produced at the FRFH are part of the spring-run Chinook salmon ESU (70 FR 37160, June 28, 2005), they compromise the genetic diversity of naturally-spawned spring-run Chinook salmon (NMFS 2009a). The spring-run hatchery stock introgressed with the fall-run hatchery stock, and both are genetically linked with the natural populations in the Feather River (NMFS 2004). The FRFH program has affected the diversity of the Central Valley spring-run Chinook salmon and, together with the loss of the San Joaquin River Basin spring-run populations, the diversity of the Central Valley spring-run Chinook salmon ESU has been reduced (NMFS 2004).

**SUMMARY OF THE VIABILITY OF THE CENTRAL VALLEY SPRING-RUN CHINOOK SALMON ESU**

According to NMFS (2005a), threats from hatchery production, climatic variation, predation, and 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, high quality critical habitat containing spawning sites with adequate water and substrate conditions, or rearing sites with adequate floodplain connectivity, cover, and water conditions (i.e., key primary constituent elements of critical habitat that contribute to its conservation value) is considered to be limited and the population is at a moderate risk of extinction.

According to NMFS (2009a), spring-run Chinook salmon fail the representation and redundancy rule for ESU viability, because the current distribution of independent populations has been severely constricted to only one of their former geographic diversity groups. NMFS (2009a) concluded that the Central Valley spring-run Chinook salmon ESU is at moderate risk of extinction in 100 years.

In 2011, NMFS completed a 5-year status review of the Central Valley spring-run Chinook salmon ESU. According to NMFS (2011b), new information for the Central Valley spring-run Chinook salmon ESU suggests an increase in extinction risk. With a few exceptions, Central Valley spring-run Chinook salmon escapements has declined over the past 10 years, in particular since 2006 (NMFS 2011b). Overall, the recent
declines have been significant but not severe enough to qualify as a catastrophe under the
criteria of Lindley et al. (2007). On the positive side, spring-run Chinook salmon appear
to be repopulating Battle Creek, home to a historical independent population in the Basalt
and Porous Lava diversity group that was extirpated for many decades. Similarly, the
spring-run Chinook salmon population in Clear Creek has been increasing, although
Lindley et al. (2004) classified this population as a dependent population, and thus it is
not expected to exceed the low-risk population size threshold of 2,500 fish (i.e., annual
spawning run size of about 833 fish).

The status of the Central Valley spring-run Chinook salmon ESU has probably
deteriorated on balance since the 2005 status review and Lindley et al.’s (2007)
assessment, with two of the three extant independent populations of spring-run Chinook
salmon slipping from low or moderate extinction risk to high extinction risk (NMFS
2011b). Butte Creek remains at low risk, although it is on the verge of moving towards
high risk (NMFS 2011b). By contrast, spring-run Chinook salmon in Battle and Clear
creeks have increased in abundance over the last decade, reaching levels of abundance
that place these populations at moderate extinction risk (NMFS 2011b).

In summary, NMFS (2011b) states that the status of the Central Valley spring-run
Chinook salmon ESU has probably deteriorated since the 2005 status review. From
2007-2009, the Central Valley experienced drought conditions and low river and stream
discharges, which are generally associated with lower survival of Chinook salmon
(NMFS 2011b). There is a possibility that with the recent cessation of the drought and a
return to more typical patterns of upwelling and sea-surface temperatures that declining
trends in abundance may reverse in the near future (NMFS 2011b). According to NMFS
(2011b), improvements in the status of two spring-run Chinook salmon populations in the
Central Valley are not sufficient to warrant a downgrading of the ESU extinction risk,
and the degradation in status of three formerly low- or moderate-risk independent
populations is cause for concern. New information available since Good et al. (2005)
indicates an increased extinction risk (NMFS 2011b).
4.2.7.2 Lower Yuba River

As previously discussed, the VSP concept was developed by McElhany et al. (2000) in order to facilitate establishment of ESU-level delisting goals and to assist in recovery planning by identifying key parameters related to population viability. The four parameters established by McElhany et al. (2000) included abundance, productivity, spatial structure and genetic and life-history diversity, although McElhany et al. (2000) did not provide quantitative criteria that would allow assessment of whether particular populations or ESUs/DPSs are viable.

Lindley et al. (2007) characterized the spring-run Chinook salmon population in the lower Yuba River as data deficient, and therefore did not characterize its viability. In 2007, there was limited information on the current population size of spring-run Chinook salmon in the lower Yuba River, although NMFS (2009) stated that ongoing monitoring is providing additional information.

ABUNDANCE AND PRODUCTIVITY

RUN DIFFERENTIATION (SPRING-RUN VS. FALL-RUN CHINOOK SALMON)

Prior to application of VSP performance indicators or the extinction risk criteria, it is necessary to differentiate between annually returning spring-run and fall-run Chinook salmon in the lower Yuba River.

However, as reported by RMT (2013), there is no discernible genetic differentiation available to determine spring-run Chinook salmon, only phenotypic differentiation. The phenotypic expression is often obscure, requiring application of advanced statistical techniques to VAKI Riverwatcher and other datasets in order to identify the phenotypic differences in run timing. The following discussion of differentiating phenotypic spring-run from phenotypic fall-run Chinook salmon in the lower Yuba River is generally taken from RMT (2013).

Infrared-imaging technology has been used to monitor fish passage at Daguerre Point Dam in the lower Yuba River since 2003 using VAKI Riverwatcher systems to document specific observations used to address VSP parameters of adult abundance and diversity. The VAKI Riverwatcher infrared systems produced by VAKI Aquaculture Systems Ltd.,
of Iceland, provided a tool for monitoring fish passage year-round. The VAKI Riverwatcher system records both silhouettes and electronic images of each fish passage event in both of the Daguerre Point Dam fish ladders. By capturing silhouettes and images, fish passage can be accurately monitored even under turbid conditions.

The VAKI Riverwatcher systems located at both the north and south ladder of Daguerre Point Dam were able to record and identify the timing and magnitude of passage for Chinook salmon at Daguerre Point Dam during most temporal periods of a given year.

Prior to applying any analysis of temporal modalities to the 8 annual time series of Chinook salmon daily VAKI counts, the annual daily count series at each ladder were adjusted to account for days when the VAKI Riverwatcher systems were not fully operational. The procedure used to obtain complete annual daily count series of Chinook salmon migrating upstream of Daguerre Point Dam is provided in RMT (2013).

The daily time series of Chinook salmon moving upstream of Daguerre Point Dam resulting from the previous step were further analyzed and temporal modalities were explored to differentiate spring-run from fall-run Chinook salmon each year. For a full description of the run differentiation process, see RMT (2013).

**Figure 4-6** and **Figure 4-7** display the daily number of Chinook salmon that passed upstream of Daguerre Point Dam during the 2004 to the 2011 biological years (March 1 through February 28) and the fitted generalized logistic functions describing the distributions of spring-run and fall-run Chinook salmon resulting from the application of the annually variable temporal demarcation procedure. Finally, **Table 4-5** summarizes the total number of spring-run and fall-run Chinook salmon estimated to have passed upstream of Daguerre Point Dam annually, and the estimated annual percentage of spring-run Chinook salmon relative to all Chinook salmon each year.
Figure 4-6. Daily number of Chinook salmon passing upstream of Daguerre Point Dam during the 2004 to 2007 biological years. Bars indicate the VAKI Riverwatcher daily counts and lines indicate the predicted daily distributions of spring-run (blue line) and fall-run (orange line) Chinook salmon based on the fitting of two generalized logistic functions to the data. The demarcation date differentiating the two runs of Chinook salmon is indicated for each year (Source: RMT 2013).
Figure 4-7. Daily number of Chinook salmon passing upstream of Daguerre Point Dam during the 2008 to 2011 biological years. Bars indicate the VAKI Riverwatcher daily counts and lines indicate the predicted daily distributions of spring-run (blue line) and fall-run (orange line) Chinook salmon based on the fitting of two generalized logistic functions to the data. The demarcation date differentiating the two runs of Chinook salmon is indicated for each year. (Source: RMT 2013)
Table 4-5. Annual number of spring-run and fall-run Chinook salmon estimated to have passed upstream of Daguerre Point Dam, and the estimated annual percentage of spring-run Chinook salmon relative to all Chinook salmon each year. (Source: RMT 2013)

<table>
<thead>
<tr>
<th>Run</th>
<th>Biological Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
</tr>
<tr>
<td>Spring-run Chinook Salmon</td>
<td>738</td>
</tr>
<tr>
<td></td>
<td>12.5%</td>
</tr>
<tr>
<td>Fall-run Chinook Salmon</td>
<td>5,189</td>
</tr>
<tr>
<td></td>
<td>87.5%</td>
</tr>
</tbody>
</table>

**ANNUAL ABUNDANCE OF SPRING-RUN CHINOOK SALMON**

For the period (2004-2011) during which VAKI Riverwatcher data are available, the annual number of spring-run Chinook salmon estimated to have passed upstream of Daguerre Point Dam ranged from 372 in 2007 to 3,592 in 2005, with an average of 1,415 (RMT 2013). The abundance of spring-run Chinook salmon during the past two years has been substantially higher than the three years prior (RMT 2013).

As previously described by NMFS (2011a), populations with a low risk of extinction (less than 5% chance of extinction in 100 years) are those with a minimum total escapement of 2,500 spawners in 3 consecutive years (mean of 833 fish per year). For the last three consecutive years, an estimated total of 4,768 spring-run Chinook salmon have passed upstream of Daguerre Point Dam, with an average of 1,589 fish per year (RMT 2013). However, as further discussed below, the annual abundances of phenotypic spring-run Chinook salmon in the lower Yuba River are strongly influenced by hatchery fish (RMT 2013).

**TRENDS IN THE ANNUAL ABUNDANCE OF SPRING-RUN CHINOOK SALMON**

The statistical approach recommended by Lindley et al. (2007) was followed by RMT (2013) to examine whether the abundance of lower Yuba River spring-run Chinook salmon exhibited a statistically significant linear trend over time during the eight most recent years for which VAKI Riverwatcher data are available. The natural logarithms of the abundance estimates of lower Yuba River spring-run Chinook salmon for the eight
most recent years (2004-2011) were linearly regressed against time (year) using a simple least-squares approach (RMT 2013). The estimated slope of the resulting line is a measure of the average rate of change of the abundance in the population over time.

**Figure 4-8** displays the antilogarithmic transformation of the estimated annual number of spring-run Chinook salmon passing upstream of Daguerre Point Dam from 2004-2011 (RMT 2013). Figure 4-8 demonstrates that the abundance of spring-run Chinook salmon in the lower Yuba River has exhibited a very slight increase over the eight years examined. However, the coefficient of determination is very weak ($r^2 = 0.0005$) and the slope is not statistically significantly different from zero ($P = 0.96$), indicating that the positive trend is not significant (RMT 2013). The relationship indicates that the phenotypic spring-run Chinook salmon annual abundance over this time period is stable, and is not exhibiting a significant declining trend (RMT 2013). These abundance and trend considerations would correspond to low extinction risk according to NMFS criteria (Lindley et al. 2007). However, the RMT (2013) questions the applicability of any of these criteria addressing extinction risk, because they presumably apply to independent populations and, as previously discussed, lower Yuba River anadromous salmonids

![Spring-run Chinook Salmon Upstream of Daguerre Point Dam](image)

**Figure 4-8.** Temporal trend and estimated annual number of phenotypic adult spring-run Chinook salmon passing upstream of Daguerre Point Dam from 2004 through 2011. (Source: RMT 2013)
represent introgressive hybridization of larger Feather-Yuba river populations, with substantial contributions of hatchery-origin fish to the annual runs. As previously mentioned, the annual abundances of phenotypic spring-run Chinook salmon in the lower Yuba River are strongly influenced by hatchery fish, as discussed below.

**Annual Abundance of Adipose Fin-Clipped and Non Adipose Fin-Clipped Spring-run Chinook Salmon**

Because the VAKI Riverwatcher systems located at both the north and south ladder of Daguerre Point Dam can record both silhouettes and electronic images of each fish passage event, the systems were able to differentiate Chinook salmon with adipose fins clipped or absent from Chinook salmon with their adipose fins intact. Thus, annual series of daily counts of Chinook salmon with adipose fins clipped (i.e., ad-clipped fish) and with adipose fins intact (i.e., not ad-clipped fish) that passed upstream of Daguerre Point Dam from March 1, 2004 through February 29, 2012 were obtained by RMT (2013).

The estimated numbers of spring-run Chinook salmon of hatchery (i.e., ad-clipped fish) and potentially non-hatchery origin (i.e., not ad-clipped fish) passing upstream of Daguerre Point Dam for the last eight years of available VAKI Riverwatcher data are presented in **Table 4-6**. Examination of Table 4-6 demonstrates a sharp increase in the annual percent contribution of ad-clipped phenotypic spring-run Chinook salmon to the total estimated annual run beginning in 2009 and extending through 2011 (RMT 2013). This may be due, in part, to the fact that FRFH-origin spring-run Chinook salmon were fractionally marked prior to 2005 and 100% marked thereafter. These fish would have returned as age-3 fish during 2008. Also, fractional marking of fall-run hatchery fish at the FRFH started during 2006, and these fish may return, to some extent, as phenotypic spring-run Chinook salmon. Age 3 fish would have returned during 2009. The first full year (age 3 and age 4) of recovery data from the CFM program occurred during 2010. Evaluation of the lower Yuba River carcass survey data indicated that hatchery-origin Chinook salmon comprised an estimated 71% of the total 2010 Chinook salmon run (Kormos et al. 2012, as cited in RMT 2013), although it was not possible to differentiate between phenotypic spring- and fall-run Chinook salmon in the lower Yuba River carcass surveys (RMT 2013).
Table 4-6. Estimated numbers of Chinook salmon, ad-clipped and non ad-clipped phenotypic spring-run Chinook salmon that passed upstream of Daguerre Point Dam annually from 2004 through 2011. (Source: RMT 2013)

<table>
<thead>
<tr>
<th>Year</th>
<th>Demarcation Date</th>
<th>Total Ad-Clipped</th>
<th>Not Ad-Clipped</th>
<th>% Ad-Clipped</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>8/1/04</td>
<td>5,927</td>
<td>72</td>
<td>666</td>
</tr>
<tr>
<td>2005</td>
<td>8/24/05</td>
<td>11,374</td>
<td>676</td>
<td>2,916</td>
</tr>
<tr>
<td>2006</td>
<td>9/6/06</td>
<td>5,203</td>
<td>81</td>
<td>1,245</td>
</tr>
<tr>
<td>2007</td>
<td>9/4/07</td>
<td>1,394</td>
<td>38</td>
<td>334</td>
</tr>
<tr>
<td>2008</td>
<td>8/10/08</td>
<td>2,533</td>
<td>15</td>
<td>506</td>
</tr>
<tr>
<td>2009</td>
<td>7/9/09</td>
<td>5,378</td>
<td>213</td>
<td>510</td>
</tr>
<tr>
<td>2010</td>
<td>7/6/10</td>
<td>6,469</td>
<td>1,774</td>
<td>1,112</td>
</tr>
<tr>
<td>2011</td>
<td>9/7/11</td>
<td>7,785</td>
<td>323</td>
<td>836</td>
</tr>
</tbody>
</table>

The average contribution of adipose fin-clipped phenotypic spring-run Chinook salmon to the total annual run size in the lower Yuba River, as inferred by the percentage of adipose fin-clipped fish passing upstream of Daguerre Point Dam during the annual defined phenotypic period, has been 20.8% over the eight years of available data and, assuming a 3-year generation, the four most recent 3-year running averages of adipose fin-clipped phenotypic spring-run Chinook salmon to the total annual run size have been 39.6%, 31.3%, 14.2%, and 6.4%, respectively. The average contribution of adipose fin-clipped phenotypic spring-run Chinook salmon to the total annual run sizes of these four generations is 22.9%. The RMT (2013) recognized that there are limitations to simply using percent adipose fin-clipped spring-run Chinook salmon passing through the VAKI Riverwatcher systems as an estimate of total hatchery influence, and that resulting estimates should be considered as minimum estimates. It is important to note that the adipose fin-clipped phenotypic spring-run Chinook salmon abundance represents a minimum indicator of hatchery-origin individuals due to fractional marking of spring-run hatchery fish prior to 2005, and constant fractional marking (CFM) of fall-run hatchery fish at the FRFH since 2006 which may return as phenotypic spring-run Chinook salmon.

It also is recognized that the hatchery influence criterion presumably is applicable to an independent, genetically distinct population. However, as previously discussed, the phenotypic spring-run Chinook salmon in the lower Yuba River actually represents hybridization between spring- and fall-run Chinook salmon in the lower Yuba River, and...
hybridization with Feather River stocks including the FRFH spring-run Chinook salmon stock, which itself represents a hybridization between Feather River fall- and spring-run Chinook salmon populations.

**Applicability of Additional VSP Parameters and Extinction Risk Criteria**

The M&E Program Framework developed by the RMT (2010) utilized VSP performance indicators that were identified based on the precept that the lower Yuba River anadromous salmonid populations represented independent populations. However, the RMT has identified a substantial amount of reproductive interaction between lower Yuba River and lower Feather River anadromous salmonid stocks. As described in RMT (2013), phenotypic spring-run Chinook salmon in the lower Yuba River likely represents hybridization between spring- and fall-run Chinook salmon in the lower Yuba River, hybridization with Feather River fall- and spring-run Chinook salmon stocks, and hybridization with the FRFH spring-run Chinook salmon stock, which itself represents hybridization between Feather River fall- and spring-run Chinook salmon populations. Additionally, it is likely that anadromous *O. mykiss* stocks are similarly hybridized, with fluid intermixing of lower Feather River and lower Yuba River fish.

The recognition of the extent of hybridization and lack of reproductive isolation of lower Yuba River and lower Feather River anadromous salmonid stocks logically constrains the manner in which the VSP concept can be applied to the lower Yuba River, because many of the VSP metrics are designed to evaluate the viability of discrete, independent populations. Even the simplified approach suggested by Lindley et al. (2007) to evaluate ‘extinction risk’ is of limited applicability in the evaluation of highly introgressed populations whose evaluation metrics are directly influenced by other stocks, and out-of-basin factors.

Lindley et al. (2007) provide criteria to assess the level of risk of extinction of Pacific salmonids based on population size, recent population decline, occurrences of catastrophes within the last 10 years that could cause sudden shifts from a low risk state to a higher one, and the impacts of hatchery influence. Populations with a low risk of extinction (less than 5% chance of extinction in 100 years) are those with a minimum total escapement of 2,500 spawners in 3 consecutive years (mean of 833 fish per year),
no apparent decline in escapement, no catastrophic declines within the last 10 years, and
a low hatchery influence (NMFS 2011a). The overall estimated risk of extinction for the
population is determined by the highest risk score for any category Lindley et al. (2007).
While more detailed population viability assessment (PVA) models could be constructed
to assess Chinook salmon populations, Lindley et al. (2007) suggest any PVA results
should be compared with the results of applying their simpler criteria to estimate status
(NMFS 2011a).

Only some of the VSP performance indicators identified in the RMT (2010) M&E
Program framework and some of the extinction risk criteria provided by Lindley et al.
(2007) are appropriate for application specifically to lower Yuba River anadromous
salmonids. VSP performance indicators regarding spatial structure are applicable to the
habitat conditions in the lower Yuba River. Similarly, the catastrophe occurrence
extinction risk criterion also is applicable to the lower Yuba River. The extinction risk
criteria including abundance, and trends in abundance are of limited applicability and
serve as illustrative comparative measures in consideration of the non-independent
salmonid populations in the lower Yuba River. The hatchery risk extinction criterion
does not appear to be applicable to the non-independent lower Yuba River salmonid
populations. Considerations regarding each of these applicabilities are discussed below.

**Spatial Structure**

According to McElhany et al. (2000), spatial structure reflects how abundance is
distributed among available or potentially available habitats, and how it can affect overall
extinction risk and evolutionary processes that may alter a population’s ability to respond
to environmental change. A population’s spatial structure depends fundamentally on
habitat quality, spatial configuration, and dynamics, as well as on the dispersal
characteristics of individuals in the population.

Performance indicators and analytics addressing spatial structure include spatial
organization of morphological units (e.g., lateral variability/diversity, adjacency,
randomness, and abundance), persistence of morphological units through time, and the
quality, number, size and distribution of morphological units available for spawning
Chinook salmon. Additional considerations include floodplain connectivity,
entrenchment, channel sinuosity, substrate size, changes in topographic depth, scour and
fill processes, bankfull and flood flow recurrence interval, and maintenance of watershed
processes to maintain suitable habitat for anadromous salmonid lifestages.

As stated in the M&E Plan (RMT 2010a), the spatial structure evaluation includes
examination of maintenance of watershed processes and regulatory management
practices to create and maintain suitable habitat for all freshwater lifestages of spring-run
and fall-run Chinook salmon, and steelhead. As discussed in RMT (2013), one of the
performance indicators preliminarily evaluated by Wyrick and Pasternack (2012) is
whether the sequence of morphological units in the lower Yuba River is non-random.
Highly disturbed systems often degrade into homogeneity or randomness.

Of the 12 major near-bankfull morphological units, the most uniformly distributed (i.e.,
randomly located) units are slackwater, slow glide, and lateral bar. As an example of
non-uniform distribution, pool units were predominantly found in the upstream reaches
(i.e., Englebright and Timbuctoo Bend) and the downstream reach (i.e., Marysville), but
were less abundant in the middle, wider reaches (i.e., Daguerre Point Dam and Dry
Creek). Consequently, evaluation of the morphological units in the lower Yuba River as
part of the spatial structure analyses indicates that, in general, the sequence of
morphological units is non-random, indicating that the channel has been self-sustaining
of sufficient duration to establish an ordered spatial structure (refer to RMT 2013 for
additional discussion).

Another new method for analyzing the morphological unit organization that Wyrick and
Pasternack (2012) developed is an adjacency probability analysis, which evaluates the
frequency at which each morphological unit is adjacent to every other unit, and compares
that against random adjacency expectations. Results of this analysis indicate that the in-
channel units near the thalweg typically exhibit low adjacency probabilities to the bar
units, although they do exhibit higher-than-random probabilities to other in-channel units.

Wide, diverse rivers should also exhibit lateral variability in its form-process
associations. In the lower Yuba River, morphological unit organization highlights the
complexity of the channel geomorphology, as well as the complex and diverse suite of
potential habitat at any given location in the Yuba River. The above summary (described
in more detail in RMT 2013) illustrates that spatial structure of morphological units in the lower Yuba River is complex, diverse, and persistent.

**CATASTROPHE OCCURRENCE**

According to Lindley et al. (2007), the catastrophe criteria trace back to Mace and Lande (1991), and the underlying theory is further developed by Lande (1993). The following discussion was taken from Lindley et al. (2007). The overall goal of the catastrophe criteria is to capture a sudden shift from a low risk state to a higher one. Catastrophes are defined as instantaneous declines in population size due to events that occur randomly in time, in contrast to regular environmental variation, which occurs constantly and can have both positive and negative effects on the population. Lindley et al. (2007) view catastrophes as singular events with an identifiable cause and only negative immediate consequences, as opposed to normal environmental variation which can produce very good as well as very bad conditions. Some examples of catastrophes include disease outbreaks, toxic spills, or volcanic eruptions. A high risk situation is created by a 90% decline in population size over one generation. A moderate risk event is one that is smaller but biologically significant, such as a year-class failure.

**EXTINCTION RISK CRITERIA AND APPLICATION**

Lindley et al. (2007) characterized the spring-run Chinook salmon population in the lower Yuba River as data deficient, and therefore did not characterize its viability. In 2007, there was limited information on the current population size of spring-run Chinook salmon in the lower Yuba River. NMFS’ 5 Year Status Review for the Central Valley Spring-run Chinook Salmon ESU (NMFS 2011) reported that the annual spawning run size of spring-run Chinook salmon in the lower Yuba River generally ranges from a few hundred to a few thousand fish with the annual trend closely following the annual abundance trend of the Feather River Hatchery spring-run Chinook salmon population. NMFS (2011a) concluded that the Yuba River spring-run Chinook salmon population satisfies the moderate extinction risk criteria for abundance, but likely falls into the high risk category for hatchery influence.
Criteria to assess extinction risk of Pacific salmonids are based on population size, recent population decline, occurrences of catastrophes within the last 10 years, and the impacts of hatchery influence (Lindley et al. 2007). As previously discussed, for the last three consecutive years, an estimated total of 4,768 phenotypic spring-run Chinook salmon have passed upstream of Daguerre Point Dam, with an average of 1,589 fish per year. Catastrophes have not occurred in the Yuba River Basin, nor have catastrophic declines been observed within the phenotypic spring-run Chinook salmon abundance estimates within the last ten years. The abundance of phenotypic spring-run Chinook salmon in the lower Yuba River has exhibited a very slight increase over the eight years examined, although the positive trend is not statistically significant. These abundance and trend considerations would correspond to low extinction risk according to NMFS criteria (Lindley et al. 2007). However, RMT (2013) questions the applicability of any of these criteria addressing extinction risk, because they presumably apply to independent populations and, as previously discussed, lower Yuba River anadromous salmonids represent introgressive hybridization of larger Feather-Yuba river populations, with substantial contributions of hatchery-origin fish to the annual runs. For additional discussion, see RMT (2013).

The average contribution of adipose fin-clipped phenotypic spring-run Chinook salmon to the total annual run size in the lower Yuba River, as inferred by the percentage of adipose fin-clipped fish passing upstream of Daguerre Point Dam during the annual defined phenotypic period, has been 20.8% over the eight years of available data and, assuming a 3-year generation, the four most recent 3-year running averages of adipose fin-clipped phenotypic spring-run Chinook salmon to the total annual run size have been 39.6%, 31.3%, 14.2%, and 6.4%, respectively. The average contribution of adipose fin-clipped phenotypic spring-run Chinook salmon to the total annual run sizes of these four generations is 22.9%. RMT (2013) recognized that there are limitations to simply using percent adipose fin-clipped spring-run Chinook salmon passing through the VAKI Riverwatcher systems as an estimate of total hatchery influence, and that resulting estimates should be considered as minimum estimates. As previously discussed, it is important to note that the adipose fin-clipped phenotypic spring-run Chinook salmon abundance represents a minimum indicator of hatchery-origin individuals due to
fractional marking of spring-run hatchery fish prior to 2006, and constant fractional marking (CFM) of fall-run hatchery fish at the FRFH which may return as phenotypic spring-run Chinook salmon.

It also is recognized that the hatchery influence criterion presumably is applicable to an independent, genetically distinct population (RMT 2013). However, as previously discussed, the phenotypic spring-run Chinook salmon in the lower Yuba River actually represents hybridization between spring- and fall-run Chinook salmon in the lower Yuba River, and hybridization with Feather River stocks including the FRFH spring-run Chinook salmon stock, which itself represents a hybridization between Feather River fall- and spring-run Chinook salmon populations.

Although straying of FRFH-origin Chinook salmon into the lower Yuba River occurs, available information indicates that: (1) the FRFH spring-run Chinook salmon is included in the ESU, in part because of the important role this stock may play in the recovery of spring-run Chinook salmon in the Feather River Basin, including the Yuba River (70 FR 37160); (2) the spring-run Chinook program at FRFH is an Integrated Recovery Program which seeks to aid in the recovery and conservation of Central Valley spring-run Chinook salmon (DWR 2009a); and (3) fish produced at FRFH are intended to spawn in the wild or be genetically integrated with the targeted natural population as FRFH broodstock (DWR 2009a).

### 4.2.8 Public Review Draft Recovery Plan Considerations

According to NMFS (2005) *Recommendations for the Contents of Biological Assessments and Biological Evaluations* pertaining to status of the species in the action area, a BA should:

- Identify any recovery plan implementation that is occurring in the action area, especially priority one action items from recovery plans.

The NMFS Draft Recovery Plan establishes three population levels to help guide recovery efforts for existing populations, referred to as Core 1, 2, and 3 populations. The NMFS Draft Recovery Plan (pg. 65) identifies lower Yuba River spring-run Chinook
salmon [and steelhead] populations as Core 1 populations. Core 1 populations form the foundation of the recovery strategy, and Core 1 populations should be the first focus of an overall recovery effort (NMFS 2009).

To meet recovery objectives for the diversity groups, the conceptual recovery scenarios for the spring-run Chinook salmon ESU (pg. 99) [and the steelhead DPS (pg. 123)] include: (1) securing extant populations by implementing key habitat restoration actions, particularly in the near term; and (2) establishment of additional viable independent populations.

The NMFS Draft Recovery Plan states, that in order to secure a viable independent population of spring-run Chinook salmon (pg. 116), [and to secure the extant population and promote a viable population of steelhead (pg. 140)], in the lower Yuba River, several key near-term and long-term habitat restoration actions were identified, including the following:

- Continued implementation of the Yuba Accord flow schedules to provide suitable habitat (flow and water temperature) conditions for all lifestages
- Improvements to adult salmonid upstream passage at Daguerre Point Dam
- Improvements to juvenile salmonid downstream passage at Daguerre Point Dam
- Implementation of a spawning gravel augmentation program in the uppermost reach (i.e., Englebright Dam to the Narrows) of the lower Yuba River
- Improvements to riparian habitats for juvenile salmonid rearing
- Creation and restoration of side-channel habitats to increase the quantity and quality of off-channel rearing (and spawning) areas
- Implementation of projects to increase floodplain habitat availability to improve habitat conditions for juvenile rearing

The NMFS Draft Recovery Plan includes Priority 1, Priority 2 and Priority 3 recovery actions. The NMFS Draft Recovery Plan Appendix C (pgs. 2, 3) states “According to NMFS’ 1990 Endangered and Threatened Species Listing and Recovery Priority
Guidelines (55 FR 24296), recovery actions identified in a Recovery Plan are to be assigned priorities of 1 to 3, as follows:

Priority 1 – An action that must be taken to prevent extinction or to identify those actions necessary to prevent extinction

Priority 2 – An action that must be taken to prevent a significant decline in population numbers, habitat quality, or other significant negative impacts short of extinction

Priority 3 – All other actions necessary to provide for full recovery of the species.”

The NMFS Draft Recovery Plan (pg. 161) identifies the following proposed action as a Priority 1 recovery action for the Yuba River:

Recovery Action 1.9.6.1. Develop and implement a phased approach to salmon reintroduction planning to recolonize historic habitats above Englebright Dam. Implement actions to: (1) enhance habitat conditions including providing flows and suitable water temperatures for successful upstream and downstream passage, holding, spawning and rearing; and (2) improve access within the area above Englebright Dam, including increasing minimum flows, providing passage at Our House, New Bullards Bar, and Log Cabin dams, and assessing feasibility of passage improvement at natural barriers. The phased approach should include:

- Conduct feasibility studies
- Conduct habitat evaluations
- Conduct 3-5 year pilot testing program
- Implement long-term fish passage program

The spring-run Chinook salmon conceptual recovery scenario also includes reintroduction of spring-run Chinook salmon to the candidate areas of the North Fork, Middle Fork and South Fork Yuba rivers. Reintroduction of anadromous salmonids above Englebright Dam has been the subject of recent and current investigations. Evaluation of habitat suitability for anadromous salmonids upstream of Englebright Dam was recently undertaken (DWR 2007), but those evaluations have yet to be finalized as
part of the Upper Yuba River Watershed Studies Program. Currently, NMFS is 
evaluating the feasibility of providing passage for anadromous salmonids at Englebright 
Dam. Hence, the conceptual recovery scenario does not further discuss specific 
restoration actions associated with reintroduction.

The NMFS Draft Recovery Plan (pg. 161) identifies the following proposed action as a 
Priority 1 recovery action for the Yuba River:

**Recovery Action 1.9.6.2.** Improve spawning habitat in the lower river by gravel 
restoration program below Englebright Dam and improve rearing habitat by increasing 
floodplain habitat availability.

Also, a gravel restoration program below Englebright Dam is discussed as a Priority 2 
action on pg. 73, and lower Yuba River floodplain habitat availability considerations are 
discussed as Priority 2 actions on pgs. 73, 74, 76, and 92 of Appendix C in NMFS (2009).

Proposed recovery action 1.9.6.2 actually includes two separate proposed actions: (1) 
improve spawning habitat in the lower river by gravel restoration program below 
Englebright Dam; and (2) improve rearing habitat by increasing floodplain habitat 
availability. Each of these is discussed separately, below.

1. **Improve spawning habitat in the lower river by gravel restoration program below 
   Englebright Dam.** The Corps completed the injection of 500 tons of gravel 
   approximately 200 yards downstream of Englebright on November 30, 2007 
   (Grothe 2011). The Corps completed additional injections of 5,000 tons of gravel 

2. **Improve rearing habitat by increasing floodplain habitat availability.** Since the 
   NMFS Draft Recovery Plan was noticed in the Federal Register on October 6, 
   2009, substantial efforts have been undertaken to identify, develop and consider 
   the relative merits of habitat restoration actions in the lower Yuba River. The 
   need for restoration actions, identification of the specific actions themselves, and 
   the relative merits of the actions to expand habitat and accomplish the goals of the 
   Oroville FERC Relicensing Habitat Expansion Agreement (HEA) were presented 
in a report submitted to the HEA Steering Committee during early November
2009 (YCWA et al. 2009). This report represents a comprehensive consideration of such restoration actions developed for the lower Yuba River. The YCWA et al. (2009) report identified several factors that continue to limit juvenile spring-run Chinook salmon [and steelhead] rearing habitat suitability in the lower Yuba River, including: (1) sparse and restricted amounts of riparian vegetation and associated instream object and overhanging object cover; (2) limited aquatic habitat complexity and diversity; and (3) altered natural river function and morphology in the lower Yuba River. Shaded Riverine Aquatic (SRA) habitat generally occurs in the lower Yuba River as scattered, short strips, with the most extensive and continuous segments of SRA habitat occurring along bars where recent channel migrations or avulsions have cut new channels through stands of riparian vegetation.

Regarding juvenile salmonid rearing habitat, the NMFS Draft Recovery Plan states that, in order to secure a viable independent population of spring-run Chinook salmon (pg. 116), [and to secure the extant population and promote a viable population of steelhead (pg.140)] in the lower Yuba River, the following key near-term and long-term habitat restoration actions should be implemented: (1) the creation and restoration of side channel habitats to increase the quantity and quality of off-channel rearing (and spawning) areas; (2) improvements to riparian habitats for juvenile salmonid rearing; and (3) implementation of projects to increase floodplain habitat availability to improve habitat conditions for juvenile rearing. Of the proposed actions regarding juvenile rearing, the actions that would be most beneficial and cost-effective for juvenile rearing habitat, and the actions that would yield the most immediate benefits, are the creation of new side-channel habitats associated with existing stands of riparian vegetation that are not presently hydraulically connected to the river channel (YCWA 2010). Specifically, new side-channel habitats would: (1) increase and maintain existing riparian vegetation; (2) provide instream object and overhanging object cover; (3) provide new SRA, and associated allochthonous food sources for rearing juveniles; (4) increase aquatic habitat complexity and diversity; (5) provide habitats more consistent with those previously available in the upper watershed; and (6) provide predator escape cover, and overall increased survival of juvenile spring-run Chinook salmon and steelhead.
The NMFS Draft Recovery Plan (pg. 83) states “The [Draft Plan’s recovery] scenarios represent some of the many possible combinations of populations, restoration actions, risk minimization and threat abatement. Different scenarios may fulfill the biological requirements for recovery”. The NMFS Draft Recovery Plan (pg. 83) further states “As this Recovery Plan is implemented over time, additional information will become available to help determine whether the threats have been abated, to further develop understanding of the linkages between threats and Chinook salmon and steelhead population responses, and to evaluate the viability of Chinook salmon and steelhead in the Central Valley Domain ... Such information is expected to lead to adjustments in recovery expectations and restoration actions and, thus, recovery scenarios.”

The NMFS Draft Recovery Plan (pg. 208) states that it may not be necessary to reintroduce fish to all of the listed river and creek systems to meet the recovery criteria for Central Valley spring-run Chinook salmon [and steelhead]. “It may not be necessary to re-establish populations to all of these rivers. The highest priority areas are the Little Sacramento River, the McCloud River, the North Fork American River, and the San Joaquin River.”

4.3 Central Valley Steelhead DPS

4.3.1 ESA Listing Status

On March 19, 1998 (63 FR 13347) NMFS listed the California Central Valley steelhead ESU as “threatened”, concluding 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. The California Central Valley steelhead ESU included all naturally spawned populations of steelhead in the Sacramento and San Joaquin rivers and their tributaries, but excluded steelhead from the tributaries of San Francisco and San Pablo bays (NMFS 2004b).

On June 14, 2004, NMFS proposed listing determinations for 27 ESUs of West Coast salmon and *O. mykiss*, including the California Central Valley steelhead ESU. In the
proposed rule, NMFS concluded that steelhead were not in danger of extinction, but were likely to become endangered within the foreseeable future throughout all or a significant portion of their range and, thus, proposed that steelhead remain listed as threatened under the ESA. Steelhead from the Coleman National Fish Hatchery and the FRFH, as well as resident populations of *O. mykiss* (rainbow trout) below impassible barriers that co-occur with anadromous populations, were included in the California Central Valley steelhead ESU and, therefore, also were included in the proposed listing.

During the 2004 comment period on the proposed listings, the USFWS provided comments that the USFWS does not use NMFS’ ESU policy in any USFWS ESA listing decisions. As a result of the comments received, NMFS re-opened the comment period to receive comments on a proposed alternative approach to delineating “species” of West Coast *O. mykiss* (70 FR 67130). NMFS proposed to depart from past practice of applying the ESU Policy to *O. mykiss* stocks, and instead proposed to apply the DPS Policy in determining “species” of *O. mykiss* for listing consideration. NMFS noted that within a discrete group of *O. mykiss* populations, the resident and anadromous life forms of *O. mykiss* remain “markedly separated” as a consequence of physical, physiological, ecological, and behavioral factors, and may therefore warrant delineation as separate DPSs (71 FR 834).

NMFS issued a policy for delineating distinct population segments of Pacific salmon in 1991 (56 FR 58612; November 20, 1991). Under this policy, a group of Pacific salmon populations is considered an “Evolutionarily Significant Unit” if it is substantially reproductively isolated from other conspecific populations, and it represents an important component in the evolutionary legacy of the biological species. Further, an ESU is considered to be a “Distinct Population Segment” (and thus a “species”) under the ESA. In 1996, NMFS and USFWS adopted a joint policy for recognizing DPSs under the ESA (DPS Policy; 61 FR 4722; February 7, 1996). The DPS Policy adopted criteria similar to, but somewhat different from, those in the ESU Policy for determining when a group of vertebrates constitutes a DPS – The group must be discrete from other populations, and it must be significant to its taxon. A group of organisms is discrete if it is “markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors.” Significance is measured
with respect to the taxon (species or subspecies) as opposed to the full species (71 FR 834). Although the ESU Policy did not by its terms apply to steelhead, the DPS Policy stated that NMFS will continue to implement the ESU Policy with respect to “Pacific salmonids” (which included *O. mykiss*). In a previous instance of shared jurisdiction over a species (Atlantic salmon), NMFS and USFWS used the DPS Policy in their determination to list the Gulf of Maine DPS of Atlantic salmon as endangered (65 FR 69459; November 17, 2000).

Given NMFS and USFWS shared jurisdiction over *O. mykiss*, and consistent with joint NMFS and USFWS approaches for Atlantic salmon, it was concluded that application of the joint DPS policy to was logical, reasonable, and appropriate for identifying DPSs of *O. mykiss* (71 FR 834). Moreover, NMFS determined that use of the ESU policy — originally intended for Pacific salmon — should not continue to be extended to *O. mykiss*, a type of salmonid with characteristics not typically exhibited by Pacific salmon (71 FR 834).

On January 5, 2006 NMFS issued a final decision that defined Central Valley steelhead as a DPS rather than an ESU, and retained the status of Central Valley steelhead as threatened (71 FR 834). The DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and manmade impassable barriers in the Sacramento and San Joaquin Rivers and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries (63 FR 13347). Steelhead in two artificial propagation programs — the Coleman National Fish Hatchery, and FRFH steelhead hatchery programs are considered to be part of the DPS. NMFS determined that these artificially propagated stocks are no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the DPS (71 FR 834).

As previously discussed, the ESA requires that NMFS review the status of listed species under its authority at least every five years and determine whether any species should be removed from the list or have its listing status changed. In August 2011, NMFS completed a 5-year status review of the Central Valley steelhead DPS. Based upon a review of available information, NMFS (2011c) recommended that the Central Valley
steelhead DPS remain classified as a threatened species. However, NMFS (2011c) also indicated that the biological status of the DPS has declined since the previous status review in 2005 and, therefore, NMFS recommend that the DPS’s status is reassessed in 2 to 3 years if it does not respond positively to improvements in environmental conditions and management actions. In the interim period, NMFS also recommended that the status of the DPS should be monitored and the most recent genetic information for the DPS, including information for the four steelhead hatchery stocks, should be reviewed to reassess the DPS membership status of the Nimbus and Mokelumne River hatcheries. New information resulting from the genetics review should be incorporated into any updated status review for the DPS (NMFS 2011c).

### 4.3.2 Critical Habitat Designation

On February 16, 2000 (65 FR 7764), NMFS published a final rule designating critical habitat for Central Valley steelhead. This critical habitat includes all river reaches accessible to listed steelhead in the Sacramento and San Joaquin rivers and their tributaries in California, including the lower Yuba River upstream to Englebright Dam. NMFS proposed new Critical Habitat for spring-run Chinook salmon and Central Valley steelhead on December 10, 2004 (69 FR 71880) and published a final rule designating critical habitat for these species on September 2, 2005. This critical habitat includes the lower Yuba River (70 FR 52488) from the confluence with the lower Feather River upstream to Englebright Dam.

#### 4.3.2.1 Primary Constituent Elements

The critical habitat designation (70 FR 52488) lists PCEs, which are physical or biological elements essential for the conservation of the listed species. The PCEs include sites essential to support one or more lifestages of the DPS (sites for spawning, rearing, migration, and foraging). The specific PCEs include:

- Freshwater spawning sites
- Freshwater rearing sites
- Freshwater migration corridors
The most recent discussion of PCEs in the Central Valley is in the CVP/SWP OCAP Biological Opinion (NMFS 2009a). The following summary descriptions of the current conditions of the PCEs for the Central Valley steelhead DPS were taken from NMFS (2009a).

**Freshwater Spawning Habitat**

According to NMFS (2009), steelhead in the Sacramento River spawn primarily between Keswick Dam and Red Bluff Diversion Dam during the winter and spring. The highest density spawning area is likely in the upstream portion of this area in the vicinity of the city of Redding, although detailed surveys of steelhead spawning in the mainstem Sacramento River are not available. Most Sacramento River steelhead probably spawn in the tributary streams. Steelhead spawn in Clear Creek mostly within a couple miles of Whiskeytown Dam but spawning extends for about 10 miles downstream of the dam (M. Brown, pers. comm. as cited in Reclamation 2008). Steelhead spawn in the Feather River from the fish barrier dam downstream to Gridley with nearly 50% of all spawning occurring the first mile of the low flow channel (DWR 2003). Steelhead spawn in the American River from Nimbus Dam (RM 23) downstream to the lowest riffle in the river at Paradise Beach (RM 5). Most spawning is concentrated in the upper seven miles of the river (Hannon and Deason 2008). Steelhead (and/or rainbow trout) spawn in the Stanislaus River from Goodwin Dam downstream to approximately the city of Oakdale. Steelhead spawning surveys have not been conducted in the Stanislaus River so detailed spawning distribution is unknown but based on observations of trout fry, most spawning occurs upstream of Orange Blossom Bridge.

**Freshwater Rearing Habitat**

Juvenile steelhead reside in freshwater for a year or more, so they are more dependent on freshwater rearing habitat than are the ocean type Chinook salmon in the Central Valley. Steelhead rearing occurs primarily in the upstream reaches of the rivers where channel
gradients tend to be higher and, during the warm weather months, where temperatures are
maintained at more suitable levels by cool water dam releases. The Sacramento River
contains a long reach of suitable water temperatures even during the heat of the summer.
Steelhead rearing in the Sacramento River occurs mostly between Keswick Dam (RM
302) and Butte City (RM 169) with the highest densities likely to be upstream of Red
Bluff Diversion Dam. Steelhead rearing in Clear Creek is concentrated in the upper river
higher gradient areas but probably occurs down to the mouth. Steelhead rearing in the
Feather River is concentrated in the low flow channel where temperatures are most
suitable (DWR 2004c). Steelhead rearing in the American River occurs down to Paradise
Beach, with concentrations during the summer on most major riffle areas and highest
densities near the higher density spawning areas. Steelhead rearing in the Stanislaus
River occurs upstream of Orange Blossom Bridge, where gradients are highest. The
highest rearing densities are upstream of Knights Ferry (Kennedy and Cannon 2002).

FRESHWATER MIGRATION CORRIDORS

Steelhead migrate during the winter and spring of the year, as juveniles, from the rearing
areas described above downstream through the rivers and the Delta to the ocean. The
habitat conditions they encounter during migration from the upstream reaches of the
rivers downstream to the Delta generally become less suitable as fish move away from
their natal streams until they reach the ocean. The generally non-turbulent flows and
sand substrates found in the lower river reaches are not preferred types of habitat, so
steelhead do not likely reside for extended periods in these areas except when food
supplies, such as smaller young fish, are abundant and temperatures are suitable.
Predatory fishes such as striped bass tend to be more abundant in the lower rivers and the
Delta. Emigration conditions for juvenile steelhead in the Stanislaus River down through
the San Joaquin River and the south Delta tend to be less suitable than conditions for
steelhead emigrating from the Sacramento River and its tributaries.

Adult steelhead migrate upstream from the ocean to their spawning grounds near the
terminal dams primarily during the fall and winter months. Flows are generally lower
during the upstream migrations than during the outmigration period. Areas where their
upstream progress can be affected are the Delta Cross Channel Gates, RBDD, and Anderson Cottonwood Irrigation District Diversion Dam.

**Estuarine Habitat Areas**

Steelhead use the San Francisco estuary as a rearing area and migration corridor between their upstream rearing habitat and the ocean. The San Francisco Bay estuarine system includes the waters of San Francisco Bay, San Pablo Bay, Grizzley Bay, Suisuin Bay, Honker Bay, and can extend as far upstream as Sherman Island during dry periods. At times steelhead likely remain for extended periods in areas of suitable habitat quality where food such as young herring, salmon and other fish and invertebrates is available.

**Nearshore Coastal Marine and Offshore Marine Areas**

The most recent discussion of PCEs for the Central Valley steelhead DPS (NMFS 2009a) did not include the PCEs of nearshore coastal marine and offshore marine areas. Although relatively little is known about steelhead utilization of nearshore coastal marine and offshore marine areas, it is reasonable to assume that the discussion of these PCEs previously provided for spring-run Chinook salmon in Section 4.1 of this BA generally is applicable to steelhead.

### 4.3.3 Historical Distribution and Abundance

According to NMFS (2009), steelhead historically occurred naturally throughout the Sacramento and San Joaquin River basins, although stocks have been extirpated from large areas in both basins. The California Advisory Committee on Salmon and Steelhead (CDFG 1988) reported a reduction in Central Valley steelhead habitat from 6,000 miles historically to 300 miles.

NMFS (2009) reported that 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; 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. (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. Presently, impassable dams block access to 80% of historically available habitat, and block access to all historical spawning habitat for about 38% of historical populations (Lindley et al. 2006). Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope Creek, Deer Creek, and Mill Creek, 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 2001).

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, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001).

It is possible that naturally spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999, as cited in NMFS 2009). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread, throughout accessible streams and rivers in the Central Valley (Good et al. 2005). Naturally spawning populations of steelhead also occur in the Feather, Yuba, American, and Mokelumne rivers, but these populations have had substantial hatchery influence and their ancestries are not clear (Busby et al. 1996). Steelhead runs in the Feather and American rivers are sustained largely by the FRFH and Nimbus Hatchery (McEwan and Jackson 1996). Steelhead also currently occur in the Stanislaus, Calaveras, Merced, and Tuolumne rivers (NMFS 2009).

Historic Central Valley steelhead run sizes are difficult to estimate because of the lack of data, but McEwan (2001) suggested that steelhead run sizes may have approached one to two million adults annually. McEwan and Jackson (1996) suggested that by the early 1960s, the steelhead run size had declined to about 40,000. Over the last 30 years the steelhead populations in the upper Sacramento River have declined substantially (NMFS
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 1996, compared to counts in excess of 10,000 fish in the late 1960s (McEwan and Jackson 1996). American River redd surveys and associated monitoring from 2002 through 2007 indicate that only a few hundred steelhead spawn in the river and a portion of those spawners originated from Nimbus Hatchery (Hannon and Deason 2008).

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 reds 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.

The lack of sustained monitoring programs for steelhead throughout most of the Central Valley persists to the present time. There is a paucity of reliable data to estimate run sizes of steelhead in the Central Valley, particularly wild stocks. However, some steelhead escapement monitoring surveys have been initiated in upper Sacramento River tributaries (e.g., Beegum, Deer, and Antelope Creeks) using snorkel methods similar to spring-run Chinook escapement surveys (NMFS 2009a).

There is a general lack of steelhead population monitoring in most of the Central Valley (NMFS 2009a). Lindley et al. (2007) stated that there are almost no data with which to assess the status of any of the Central Valley steelhead populations. They further stated that Central Valley steelhead populations are classified as data deficient, with the exceptions restricted to streams with long-running hatchery programs including Battle Creek and the Feather, American and Mokelumne rivers.

According to NMFS (2007a), in the "Updated Status Review of West Coast Salmon and Steelhead" (Good et al. 2005), the Biological Review Team made the following conclusion based on steelhead Chipps Island trawl 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% 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."

In the Yuba River, definitive historic population estimates do not exist for steelhead, but it is likely that the river supported large steelhead runs in the 1800s (USFWS 1995). McEwan and Jackson (1996) reported that the Yuba River historically supported the largest, naturally reproducing, persistent population of steelhead in the Central Valley.

Prior to construction of Englebright Dam in 1941, CDFW fisheries biologists stated that they observed large numbers of steelhead spawning in the uppermost reaches of the Yuba River and its tributaries (CDFG 1998; Yoshiyama et al. 1996). After construction of Englebright Dam in 1941, CDFW estimated that only approximately 200 steelhead spawned in the lower Yuba River annually before New Bullards Bar Reservoir was completed in 1969. From 1970 to 1979, CDFW annually stocked 27,270–217,378 fingerlings, yearlings, and sub-catchables from Coleman National Fish Hatchery into the lower Yuba River (CDFG 1991a). CDFW stopped stocking steelhead into the lower Yuba River in 1979. Based on angling data, CDFW estimated a run size of 2,000 steelhead in the lower Yuba River in 1975 (CDFG 1991a). McEwan and Jackson (1996) reported that, as of 1996, the status of the lower Yuba River steelhead population was unknown, but it appeared to be stable and able to support a significant sport fishery. CDFW currently manages the river to protect natural steelhead through strict "catch-and-release" fishing regulations.

4.3.4 General Life History and Habitat Requirements

Steelhead exhibits perhaps the most complex suite of life-history traits of any species of Pacific salmonid. Members of this species can be anadromous or freshwater residents and, under some circumstances, members of one form can apparently yield offspring of another form (YCWA 2010).

“Steelhead” is the name commonly applied to the anadromous form of the biological species *O. mykiss*. The physical appearance of *O. mykiss* adults and the presence of seasonal runs and year-round residents indicate that both anadromous (steelhead) and resident rainbow trout exist in the lower Yuba River downstream of Englebright Dam,
although no definitive visual characteristics have been identified to distinguish young steelhead from resident trout (SWRI et al. 2000). Zimmerman et al. (2009) analyzed otolith strontium:calcium (Sr:Ca) ratios in 964 otolith samples comprised of young-of-year, age-1, age-2, age-3, and age-4+ fish to determine maternal origin and migratory history (anadromous vs. non-anadromous) of *O. mykiss* collected in Central Valley rivers between 2001 and 2007, including the lower Yuba River. The proportion of steelhead progeny in the lower Yuba River (about 13%) was intermediate to the other rivers examined (Sacramento, Deer Creek, Calaveras, Stanislaus, Tuolumne, and Merced), which ranged from about 4% in the Merced River to 74% in Deer Creek (Zimmerman et al. 2009). Results from Mitchell (2010) indicate *O. mykiss* in the lower Yuba River are exhibiting a predominately residential life history pattern. He found that 14% of scale samples gathered from 71 *O. mykiss* moving upstream and trapped in the fish ladder at Daguerre Point Dam from November 1, 2000, through March 28, 2001, exhibited an anadromous life history. Thus, it is recognized that both anadromous and resident life history strategies of *O. mykiss* have been and continue to be present in the lower Yuba River.

The RMT (2013) developed representative temporal distributions for specific steelhead lifestages in the lower Yuba River through review of previously conducted studies, as well as recent and currently ongoing data collection activities of the M&E Program. As with spring-run Chinook salmon, the resultant lifestage periodicities are intended to encompass the majority of activity for a particular lifestage, and are not intended to be inclusive of every individual in the population. The lifestage-specific periodicities for steelhead in the lower Yuba River are summarized in Table 4-7, and are discussed below.

### 4.3.4.1 Adult Immigration and Holding

Adult migration from the ocean to spawning grounds occurs during much of the year, with peak migration occurring in the fall or early winter. 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 present location of Shasta Dam, except as a migration corridor to and from headwater streams (NMFS 2009).
Migration through the Sacramento River mainstem begins in July, peaks at the end of September, and continues through February or March (Bailey 1954; Hallock et al. 1961 both as cited in McEwan and Jackson 1996). Counts made at RBDD from 1969 through 1982 (Hallock 1989 as cited in McEwan and Jackson 1996) and on the Feather River (Painter et al. 1977) follow the above pattern, although some fish were counted as late as April and May. Weekly counts at Clough Dam on Mill Creek during a 10-year period from 1953 to 1963 showed a similar migration pattern as well, with a peak in migration during mid-November and another peak during February (NMFS 2009a). This second peak is not reflected in counts made in the Sacramento River mainstem (Bailey 1954; Hallock et al. 1961; both as cited in McEwan and Jackson 1996) or at RBDD (Hallock 1989 as cited in McEwan and Jackson 1996).

According to NMFS (2009a), Central Valley steelhead are mostly ‘winter steelhead’ and may contain some ‘summer steelhead’ (the naming convention refers to the seasonal period of adult upstream migration). Winter steelhead mature in the ocean and arrive on the spawning grounds nearly ready to spawn, whereas summer steelhead enter freshwater with immature gonads and typically spend several months in freshwater before spawning. The reported minimum depth for successful passage is about 7 inches (Reiser and Bjornn 1979 as cited in McEwan and Jackson 1996). Excessive water velocity (>10 to 13 ft/s) and obstacles may prevent access to upstream spawning grounds (NMFS 2009a).
The optimal temperature range during adult upstream migration is unknown for Central Valley steelhead stocks (NMFS 2009a). Prolonged exposure to water temperatures above 73°F is reported to be lethal to adult steelhead (Moyle 2002). Based on northern stocks, the optimal temperature range for migrating adult steelhead is 46 to 52°F (Bovee 1978; Reiser and Bjornn 1979; Bell 1986; all as cited in McEwan and Jackson 1996).

The immigration of adult steelhead in the lower Yuba River has been reported to occur from August through March, with peak immigration from October through February (CALFED and YCWA 2005; McEwan and Jackson 1996). CDFG (1984a) reported that during the drought years of 1976-1977, two steelhead immigration peaks were observed—one in October and one in February. CDFG (1991a) reported that steelhead enter the lower Yuba River as early as August, migration peaks in October through February, and may extend through March. In addition, they report that a run of “half-pounder” steelhead occurred from late-June through the winter months.

The RMT (2010b) examined preliminary data and identified variable annual timing of *O. mykiss* ascending the fish ladders at Daguerre Point Dam since the VAKI Riverwatcher infrared and videographic sampling system began operations in 2003. For example, Massa et al. (2010) state that peak passage of steelhead at Daguerre Point Dam occurred from April through June during 2007. They also suggest that the apparent disparity between the preliminary data and other reports of steelhead adult immigration periodicity may be explained by the previously reported (Zimmerman et al. 2009; Mitchell 2010) relatively high proportion of resident (vs. anadromous) *O. mykiss* occurring in the lower Yuba River, because the VAKI Riverwatcher system did document larger (>40.6 cm) *O. mykiss* ascending the fish ladders at Daguerre Point Dam during the winter months (December through February). The observed timing of larger *O. mykiss* ascending the fish ladders at Daguerre Point Dam more closely corresponds with previously reported adult steelhead immigration periodicities. The RMT (2010b; 2013) identified the period extending from August through March as encompassing the majority of the upstream migration and holding of adult steelhead in the lower Yuba River.
4.3.4.2 Adult Spawning

Central Valley adult steelhead generally begin spawning in late December and spawning extends through March, but also can range from November through April (CDFG 1986). 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). Based on all available information collected to date, the RMT (2013) recently identified the steelhead spawning period as extending from January through April.

Central Valley steelhead spawn downstream of dams on every major tributary within the Sacramento and San Joaquin River systems. Due to water development projects, most spawning is now confined to lower stream reaches below dams. In a few streams, such as Mill and Deer Creeks, steelhead still have access to historical spawning areas (NMFS 2009a).

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 (NMFS 2009). Spawning occurs mainly in gravel substrates (particle size range of about 0.2–4.0 inches). Sand-gravel and gravel-cobble substrates are also used, but these must be highly permeable and contain less than 5% sand and silt for the water to be able to provide sufficient oxygen to the incubating eggs. Adults tend to spawn in shallow areas (6–24 inches deep) with moderate water velocities (about 1 to 3.6 ft/s) (Bovee 1978 as cited in McEwan and Jackson 1996; Hannon and Deason 2007 as cited in Reclamation 2008). The optimal temperature range for spawning has been reported to range from 39 to 52°F (Bovee 1978; Reiser and Bjornn 1979; Bell 1986 all as cited in McEwan and Jackson 1996). Egg mortality begins to occur at 56°F (McEwan and Jackson 1996).

Unlike Chinook salmon, Central Valley steelhead may not die after spawning (McEwan and Jackson 1996). Some may return to the ocean and repeat the spawning cycle for two or three years. The percentage of adults surviving spawning is generally thought to be low for Central Valley steelhead, but varies annually and between stocks. Acoustic tagging of Central Valley steelhead kelts from the Coleman Hatchery indicates survival
rates can be high, especially for Central Valley steelhead reconditioned by holding and feeding at the hatchery prior to release. Some return immediately to the ocean and some remain and rear in the Sacramento River (NMFS 2009a).

Steelhead spawning has been reported to generally extend from January through April in the lower Yuba River (CALFED and YCWA 2005; CDFG 1991a; YCWA et al. 2007). The RMT conducted a pilot redd survey from September 2008 through April 2009 (RMT 2010a). Surveys were not conducted during March, which is a known time for steelhead spawning in other Central Valley rivers, due to high flows and turbidity. An extensive area redd survey was conducted by surveyors kayaking from the downstream end of the Narrows pool to the Simpson Lane Bridge. During the extensive area redd survey, redds that were categorized as steelhead based on redd size criteria were reportedly observed from October through April. However, some of those redds categorized as steelhead, particularly during October, may actually have been small Chinook salmon redds because the size criteria used to identify steelhead redds was found to be 53% accurate for identifying steelhead redds in the Feather River (USFWS 2008a).

Campos and Massa (2010b and 2011) synthesized results of near-census redd surveys conducted on the lower Yuba River during the 2009 and 2010 survey periods. During both annual survey efforts, a substantial proportion of the weekly strata in the January through April time periods were not sampled due to elevated flows and associated turbidity levels. Nonetheless, RMT (2013) demonstrated that based upon cumulative temporal distribution curves, the steelhead spawning period in the lower Yuba River is generally characterized to extend from January through April.

Steelhead spawning has been reported to primarily occur in the lower Yuba River upstream of Daguerre Point Dam (SWRI et al. 2000; YCWA et al. 2007). Kozlowski (2004) states that field observations during winter and spring 2000 (YCWA unpublished data) indicated that the majority of steelhead spawning in the lower Yuba River occurred from Long Bar upstream to the Narrows, with the highest concentration of redds observed upstream of the Highway 20 Bridge. USFWS (2007) data were collected on *O. mykiss* redds in the lower Yuba River during 2002, 2003, and 2004, with approximately 98% of the redds located upstream of Daguerre Point Dam. During the pilot redd survey
conducted from the fall of 2008 through spring of 2009, the RMT (2010) report that most (65%) of the steelhead redds were observed upstream of Daguerre Point Dam. Female steelhead construct redds within a range of depths and velocities in suitable gravels, oftentimes in pool tailouts and heads of riffles. In the lower Yuba River, steelhead have also been observed to spawn in side channel areas (YCWA unpublished data).

4.3.4.3 Embryo Incubation

California Central Valley adult steelhead eggs incubate within the gravel and hatch from approximately 19 to 80 days at water temperatures ranging from 60°F to 40°F, respectively (NMFS 2009). After hatching, the young fish (alevins) remain in the gravel for an extra two to six weeks before emerging from the gravel and taking up residence in the shallow margins of the stream.

Steelhead embryo incubation generally occurs from December through June in the Central Valley. The RMT (2013) identified the period of January through May as encompassing the majority of the steelhead embryo incubation period in the lower Yuba River. 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). Steelhead eggs reportedly have the highest survival rates at water temperature ranges of 44.6°F to 50.0°F (Myrick and Cech 2001). Studies conducted at or near 54.0°F report high survival and normal development of steelhead incubating embryos, a relatively low mortality of incubating steelhead embryos is reported to occur at 57.2°F, and a sharp decrease in survival has been reported for *O. mykiss* embryos incubated above 57.2°F (RMT 2010b).

Steelhead 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). Steelhead embryo development requires a constant supply of well oxygenated water. This implies a loose gravel substrate allowing high permeability, with little silt or sand deposition during the development time period. Merz et al. (2004) showed that spawning substrate quality influenced a number of physical parameters affecting egg survival including temperature, dissolved oxygen, and substrate permeability.
The entire egg incubation lifestage encompasses the time when adult steelhead spawn through the time when emergent fry exit the gravel (CALFED and YCWA 2005). In the lower Yuba River, steelhead embryo incubation generally occurs from January through May (CALFED and YCWA 2005; SWRI 2002).

### 4.3.4.4 Juvenile Rearing and Outmigration

As reported in NMFS (2009a), juvenile Central Valley steelhead may migrate to the ocean after spending one to three years in freshwater (McEwan and Jackson 1996). Upon emergence from the gravel, the fry move to shallow protected areas associated with the stream margin (Royal 1972; Barnhart 1986; both as cited in McEwan and Jackson 1996).

Steelhead fry tend to inhabit areas with cobble-rubble substrate, a depth less than 14 inches, and temperature ranging from 45 to 60°F (Bovee 1978 as cited in McEwan and Jackson 1996). Myrick (1998, as cited in Reclamation 2008) found steelhead from the Feather and Mokelumne rivers preferred temperatures between 62.5°F and 68°F.

In general, it has been reported that after emergence steelhead fry move to shallow-water, low velocity habitats, such as stream margins and low gradient riffles, and will forage in open areas lacking instream cover (Hartman 1965; Everest et al. 1986; Fontaine 1988). As fry increase in size and their swimming abilities improve in late summer and fall, juvenile steelhead have been reported to increasingly use areas with cover and show a preference for higher velocity, deeper mid-channel areas near the thalweg (Hartman 1965; Everest and Chapman 1972; Fontaine 1988).

Juvenile steelhead have been reported to occupy a wide range of habitats, preferring deep pools as well as higher velocity rapid and cascade habitats (Bisson et al. 1982; 1988). During the winter period of inactivity, steelhead prefer low velocity pool habitats with large rocky substrate or woody debris for cover (Hartman 1965; Swales et al. 1986; Raleigh et al. 1984; Fontaine 1988). During periods of low temperatures and high flows associated with the winter months, juvenile steelhead seek refuge in interstitial spaces in cobble and boulder substrates (Bustard and Narver 1975; Everest et al. 1986).

Older juveniles use riffles and larger juveniles may also use pools and deeper runs (Barnhart 1986 as cited in McEwan and Jackson 1996). However, specific depths and
habitats used by juvenile rainbow trout can be affected by predation risk (Brown and Brasher 1995). Central Valley steelhead can show mortality at constant temperatures of 77°F although they can tolerate 85°F for short periods (Myrick and Cech 2001). 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). Hatchery reared steelhead in thermal gradients selected temperatures of 64-66°F while wild caught steelhead selected temperatures around 63°F (Myrick and Cech 2001). An upper water temperature limit of 65°F is preferred for growth and development of Sacramento River and American River juvenile steelhead (NMFS 2002a).

In the lower Yuba River, juvenile steelhead exhibit variable durations of rearing. The RMT (2010b) distinguished fry, juvenile, and yearling+ lifestages through evaluation of bi-weekly length-frequency distributions of *O. mykiss* captured in rotary screw traps in the lower Yuba River, and other studies that report length-frequency estimates (Mitchell 2010; CDFG 1984a). Some juvenile *O. mykiss* may rear in the lower Yuba River for short periods (up to a few months) and others may spend from one to three years rearing in the river.

Some age-0 *O. mykiss* disperse downstream soon after emerging and continue throughout the year (Kozlowski 2004). Thus, the steelhead fry (individuals less than about 45 mm) lifestage generally extends from the time of initial emergence (based upon accumulated thermal units from the time of egg deposition through hatching and alevin incubation) until three months following the end of the spawning period. YCWA (2010) identified the fry rearing lifestage as generally extending from mid-March through July, and identified the juvenile rearing lifestage as extending year-round. Based on all information collected to date, the RMT (2013) identified the steelhead fry rearing period as extending from April through July.

Juvenile steelhead have been reported to rear in the lower Yuba River for up to 1 year or more (SWRI 2002). CDFG (1991a) reported that juvenile steelhead rear throughout the year in the lower Yuba River, and may spend from 1 to 3 years rearing in the river. Scale analysis conducted by Mitchell (2010) indicates the presence of at least four age
categories for *O. mykiss* in the lower Yuba River that spent 1, 2, or 3 years in freshwater and 1 year at sea before returning to the lower Yuba River to spawn.

Based on the combined results from electrofishing and snorkeling surveys conducted during the late 1980s, CDFG (1991a) reported that juvenile steelhead were observed in all river reaches downstream of the Englebright Dam and, in addition to Chinook salmon, were the only fish species observed in the Narrows Reach. They also indicated that most juvenile steelhead rearing occurred above Daguerre Point Dam. SWRI et al. (2000) summarized data collection in the lower Yuba River obtained from 1992 through 2000. Since 1992, Jones and Stokes Associates (JSA) biologists conducted fish population surveys in the lower Yuba River using snorkel surveys to determine annual and seasonal patterns of abundance and distribution of juvenile *O. mykiss* (and Chinook salmon) during the spring and summer rearing periods. The primary rearing habitat for juvenile *O. mykiss* is upstream of Daguerre Point Dam. In 1993 and 1994, snorkeling surveys indicated that the population densities and overall abundance of juvenile *O. mykiss* (age 0 and 1+) were substantially higher upstream of Daguerre Point Dam, with decreasing abundance downstream of Daguerre Point Dam.

Similarly, Kozlowski (2004) found higher abundances of juvenile *O. mykiss* above Daguerre Point Dam, relative to downstream of Daguerre Point Dam. Kozlowski (2004) observed age-0 *O. mykiss* throughout the entire study area, with highest densities in upstream habitats and declining densities with increasing distance from the Narrows. Approximately 82% of juvenile *O. mykiss* were observed upstream of Daguerre Point Dam. Kozlowski (2004) suggested that the distribution of age-0 *O. mykiss* appeared to be related to the distribution of spawning adults. SWRI et al. (2000) suggested that higher abundances of juvenile *O. mykiss* above Daguerre Point Dam may have been due to larger numbers of spawners, greater amounts of more complex, high quality cover, and lower densities of predators such as striped bass and American shad, which reportedly were restricted to areas below Daguerre Point Dam.

In the lower Yuba River, Kozlowski (2004) reports that juvenile *O. mykiss* were observed in greater numbers in pool habitats than in run habitats. He suggests that results of his study indicated a relatively higher degree of habitat complexity, suitable for various
lifestages, in the reaches just below the Narrows compared to farther downstream. The
Narrows reach includes greater occurrence of pool-type microhabitat suitable for juvenile
*O. mykiss* rearing, as well as small boulders and cobbles preferred by the age-0 emerging
lifestage (Kozlowski 2004).

Juvenile *O. mykiss* apparently demonstrate a proclivity for near-bank areas, rather than
open-channel habitats, in the lower Yuba River. USFWS (2008a) reports 258
observations of juvenile *O. mykiss* and 244 observations of juvenile Chinook salmon, all
but 8 of them made near the river banks in the lower Yuba River.

A broad range of *O. mykiss* size classes have been observed in the lower Yuba River
during spring and summer snorkeling, electrofishing, and angling surveys (SWRI et al.
2000). Juvenile *O. mykiss* ranging in size from 40-150 mm were commonly observed
upstream of Daguerre Point Dam. Numerous larger juveniles and resident trout up to 18
inches long were also commonly observed in the mainstem upstream and downstream of
Daguerre Point Dam (SWRI et al. 2000). Age 0 (young-of-the-year) *O. mykiss* were
clearly shown by the distinct mode in lengths of fish caught by electrofishing (40-100 mm fork length). A preliminary examination of scales indicated that most yearling (age
1+) and older *O. mykiss* were represented by fish greater than 110 mm long, including
most if not all of the fish caught by hook and line. The sizes of age 0 and 1+ *O. mykiss*
indicated substantial annual growth of *O. mykiss* in the lower Yuba River. Seasonal
growth of age 0 *O. mykiss* was evident from repeated sampling in 1992 and 1999, but
actual growth rates could not be estimated because of continued recruitment of fry (newly
emerged juveniles) or insufficient sample sizes (SWRI et al. 2000).

Mitchell (2010) reports that analysis of scale growth patterns of juvenile *O. mykiss* in the
lower Yuba River indicates a period of accelerated growth during the spring peaking
during the summer months, followed by decelerated growth during the fall and winter.
Following the second winter, juvenile *O. mykiss* in the lower Yuba River exhibit reduced
annual growth in length with continued growth in mass until reaching reproductive age.
Additionally, more rapid juvenile and adult *O. mykiss* growth occurred in the lower Yuba
River compared to the lower Sacramento River and Klamath River *O. mykiss*, with
comparable growth rates to *O. mykiss* in the upper Sacramento River (Mitchell 2010).
CDFG (1991a) reports that juvenile steelhead in the lower Yuba River rear throughout the year, and may spend from one to three years in the river before emigrating primarily from March to June. Salvage data at the Hallwood-Cordua fish screen suggest that most juvenile fish initiated their downstream movements immediately preceding and following a new moon, indicating the presence of lunar periodicity in the timing of outmigration patterns in the lower Yuba River (Kozlowski 2004).

Based on all information collected to date, the RMT (2013) identified the steelhead juvenile rearing period as extending year-round, and the steelhead juvenile downstream movement period as extending from April through September.

In the lower Yuba River, some young-of-year (YOY) *O. mykiss* are captured in rotary screw traps (RSTs) located downstream of Daguerre Point Dam during late-spring and summer, indicating movement downstream. However, at least some of this downstream movement may be associated with the pattern of flows in the river. Water transfer monitoring in 2001, 2002, and 2004 (YCWA and SWRCB 2001; YCWA 2003; YCWA 2005), generally from about mid-June through September, indicated that the character of the initiation of the water transfers could potentially affect juvenile *O. mykiss* downstream movement. Based upon the substantial differences in juvenile *O. mykiss* downstream movements (RST catch data) noted between the 2001 study, and the 2002 and 2004 studies, it was apparent that the increases in juvenile *O. mykiss* downstream movement associated with the initiation of the 2001 water transfers were avoided due to a more gradual ramping-up of flows that occurred in 2002 and 2004 (YCWA et al. 2007).

Numerous studies have been conducted regarding temperature preference, mortality, and water temperature growth-related relationships for *O. mykiss*. As previously described, some steelhead may rear in freshwater for up to three years before emigrating as yearling+ smolts, whereas other individuals move downstream shortly after emergence as post-emergent fry, or rear in the river for several months and move downstream as juveniles without exhibiting the ontogenetic characteristics of smolts. Presumably, these individuals continue to rear and grow in downstream areas (e.g., lower Feather River, Sacramento River, and Upper Delta) and undergo the smoltification process prior to entry.
into saline environments. Thus, fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement.

### 4.3.4.5 Smolt Emigration

Most juvenile steelhead spend one to three years in fresh water before emigrating to the ocean as smolts (Shapovalov and Taft 1954). During their downstream migration, juvenile steelhead undergo a process referred to as smoltification, which is a physiologic transformation and osmoregulatory pre-adaptation to residence in saline environs. Physiologic expressions of smoltification include increased gill ATPase and thyroxin levels, and more slender body form which is silvery in appearance. The primary period of steelhead smolt outmigration from rivers and creeks to the ocean generally occurs from January to June (NMFS 2009).

In the Sacramento River, juvenile steelhead migrate to the ocean in spring and early summer at 1 to 3 years of age with peak migration through the Delta in March and April (Reynolds et al. 1993 as cited in NMFS 2009). 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 (NMFS 2009).

According to NMFS (2009a), steelhead are present at Chipps Island between at least October and July, according to catch data from the USFWS Chipps Island Trawl. It appears that adipose fin-clipped steelhead have a different emigration pattern than unclipped steelhead. Adipose fin-clipped steelhead showed distinct peaks in catch between January and March corresponding with time of release, whereas unclipped steelhead were more evenly distributed over a period of six months or more. These differences are likely an artifact of the method and timing of hatchery releases (NMFS 2009a).

Steelhead successfully smolt at water temperatures in the 43.7°F to 52.3°F range (Myrick and Cech 2001). The optimum water temperature range for successful smoltification in young steelhead has been reported as 44.0°F to 52.3°F (Rich 1987 as cited in NMFS 2009). Wagner (1974) reported smolting ceased rather abruptly when water temperatures
increased to 57°F-64°F. NMFS (2009a) reported that water temperatures under 57°F are considered best for smolting.

In the lower Yuba River, the steelhead smolt emigration period has been reported to extend from October through May (CALFED and YCWA 2005; SWRI 2002; YCWA et al. 2007). The RMT’s (2010b; 2013) review of all available data indicate that yearling+ steelhead smolt emigration may extend from October through mid-April.

For the purposes of impact assessment, the RMT (2010b) developed separate water temperature index values for the yearling+ smolt emigration lifestages distinct from values for juvenile steelhead rearing and/or outmigration as juveniles from the lower Yuba River. They assumed that juvenile steelhead that exhibit extended rearing in the lower Yuba River undergo the smoltification process and volitionally emigrate from the river as yearling+ individuals.

### 4.3.4.6 Lifestage-Specific Water Temperature Suitabilities

Since the RMT prepared its November 2010 water temperature objectives memorandum, additional water temperature monitoring and life history investigations of anadromous salmonids in the lower Yuba River have been conducted by the RMT. Through review of previously conducted studies, as well as recent and currently ongoing data collection activities of the M&E Program, the RMT (2013) developed the following representative steelhead lifestage-specific periodicities and primary locations for water temperature suitability evaluations. The locations used for water temperature evaluations correspond to Smartsville, Daguerre Point Dam, and Marysville.

- Adult Immigration and Holding (August through March) – Smartsville, Daguerre Point Dam, and Marysville
- Spawning (January through April) – Smartsville and Daguerre Point Dam
- Embryo Incubation (January through May) – Smartsville and Daguerre Point Dam
- Juvenile Rearing and Downstream Movement (Year-round) – Daguerre Point Dam and Marysville
Smolt (Yearling+) emigration (October through mid-April) – Daguerre Point Dam and Marysville

Steelhead lifestage-specific WTI values are provided in Table 4-8. The lifestages and periodicities presented in Table 4-8 differ from those presented in Table 4-7 due to specific lifestages that have the same or distinct upper tolerable WTI values.

Table 4-8. Steelhead lifestage-specific upper tolerance WTI values.

<table>
<thead>
<tr>
<th>Lifestage</th>
<th>Upper Tolerance WTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult Migration</td>
<td>68°F</td>
</tr>
<tr>
<td>Adult Holding</td>
<td>65°F</td>
</tr>
<tr>
<td>Spawning</td>
<td>57°F</td>
</tr>
<tr>
<td>Embryo Incubation</td>
<td>57°F</td>
</tr>
<tr>
<td>Juvenile Rearing and Downstream Movement</td>
<td>68°F</td>
</tr>
<tr>
<td>Smolt (Yearling+) Emigration</td>
<td>55°F</td>
</tr>
</tbody>
</table>

Recent water temperature monitoring data in the lower Yuba River are available for the period extending from 2006 into June 2013, during which time operations have complied with the Yuba Accord. Figure 4-9 displays daily water temperature monitoring results from October 2006 through June 2013 at Smartsville, Daguerre Point Dam, and Marysville water temperature gages, with steelhead lifestage-specific upper tolerance WTI values. Water temperatures at all three gages are always below the upper tolerance WTI values for juvenile rearing and downstream movement, and adult immigration and holding. The upper tolerance spawning and embryo incubation WTI value is never exceeded at Smartsville, and is generally not exceeded at Daguerre Point Dam with the exception of the end of May of some years. The smolt (yearling+) emigration upper tolerance WTI value generally is not exceeded at the Smartsville Gage, and is not exceeded at the Daguerre Point Dam and Marysville gages after mid-November.
4.3.5 Limiting Factors, Threats and Stressors

As stated by NMFS (2005b), the factors affecting the survival and recovery of Central Valley steelhead and their habitat are similar to those affecting spring-run Chinook salmon and are primarily associated with habitat loss (McEwan 2001). McEwan and Jackson (1996) attribute this habitat loss and other impacts to steelhead habitat primarily to water development resulting in inadequate flows, flow fluctuations, blockages, and entrainment into diversions. Other effects on critical habitat related to land use practices and urbanization have also contributed to steelhead declines (Busby et al. 1996).

Although many of the factors affecting spring-run Chinook salmon habitat are common to steelhead, some stressors, especially summer water temperatures, cause greater effects to steelhead because juvenile steelhead rear in freshwater for more than one year. Because most suitable habitat has been lost to dam construction, juvenile steelhead rearing is generally confined to lower elevation stream reaches, where water temperatures during late summer and early fall can be sub-optimal (NMFS 2005b).

Many of the improvements to critical habitat that have benefited spring-run Chinook salmon, including water management through the CVPIA Section 3406(b)(2) water
supply and the CALFED Environmental Water Account, improved screening conditions at water diversions, and changes in inland fishing regulations (there is no ocean steelhead fishery) also benefit Central Valley steelhead (NMFS 2005b). However, many dams and reservoirs in the Central Valley do not have water storage capacity or release mechanisms necessary to maintain suitable water temperatures for steelhead rearing through the critical summer and fall periods, especially during critically dry years (McEwan 2001).

4.3.5.1 DPS

According to the NMFS Draft Recovery Plan (NMFS 2009), threats to Central Valley steelhead are similar to those for spring-run Chinook salmon and fall into three broad categories: (1) loss of historical spawning habitat; (2) degradation of remaining habitat; and (3) threats to the genetic integrity of the wild spawning populations from hatchery steelhead production programs in the Central Valley. Also, as for spring-run Chinook salmon, the potential effects of long-term climate change also may adversely affect steelhead and their recovery.

In 1998, NMFS concluded that the risks to Central Valley steelhead had diminished, 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 (NMFS 2009). NMFS stated that Central Valley steelhead were benefiting from two major conservation initiatives, being simultaneously implemented: (1) the CVPIA, which was passed by Congress in 1992; and (2) the CALFED Program, a joint state/federal effort implemented in 1995. The following discussion of these two programs was taken directly from NMFS (2009).

The CVPIA is specifically intended to remedy habitat and other problems associated with the construction and operation of the CVP. The CVPIA has two key features related to steelhead. First, it directs the Secretary of the Interior to develop and implement a program that makes all reasonable efforts to double natural production of anadromous fish in Central Valley streams (Section 3406(b)(1)) by the year 2002. The AFRP was initially drafted in 1995 and subsequently revised in 1997. Funding has been appropriated since 1995 to implement restoration projects identified in the AFRP planning process. Second, the CVPIA dedicates up to 800,000 acre-feet of water
annually for fish, wildlife, and habitat restoration purposes (Section 3406(b)(2)) and provides for the acquisition of additional water to supplement the 800,000 acre-feet (Section 3406(b)(3)). USFWS, in consultation with other federal and state agencies, has directed the use of this dedicated water yield since 1993.

The CALFED Program, which began in June 1995, was charged with the responsibility of developing a long-term Bay-Delta solution. A major element of the CALFED Program is the Ecosystem Restoration Program (ERP), which was intended to provide the foundation for long-term ecosystem and water quality restoration and protection throughout the region. Among the non-flow factors causing decline that have been targeted by the program are unscreened diversions, waste discharges and water pollution, impacts due to poaching, land derived salts, exotic species, fish barriers, channel alterations, loss of riparian wetlands, and other causes of estuarine habitat degradation.

The level of risk faced by the Central Valley steelhead DPS may have diminished since the 1996 listing proposal as a result of habitat restoration and other measures that have recently been implemented through the CALFED and CVPIA programs. Although most restoration measures designed to recover Chinook salmon stocks can benefit steelhead, focusing restoration solely on Chinook salmon may lead to inadequate measures to restore steelhead because of their different life histories and resource requirements, particularly for rearing juveniles (McEwan 2001). Additional actions that benefit Central Valley steelhead include efforts to enhance fisheries monitoring, such as the Central Valley Steelhead Monitoring Plan, and conservation actions to address artificial propagation.

In spite of the benefits derived from implementation of these two programs, NMFS (2009) identified several major stressors presently applicable to the entire Central Valley steelhead DPS. Many of the most important stressors specific to the steelhead DPS correspond to the stressors described for the spring-run Chinook salmon ESU. As previously stated, the 2009 NMFS OCAP BO (2009a) identified factors leading to the current status of the spring-run Chinook salmon ESU, which also are applicable to the steelhead DPS, including habitat blockage, water development and diversion dams, water conveyance and flood control, land use activities, water quality, hatchery operations and practices, over-utilization (e.g., ocean commercial and sport harvest, inland sport
harvest), disease and predation, environmental variation (e.g., natural environmental
cycles, ocean productivity, climate change), and non-native invasive species. The
previous discussions in this BA addressing limiting factors and threats for the spring-run
Chinook salmon ESU and their specific geographic influences, including the Sacramento
River and the Delta, are not repeated in this section of this BA. Stressors that are unique
to the steelhead DPS, or substantially differ in the severity from the stressor for the
previously described spring-run Chinook salmon ESU, are described below.

Threats and stressors for the Central Valley steelhead DPS identified in Appendix B
(Threats Assessment) of the NMFS Draft Recovery Plan (NMFS 2009) include: (1)
destruction, modification, or curtailment of habitat or range; (2) overutilization for
commercial, recreational, scientific or education purposes; (3) disease or predation; (4)
inadequacy of existing regulatory mechanisms, including federal and non-federal efforts;
(5) other natural and man-made factors affecting its continued existence; and (6) non-
lifestage specific threats and stressors including artificial propagation programs, small
population size, genetic integrity and long-term climate change. The following
summarization of threats and stressors for the Central Valley steelhead DPS is taken
directly from Appendix B (Threats Assessment) of the NMFS Draft Recovery Plan
(NMFS 2009).

DESTRUCTION, MODIFICATION, OR CURTAILMENT OF HABITAT OR RANGE

The spawning habitat for Central Valley steelhead has been greatly reduced from its
historical range (NMFS 2009). The vast majority of historical spawning habitat for
Central Valley steelhead has been eliminated by fish passage impediments associated
with water storage, withdrawal, conveyance, and diversions for agriculture, flood control,
and domestic and hydropower purposes (NMFS 2009). Modification of natural flow
regimes has resulted in increased water temperatures, changes in fish community
structures, depleted flow necessary for migration, spawning, rearing, and flushing of
sediments from spawning gravels. These changes in flow regimes may be driving a shift
in the frequencies of various life history strategies, especially a decline in the proportion
of the population migrating to the ocean. Land use activities, such as those associated
with agriculture and urban development, have altered steelhead habitat quantity and
quality. Although many historically harmful practices have been halted, much of the
historical damage to habitats limiting steelhead remains to be addressed, and the
necessary restoration activities will likely require decades.

**OVERUTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC OR EDUCATIONAL PURPOSES**

*(INLAND SPORT HARVEST)*

Steelhead have been, and continue to be, an important recreational fishery throughout
their range. Although there are no commercial fisheries for steelhead in the ocean, inland
steelhead fisheries include tribal and recreational fisheries. In the Central Valley,
recreational fishing for steelhead is popular, yet harvest is restricted to only the visibly
marked hatchery-origin fish, which reduces the likelihood of retaining naturally spawned
wild fish. The permits NMFS issues for scientific or educational purposes stipulate
specific conditions to minimize take of steelhead individuals during permitted activities.
There are currently 11 active permits in the Central Valley that may affect steelhead.
These permitted studies provide information about Central Valley steelhead that is useful
to the management and conservation of the DPS. [Additional information regarding
inland sport harvest of steelhead in the Central Valley contained in Reclamation (2008) is
provided below.]

**INLAND SPORT HARVEST**

Historically in California, almost half of the river sport fishing effort has occurred in the
Sacramento-San Joaquin River system, particularly upstream from the city of Sacramento
(Emnett et al. 1991). There is little information on steelhead harvest rates in California.
Hallock et al. (1961) estimated that harvest rates for Sacramento River steelhead from the
1953/1954 through 1958/1959 seasons ranged from 25.1 to 45.6% assuming a 20% non-
return rate of tags. The average annual harvest rate of adult steelhead above RBDD for
the 3-year period from 1991/1992 through 1993/1994 was 16% (McEwan and Jackson
1996). Since 1998, all hatchery steelhead have been marked with an adipose fin clip
allowing anglers to distinguish hatchery and wild steelhead. Current regulations restrict
anglers from keeping unmarked steelhead in Central Valley streams. Overall, this
regulation has greatly increased protection of naturally produced adult steelhead
(Reclamation 2008). However, the total number of steelhead contacted might be a
significant fraction of basin-wide escapement, and even low catch-and-release mortality may pose a problem for wild populations (Good et al. 2005).

**Disease or Predation**

Steelhead are exposed to bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment. Very little current or historical information exists to quantify changes in infection levels and mortality rates attributable to these diseases for steelhead. Naturally spawned fish tend to be less susceptible to pathogens than hatchery-reared fish. Introduction of non-native species and modification of habitat have resulted in increased predatory populations and salmonid predation in river systems. In general, predation rates on steelhead are considered to be an insignificant contribution to the large declines observed in West Coast steelhead populations. In some local populations, however, predation may significantly influence salmonid abundance when other prey species are not present and habitat conditions lead to the concentration of adults and/or juveniles.

**Inadequacy of Existing Regulatory Mechanisms (Federal Efforts, Non-Federal Efforts)**

**Federal Efforts**

There have been several federal actions attempting to reduce threats to the Central Valley steelhead DPS. The BOs for the CVP and SWP and other federal projects involving irrigation and water diversion and fish passage, for example, have improved or minimized adverse impacts to steelhead in the Central Valley. There have also been several habitat restoration efforts implemented under CVPIA and CALFED programs that have led to several projects involving fish passage improvements, fish screens, floodplain management, habitat restoration, watershed planning, and other projects that have contributed to improvement of steelhead habitat. However, despite federal actions to reduce threats to the Central Valley steelhead DPS, the existing protective efforts are inadequate to ensure the DPS is no longer in danger of extinction. There remain high risks to the abundance, productivity, and spatial structure of the steelhead DPS.
NON-FEDERAL EFFORTS

Measures to protect steelhead throughout the State of California have been in place since 1998. The State’s Natural Communities Conservation Planning (NCCP) program involves long-term planning with several stakeholders. A wide range of measures have been implemented, including 100% marking of all hatchery steelhead, zero bag limits for unmarked steelhead, gear restrictions, closures, and size limits designed to protect smolts. NMFS and CDFW are working to improve inland fishing regulations to better protect both anadromous and resident forms of *O. mykiss* populations. A proposal to develop a comprehensive status and trends monitoring plan for Central Valley steelhead was submitted for funding consideration to the CALFED ERP in 2005. The proposal, drafted by CDFW and the interagency Central Valley Steelhead Project Work Team, was selected by the ERP Implementing Agency Managers, and is to receive funding as a directed action. Long-term funding for implementation of the monitoring plan, once it is developed, still needs to be secured. There are many sub-watershed groups, landowners, environmental groups, and non-profit organizations that are conducting habitat restoration and planning efforts that may contribute to the conservation of steelhead. However, despite federal and non-federal efforts to promote the conservation of the Central Valley steelhead DPS, few efforts address conservation needs at scales sufficient to protect the entire steelhead DPS. The lack of status and trend monitoring and research is one of the critical limiting factors to this DPS.

OTHER NATURAL AND MAN-MADE FACTORS AFFECTING THE CONTINUED EXISTENCE OF THE DPS

NMFS and the Biological Review Team (BRT) are concerned that the proportion of naturally produced fish is declining. Two artificial propagation programs for steelhead in the Central Valley – Coleman National Fish Hatchery and FRFH – may decrease risk to the DPS to some degree by contributing increased abundance to the DPS. Potential threats to natural steelhead posed by hatchery programs include: (1) mortality of natural steelhead in fisheries targeting hatchery-origin steelhead; (2) competition for prey and habitat; (3) predation by hatchery-origin fish on younger natural fish; (4) genetic introgression by hatchery-origin fish that spawn naturally and interbreed with local natural populations; and (5) disease transmission.
Changes in climatic events and global climate, such as El Niño ocean conditions and prolonged drought conditions, can threaten the survival of steelhead populations already reduced to low abundance levels as the result of the loss and degradation of freshwater and estuarine habitats. Floods and persistent drought conditions have reduced already limited spawning, rearing, and migration habitats. Unscreened water diversions and CVP and SWP pumping plants entrain outmigrating juvenile steelhead and fry, leading to fish mortality.

**NON-LIFESTAGE SPECIFIC THREATS AND STRESSORS FOR THE DPS (ARTIFICIAL PROPAGATION PROGRAMS, SMALL POPULATION SIZE, GENETIC INTEGRITY AND LONG-TERM CLIMATE CHANGE)**

Potential threats to the Central Valley steelhead population that are not specific to a particular lifestage include the potential negative impacts of the current artificial propagation program utilizing several hatcheries in the Sacramento-San Joaquin drainage, the small wild population size, the genetic integrity of the population due to both hatchery influence and small population size, and the potential effects of long-term climate change. Each of these potential threats is discussed in the following sections.

**ARTIFICIAL PROPAGATION PROGRAM**

Recent research has indicated that approximately 63 to 92% of steelhead smolt production is of hatchery-origin (NMFS 2003). These data suggest that the relative proportion of wild to hatchery smolt production is decreasing (NMFS 2003). All California hatchery steelhead programs began 100% adipose fin-clipping in 1998 to differentiate between hatchery steelhead from natural steelhead.

Propagation of steelhead at the Coleman National Fish Hatchery has been occurring for over 50 years. Hatchery-origin and natural-origin steelhead have been managed as a single stock; mixing of hatchery and natural origin population components occurred through spawning at the hatchery and intermingling with natural spawners in Battle Creek. Niemela et al. (2008) used genetic pedigree analysis to evaluate relative reproductive success and fitness among hatchery-origin and natural origin population components based on multilocus DNA microsatellite genotypes. Preliminary results suggest that hatchery origin spawners experienced low relative reproductive success, producing significantly fewer adult offspring in comparison to natural origin spawners.
Additionally, repeat spawning was more prevalent in the natural origin component of the population.

**Population Size**

In the technical memorandum titled *Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead* (Good et al. 2005), NMFS estimated the abundance of natural spawners for the steelhead DPS (then classified as an ESU), which was reported as the geometric mean (and range) of the most recent data available at that time, consistent with previous coast-wide status reviews of the species (Weitkamp et al. 1995; Busby et al. 1996; Gustafson et al. 1997; Johnson et al. 1997; Myers et al. 1998). Geometric means were calculated to represent the abundance of natural spawners for each population or quasi-population. Geometric means were calculated for the most recent 5 years of steelhead data, to correspond with modal age at maturity (Good et al. 2005). Where possible, the BRTs obtained population or ESU-level estimates of the fraction of hatchery-origin spawners or calculated estimates from information using scale analyses, fin clips, etc. (Good et al. 2005).

The Central Valley steelhead DPS mean annual escapement of natural spawners was estimated at 1,952 based on a 5-year period ending in 1993 (Good et al. 2005). During that time period a minimum escapement of 1,425 and a maximum escapement of 12,320 were observed (Good et al. 2005). A long-term trend analysis indicated that the population was declining (Good et al. 2005). In the *Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead* (Good et al. 2005), NMFS suggests that there has been no significant status change since the 1993 data and the Central Valley steelhead population continues to decline (Good et al. 2005). Good et al. (2005) also suggested that hatchery production is large relative to natural production. As an example, the steelhead run in the lower Feather River has been increasing over the past several years; however, over 99% of the run is of direct hatchery-origin (DWR 2002).

**Genetic Integrity**

There is still significant local genetic structure to Central Valley steelhead populations, although fish from the San Joaquin and Sacramento basins cannot be distinguished
genetically (Nielsen et al. 2003). Hatchery effects appear to be localized – for example, Feather River and FRFH steelhead are closely related as are American River and Nimbus Hatchery fish (DWR 2002). Leary et al. (1995) report that hatchery straying has increased gene flow among steelhead populations in the Central Valley and that a smaller amount of genetic divergence is observed among Central Valley populations compared to wild British Columbia populations largely uninfluenced by hatcheries. Natural annual production of steelhead smolts in the Central Valley is estimated at 181,000 and hatchery production is 1,340,000 for a ratio of 0.148 (Good et al. 2005). Current monitoring by hydroacoustic tracking has revealed that Mokelumne River/Hatchery steelhead (FRFH source stock) are straying into the American River (J. Smith, EBMUD, pers. comm. as cited in NMFS 2009).

There has also been significant transfer of genetic material among hatcheries within the Central Valley as well as some transfer from systems outside the Central Valley. There have also been transfers of steelhead from the FRFH to the Mokelumne Hatchery. For example, eyed eggs from the Nimbus Hatchery were transferred to the FRFH several times in the late 1960s and early 1970s (DWR 2002). Also, Nimbus Hatchery steelhead eggs have often been transferred to the Mokelumne Hatchery. Additionally, an Eel River strain of steelhead was used as the founding broodstock for the Nimbus Hatchery (CDFG 1991a). In the late 1970s, a strain of steelhead was brought in from Washington State for the FRFH (DWR 2002).

**LONG-TERM CLIMATE CHANGE**

Because steelhead normally spend a longer time in freshwater as juveniles than other anadromous salmonids, any negative effects of climate change may be more profound on steelhead populations.

**HATCHERY OPERATIONS AND PRACTICES**

In addition to the immediately previous discussion taken from Appendix B (Threats Assessment) of the NMFS Draft Recovery Plan (NMFS 2009), an additional discussion regarding the impacts of hatcheries on the Central Valley steelhead DPS is provided below.
Hatcheries have come under scrutiny for their potential effects on wild salmonid populations (Bisson et al. 2002; Araki et al. 2007). The concern with hatchery operations is two-fold. First, they may result in unintentional, but maladaptive genetic changes in wild steelhead stocks (McEwan and Jackson 1996). CDFW believes its hatcheries take eggs and sperm from enough individuals to avoid loss of genetic diversity through inbreeding depression and genetic drift. However, artificial selection for traits that improve hatchery success (e.g., fast growth, tolerance of crowding) are not avoidable and may reduce genetic diversity and population fitness (Araki et al. 2007). Past and present hatchery practices represent the major threat to the genetic integrity of Central Valley steelhead (NMFS 2009). Overlap of spawning hatchery and natural fish within the steelhead DPS exists, resulting in genetic introgression. Also, a substantial problem with straying of hatchery fish exists within this DPS (Hallock 1989). Habitat fragmentation and population declines resulting in small, isolated populations also pose genetic risk from inbreeding, loss of rare alleles, and genetic drift (NMFS 2009).

The second concern with hatchery operations revolves around the potential for undesirable competitive interactions between hatchery and wild stocks. Intraspecific competition between wild and artificially produced stocks can result in wild fish declines (McMichael et al. 1997; 1999). Although wild fish are presumably more adept at foraging for natural foods than hatchery-reared fish, this advantage can be negated by density-dependent effects resulting from large numbers of hatchery fish released at a specific locale, as well as the larger size and more aggressive behavior of the hatchery fish (Reclamation 2008).

Currently, four hatcheries in the Central Valley produce steelhead to supplement the Central Valley wild steelhead population. These four Central Valley steelhead hatcheries (Mokelumne River, FRFH, Coleman, and Nimbus hatcheries) collectively produce approximately 1.5 million steelhead yearlings annually when all four hatcheries reach production goals (CMARP 1998). The hatchery steelhead programs originated as mitigation for the habitat lost by construction of dams. Steelhead are released at downstream locations in January and February at about four fish per pound, generally corresponding to the initiation of the peak of outmigration (Reclamation 2008). In the Central Valley, practices such as transferring eggs between hatcheries and trucking
smolts to distant sites for release contribute to elevated straying levels (USDOI 1999, as cited in NMFS 2009a).

According to Reclamation (2008), the hatchery runs in the American and Mokelumne rivers are probably highly introgressed mixtures of many exotic stocks introduced in the early days of the hatcheries (McEwan and Jackson 1996; NMFS 1998b). Beginning in 1962, steelhead eggs were imported into Nimbus Hatchery from the Eel, Mad, upper Sacramento, and Russian rivers and from the Washougal and Siletz Rivers in Washington and Oregon, respectively (McEwan and Nelson 1991, as cited in McEwan and Jackson 1996). Egg importation has also occurred at other Central Valley hatcheries (McEwan and Jackson 1996).

Reclamation (2008) further states that stock introductions began at the FRFH in 1967, when steelhead eggs were imported from Nimbus Hatchery to be raised as broodstock. In 1971, the first release of Nimbus origin fish occurred. From 1975 to 1982, steelhead eggs or juveniles were imported from the American, Mad, and Klamath rivers and the Washougal River in Washington. The last year that Nimbus-origin fish were released into the Feather River was 1988. Based on preliminary genetic assessments of Central Valley steelhead, NMFS (1998b) concluded the FRFH steelhead were part of the Central Valley DPS despite an egg importation history similar to the Nimbus Hatchery stock, which NMFS did not consider part of the Central Valley DPS.

The increase in Central Valley hatchery production has reversed the composition of the steelhead population, from 88% naturally-produced fish in the 1950s (McEwan 2001) to an estimated 23 to 37% naturally-produced fish (Nobriga and Cadrett 2003). The increase in hatchery steelhead production proportionate to the wild population has reduced the viability of the wild steelhead populations, increased the use of out-of-basin stocks for hatchery production, and increased straying (NMFS and CDFG 2001). Thus, the ability of natural populations to successfully reproduce and continue their genetic integrity likely has been diminished (Reclamation 2008).

In addition, harvest impacts associated with hatchery-wild population interactions have been identified as a stressor to wild Central Valley steelhead stocks (NMFS 2009). The relatively low number of spawners needed to sustain a hatchery population can result in
high harvest-to-escapements ratios in waters where fishing regulations are set according to hatchery population. This can lead to over-exploitation and reduction in the size of wild populations existing in the same system as hatchery populations due to incidental bycatch (McEwan 2001). According to CDFW creel census surveys, the majority (93%) of steelhead catches occur on the American and Feather rivers, sites of steelhead hatcheries (CDFG 2001d, as cited in NMFS 2009). Creel census surveys conducted during 2000 indicated that 1,800 steelhead were retained, and 14,300 were caught and released. The total number of steelhead contacted might be a significant fraction of basin-wide escapement, so even low catch-and-release mortality may pose a problem for wild populations. Additionally, NMFS (2005b) asserted that steelhead fisheries on some tributaries and the mainstem Sacramento River may affect some steelhead juveniles.

### 4.3.5.2 Lower Yuba River

The lower Yuba River steelhead population is exposed and subject to the myriad of limiting factors, threats and stressors described above for the DPS. Concurrently with the effort conducted for spring-run Chinook salmon, NMFS (2009) recently conducted a comprehensive assessment of stressors affecting both steelhead within the lower Yuba River, and lower Yuba River steelhead populations as they migrate downstream (as juveniles) and upstream (as adults) through the lower Feather River, the lower Sacramento River, and the Bay-Delta system. For the lower Yuba River population of steelhead, the number of stressors according to the categories of “Very High”, “High”, “Medium”, and “Low” that occur in the lower Yuba River or occur out of basin are presented below by lifestage (Table 4-9).

As shown by the numbers in Table 4-9, of the total number of 94 stressors affecting all identified lifestages of lower Yuba River populations or steelhead, 31 are within the lower Yuba River and 63 are out-of-basin. Because spawning and incubation occurs only in the lower Yuba River, all of the stressors associated with these lifestages occur in the lower Yuba River. For the adult immigration and holding, and the juvenile rearing and outmigration lifestages combined, a total of 49 “Very High” and “High” stressors were identified, with 15 of those occurring in the lower Yuba River and 34 occurring out-of-basin.
Table 4-9. The number of stressors according to the categories of “Very High”, “High”, “Medium”, and “Low” that occur in the lower Yuba River, or occur out-of-basin, by lifestage for the lower Yuba River population of steelhead (Source: NMFS 2009).

<table>
<thead>
<tr>
<th>Lifestage</th>
<th>Location</th>
<th>Stressor Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Very High</td>
</tr>
<tr>
<td>Adult Immigration and Holding</td>
<td>Lower Yuba River</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Out of Basin</td>
<td>1</td>
</tr>
<tr>
<td>Spawning</td>
<td>Lower Yuba River</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Out of Basin</td>
<td>N/A*</td>
</tr>
<tr>
<td>Embryo Incubation</td>
<td>Lower Yuba River</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Out of Basin</td>
<td>N/A</td>
</tr>
<tr>
<td>Juvenile Rearing and Outmigration</td>
<td>Lower Yuba River</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Out of Basin</td>
<td>12</td>
</tr>
</tbody>
</table>

* N/A – Not Applicable.

The NMFS (2009) Draft Recovery Plan states that “The lower Yuba River, below Englebright Dam, is characterized as having a high potential to support a viable population of steelhead, primarily because: (1) the river supports a persistent population of steelhead and historically supported the largest, naturally reproducing population of steelhead in the Central Valley (McEwan and Jackson 1996); (2) flow and water temperature conditions are generally suitable to support all life stage requirements; (3) the river does not have a hatchery on it; (4) spawning habitat availability does not appear to be limited; and (5) high habitat restoration potential”.

Similar to the statement for spring-run Chinook salmon, the NMFS (2009) Draft Recovery Plan further states that “For currently occupied habitats below Englebright Dam, it is unlikely that habitats can be restored to pre-dam conditions, but many of the processes and conditions that are necessary to support a population of steelhead can be improved with improvements to instream flow regimes, water temperatures, and habitat availability. Continued implementation of the Yuba Accord is expected to address these factors and considerably improve conditions in the lower Yuba River.”
Many of the most important stressors specific to steelhead in the lower Yuba River correspond to the stressors described for spring-run Chinook salmon in the lower Yuba River, which included passage impediments and barriers, harvest and angling impacts, poaching, physical habitat alteration, loss of riparian habitat and instream cover (e.g., riparian vegetation, instream woody material), loss of natural river morphology and function, loss of floodplain habitat, entrainment, predation, and hatchery effects.

The previous discussions in this BA addressing limiting factors and threats for the spring-run Chinook salmon population in the lower Yuba River that are pertinent to the steelhead population in the lower Yuba River are not repeated in this section of the BA. Stressors that are unique to steelhead in the lower Yuba River, and stressors that substantially differ in severity for steelhead, are described below.

**Harvest/Angling Impacts**

Fishing for steelhead on the lower Yuba River is regulated by CDFW. Angling regulations on the lower Yuba River are intended to protect sensitive species, including wild steelhead. CDFW angling regulations (2013/2014) permit fishing for steelhead from the mouth of the Yuba River to the Highway 20 Bridge with only artificial lures with barbless hooks all year-round. The regulations include a daily bag limit of two hatchery trout or hatchery steelhead (identified by an adipose fin clip), and a possession limit of four hatchery trout or hatchery steelhead. From the Highway 20 Bridge to Englebright Dam, fishing for steelhead is permitted from December 1 through August 31 only, with only artificial lures with barbless hooks. For this time period, the regulations include a daily bag limit of two hatchery trout or hatchery steelhead (identified by an adipose fin clip), and a possession limit of four hatchery trout or hatchery steelhead.

**Poaching**

By contrast to the previous discussion regarding the potential for poaching to be a stressor to spring-run Chinook salmon, no references have been reported regarding the potential poaching of steelhead at the fish ladders, or at the base of Daguerre Point Dam. In addition, no reference has been located regarding the occurrence of steelhead jumping out of the fish ladders at Daguerre Point Dam.
Hatchery Effects

The previous discussion in this BA addressing limiting factors, threats and stressors resulting from straying and other hatchery effects on the steelhead DPS that are pertinent to steelhead in the lower Yuba River are not repeated in this section of the BA. Hatchery-related stressors that are unique to steelhead in the lower Yuba River, or substantially differ in severity for Yuba River steelhead, are described below.

Although it has been oft-repeated that hatcheries historically have not been located on the Yuba River, that does not appear to be the case. According to a document titled "A History of California's Fish Hatcheries 1870–1960" (Leitritz 1970), an experimental fish hatchery station (i.e., the Yuba River Hatchery) was established in 1928 by the California Department of Natural Resources, Division of Fish and Game. The site was on Fiddle Creek, a tributary of the North Fork Yuba River about 34 miles north of Nevada City, near Camptonville. Fish rearing began at the station in 1929. Over the years, improvements were made to the hatchery. No reference could be found regarding salmon, but the hatchery was reported to hatch and rear trout, including steelhead (CDNR 1931). The hatchery continued operations until storms during November 1950 caused such extensive damage that repairs could not be made and it was permanently closed (Leitritz 1970).

Since that time, no fish hatcheries have been located on the lower Yuba River, and the river continues to support a persistent population of steelhead. According to the NMFS Draft Recovery Plan (NMFS 2009), the major threat to the genetic integrity of Central Valley steelhead results from past and present hatchery practices. These practices include the planting of non-natal fish, overlap of spawning hatchery and natural fish, and straying of hatchery fish.

Genetic Considerations

From 1970 to 1979, CDFW annually stocked 27,270–217,378 fingerlings, yearlings, and sub-catchable steelhead from Coleman National Fish Hatchery into the lower Yuba River (CDFG 1991a). CDFW stopped stocking steelhead into the lower Yuba River in 1979. In addition, it is possible that some hatchery-reared juvenile steelhead from the FRFH
may move into the lower Yuba River in search of rearing habitat. Some competition for resources with naturally spawned steelhead could occur as a result.

Previous genetic work on population structure of steelhead in California has relied primarily on analyses of mitochondrial DNA (e.g. Berg and Gall 1988; Nielsen et al. 1997), which is a single gene that is often not reflective of population history or true relationships (Chan and Levin 2005). However, microsatellites, also known as simple sequence repeat loci, have been used in numerous studies of salmonids and have proven to be a valuable tool for elucidating population genetic structure. Work on *O. mykiss* in California using microsatellite loci has demonstrated that genetic structure can be identified with such data, both at larger scales (Aguilar and Garza 2006) and at relatively fine ones (Deiner et al. 2007; Pearse et al. 2007). The following discussion was taken from Garza and Pearse (2008).

Garza and Pearse (2008) studied populations of *O. mykiss* in the Central Valley using molecular genetic techniques to provide insight into population structure in the region. Data were collected from 18 nuclear microsatellite loci and variation analyzed to trace ancestry and evaluate genetic distinction among populations. The goals of the study were to use population genetic analyses of the data to assess origins and ancestry of *O. mykiss* populations above and below dams in Central Valley tributary rivers, to better understand the relationship of these populations to others in California, and to provide information on genetic diversity and population structure of these populations. Genotypes were collected from over 1,600 individual fish from 17 population samples and five hatchery rainbow trout strains. Fish populations from rivers and creeks that flow to both the Sacramento and San Joaquin Rivers were evaluated, including the McCloud River, Battle Creek, Deer Creek, Butte Creek, Feather River, Yuba River, American River, Calaveras River, Stanislaus River and Tuolumne River sub-basins. Analyses included fish collected both above and below barriers to anadromy in some of the study basins (Garza and Pearse 2008).

Phylogeographic trees were used to visually and quantitatively evaluate genetic relationships of Central Valley *O. mykiss* populations both with each other and with other California populations. Genetic diversity was relatively similar throughout the Central
Valley. 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. In phylogeographic analyses, above-barrier populations are more similar to San Francisco Bay *O. mykiss* populations than the below-barrier populations in the Central Valley. Because this relationship is expected for steelhead, given their extraordinary historic dependence on short distance migration events (Pearse and Garza 2007), they may represent relatively non-introgressed historic population genetic structure for the region. Other possible explanations for this pattern that rely on complicated, widespread patterns of introgression with hatchery fish are not entirely ruled out, but are highly improbable given that the above-barrier populations also group with moderate consistency into geographically-consistent clusters (e.g. Yuba-Upper and Feather-Upper) in all analyses and also because of the low apparent reproductive success of hatchery trout in streams throughout California (Garza and Pearse 2008).

The analyses also identified possible heterogeneity between samples from different tributaries of the upper Yuba and Feather Rivers, although linkage disequilibrium was lower in these populations. Linkage disequilibrium can be caused by physical linkage of loci, sampling of related individuals/family structure, and by the sampling of more than one genetically distinct group within a population sample (Garza and Pearse 2008).

In general, although 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 (Garza and Pearse 2008). 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.
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).

**Straying into the Lower Yuba River**

The observation of adipose fin clips on adult steelhead passing upstream through the VAKI Riverwatcher system at Daguerre Point Dam demonstrates that hatchery straying into the lower Yuba River has, and continues, to occur. Although no information is presently available regarding the origin of adipose-clipped steelhead observed at the VAKI Riverwatcher system at Daguerre Point Dam, it is reasonable to surmise that they most likely originate from the FRFH. The remainder of this discussion pertains to hatchery effects associated with the straying of adult steelhead into the lower Yuba River.

If hatchery-origin steelhead stray into the lower Yuba River and interbreed with naturally-spawning Yuba River steelhead, then such interbreeding has been suggested to represent a threat to the genetic diversity and integrity of the naturally-spawning steelhead population in the lower Yuba River. No previously conducted quantitative analyses or data addressing the extent of hatchery-origin steelhead straying into the lower Yuba River is available for presentation in this BA. However, some information is presently available to assess the amount of straying of hatchery-origin (adipose fin-clipped) steelhead into the lower Yuba River from VAKI Riverwatcher data.

In the lower Yuba River, attempts were made to differentiate adult steelhead from other *O. mykiss* (i.e., juvenile steelhead and resident rainbow trout) recorded passing Daguerre Point Dam utilizing daily VAKI Riverwatcher data. However, only two years of data (2010/2011 and 2011/2012) are available identifying adipose fin-clipped *O. mykiss* passing through the VAKI Riverwatcher system, during which extensive inoperable periods did not occur during the adult steelhead upstream migration period. Data reduction, limitations and applications are described in Section 4.2.6 (Viability) of this BA, below.

Analysis of the VAKI Riverwatcher data indicates that the percent contribution of hatchery-origin adult upstream migrating fish (represented by the percentage of adipose
fin-clipped adult steelhead relative to the total number of adult upstream migrating steelhead, because 100% of FRFH-origin steelhead have been marked since 1996) was approximately 43% for the 2010/2011 biological year, and about 63% for the 2011/2012 biological year (RMT 2013).

4.3.6 Viability of the Central Valley Steelhead DPS

The VSP concept (McElhany et al. 2000) previously described in Section 4.1.6 of this BA for the spring-run Chinook salmon ESU also is used to address and describe the viability of the Central Valley Steelhead DPS.

4.3.6.1 DPS

As described by NMFS (2009), there are few data with which to assess the status of Central Valley steelhead populations. Lindley et al. (2007) stated that, with the few exceptions of streams with long-running hatchery programs such as Battle Creek and the Feather, American and Mokelumne rivers, Central Valley steelhead populations are classified as data deficient. In all cases, hatchery-origin fish likely comprise the majority of the natural spawning run, placing the natural populations at high risk of extinction (Lindley et al. 2007). As of 2009, NMFS (2009) reinforced the conclusion that the Central Valley steelhead DPS is data deficient, with the exception of these hatchery programs.

From 1967-1993, steelhead run-size estimates were generated from fish counts in the fish ladder at RBDD (CDFG 2010a). From these counts, estimates of the natural spawner escapement upstream of RBDD were generated. Because RBDD impacted winter-run Chinook salmon by delaying their upstream migration, dam operations were changed in 1993 so that dam gates were raised earlier in the season, which eliminated the need for fish to navigate fish ladders, but also eliminated the ability to generate accurate run-size estimates for the upper Sacramento River Basin (CDFG 2010a).

Presently, little information is available regarding the abundance of steelhead in the Central Valley (CDFG 2010a). Currently there is virtually no coordinated, comprehensive, or consistent monitoring of steelhead in the Central Valley. In 2004, the
Interagency Ecological Program Steelhead Project Work Team developed a proposal to
develop a comprehensive monitoring plan for Central Valley steelhead. In 2007,
development of this steelhead monitoring plan was funded by the CALFED Ecosystem
Steelhead in the California Central Valley” was completed by CDFG (2010a), which
recommended steelhead monitoring activities in the Central Valley. The objectives of the
plan include: (1) estimate steelhead population abundance with levels of precision; (2)
examine trends in steelhead abundance; and (3) identify the spatial distribution of
steelhead in the Central Valley to assess their current range and observe changes in their
range that may occur over time. However, for the most part, recommendations in the
plan remain to be implemented.

According to NMFS (2009), data are lacking to suggest that the Central Valley steelhead
DPS is at low risk of extinction, or that there are viable populations of steelhead
anywhere in the DPS. Conversely, there is evidence to suggest that the Central Valley
steelhead DPS is at moderate or high risk of extinction (McEwan 2001; Good et al.
2005). Most of the historical habitat once available to steelhead has been lost (Yoshiyama
et al. 1996; McEwan 2001; Lindley et al. 2006). Furthermore, the observation that
anadromous *O. mykiss* are becoming rare in areas where they were probably once
abundant indicates that an important component of life history diversity is being
suppressed or lost (NMFS 2009). Habitat fragmentation, degradation, and loss are likely
having a strong negative impact on many resident as well as anadromous *O. mykiss*
populations (Hopelain 2003 as cited in NMFS 2009).

**VIABLE SALMONID POPULATION (VSP) PARAMETERS AND APPLICATION**

**ABUNDANCE AND PRODUCTIVITY**

According to NMFS (2009a) and CDFG (2010a), there is still a paucity of steelhead
monitoring in the Central Valley. Therefore, data are lacking regarding abundance
estimates for the steelhead DPS, or for specific steelhead populations in the Central
Valley (NMFS 2009a). Recognizing these data limitations, NMFS (2009a) suggested
that natural steelhead escapement in the upper Sacramento River declined substantially
from 1967 through 1993, and that the little data that do exist indicate that the steelhead
population continues to decline. Also, according to Lindley et al. (2007), even if there were adequate data on the distribution and abundance of steelhead in the Central Valley, their approaches for assessing steelhead population and DPS viability might be problematical because the effect of resident \textit{O. mykiss} on the viability of steelhead populations and the DPS is unknown.

**SPATIAL STRUCTURE**

For the Central Valley steelhead DPS, Lindley et al. (2006) identified historical independent populations based on a model that identifies discrete habitat and interconnected habitat patches isolated from one another by downstream regions of thermally unsuitable habitat. They hypothesized that historically 81 independent populations of steelhead were dispersed throughout the Central Valley domain.

About 80% of the habitat that was historically available to steelhead is now behind impassable dams, and 38% of the populations have lost all of their habitats (NMFS 2009a). Although much of the habitat has been blocked, or degraded, by impassable dams, small populations of steelhead are still found throughout habitat available in the Sacramento River and many of the tributaries, and some of the tributaries to the San Joaquin River. The current distribution of steelhead is less well understood, but the DPS is composed of at least four diversity groups and at least 26 populations (NMFS 2009).

Remnant steelhead populations are presently distributed through the mainstem of the Sacramento and San Joaquin rivers, as well as many of the major tributaries of these rivers (NMFS 2009). Steelhead presence in highly variable “flashy” streams and creeks in the Central Valley depend primarily on flow and water temperature, which can change drastically from year to year (McEwan and Jackson 1996). As stated in NMFS (2009), spawner surveys of small Sacramento River tributaries (Mill, Deer, Antelope, Clear, and Beegum creeks) and incidental captures of juvenile steelhead during Chinook salmon monitoring (Calaveras, Cosumnes, Stanislaus, Tuolumne, and Merced rivers) confirmed that steelhead are widespread, if not abundant, throughout accessible streams and rivers (Good et al. 2005).
DIVERSITY

Steelhead naturally experience the most diverse life history strategies of the listed Central Valley anadromous salmonid species (NMFS 2009a). However, steelhead has less flexibility to track changes in the environment as the species’ abundance decreases and spatial structure of the DPS is reduced (NMFS 2009a).

The posited historical existence of 81 independent steelhead populations is likely to be an underestimate because large watersheds that span a variety of hydrological and environmental conditions, such as the Pit River, probably contained multiple populations (Lindley et al. 2006). Regardless, the distribution of many discrete populations across a wide variety of environmental conditions implies that the Central Valley steelhead DPS contained biologically significant amounts of spatially structured genetic diversity (Lindley et al. 2006). However, it appears that much of the historical diversity within Central Valley *O. mykiss* has been lost or is threatened by dams, which have heavily altered the distribution and population structure of steelhead in the Central Valley (Lindley et al. 2006).

Although historically two different runs of steelhead (summer-run and winter-run) occurred in the Central Valley (McEwan and Jackson 1996), the summer run has been largely extirpated due to a lack of suitable holding and staging habitat, such as coldwater pools in the headwaters of Central Valley streams, presently located above impassible dams (Lindley et al. 2006).

Throughout the Central Valley (and in particular the Merced River, Tuolumne River, and upper Sacramento River) it is difficult to discriminate between adult anadromous and resident forms of *O. mykiss*, as well as their progeny (McEwan 2001), further complicating resource management agencies’ understanding of steelhead distribution in the Central Valley (CDFG 2008).

The genetic diversity of steelhead also is compromised by hatchery-origin fish. According to Reclamation (2008), estimates of straying rates only exist for Chinook salmon produced at the FRFH. However, general principles and the potential effects of straying are also applicable for steelhead. Based on available genetic data, the effects of hatcheries that rear steelhead appear to be restricted to the populations on hatchery
streams (DWR 2004c). These findings suggest that, although ongoing operations may impact the genetic composition of the naturally spawning steelhead population in these rivers, hatchery effects appear to be localized, although it should be noted that genetic data for steelhead are limited (DWR 2004c).

**SUMMARY OF THE VIABILITY OF THE CENTRAL VALLEY STEELHEAD DPS**

Although data are lacking to quantitatively evaluate extinction risk for the Central Valley steelhead DPS, NMFS (2009) states that there is evidence to suggest that the Central Valley steelhead DPS is at moderate or high risk of extinction. Steelhead have been extirpated from most of their historical range throughout the Central Valley domain, and most of the historical habitat once available to steelhead is largely inaccessible. Anadromous forms of *O. mykiss* are becoming less abundant or rare in areas where they were probably once abundant, and habitat fragmentation, degradation, and loss are likely having a strong negative impact on many resident as well as anadromous *O. mykiss* populations. In addition, widespread hatchery steelhead production within this DPS also raises concerns about the potential ecological interactions between introduced stocks and native stocks (Corps 2007).

As previously discussed, NMFS completed a 5-year status review of the Central Valley steelhead DPS during August 2011. Good et al. (2005) previously found that Central Valley steelhead were in danger of extinction, with a minority of the NMFS BRT viewing the DPS as likely to become endangered. The NMFS BRT’s primary concerns for the DPS included the low abundance of naturally-produced anadromous fish at the DPS level, the lack of population-level abundance data, and the lack of information to suggest that the monotonic decline in steelhead abundance evident from 1967-1993 dam counts has stopped (NMFS 2011c).

Steelhead population trend data remain extremely limited (Williams et al. 2011). The Chipps Island midwater trawl dataset of USFWS provides information on the trend in abundance for the Central Valley steelhead DPS as a whole. Updated through 2010, the trawl data indicate that the decline in natural production of steelhead has continued unabated since the 2005 status review (NMFS 2011c). Catch-per-unit-effort has fluctuated but remained level over the past decade, but the proportion of the catch that is
ad-clipped (100% of hatchery steelhead production have been ad-clipped starting in 1998) has risen steadily, exceeding 90% in recent years and reaching 95% in 2010 (NMFS 2011c). Because hatchery releases have been fairly constant, this implies that natural production of juvenile steelhead has been declining (NMFS 2011c).

According to NMFS (2011c), steelhead returns to the FRFH have decreased substantially in the last several years with only 679, 312 and 86 fish returning in 2008, 2009 and 2010, respectively. Because almost all of the returning fish are of hatchery origin and stocking levels have remained fairly constant over the years, data suggest that adverse freshwater and/or ocean survival conditions have caused or at least contribute to these declining hatchery returns (NMFS 2011c). The Central Valley experienced three consecutive years of drought (2007-2009), which NMFS (2011c) states would likely have impacted parr and smolt growth and survival. Additionally, poor ocean conditions have occurred in at least 2005 and 2006, which have affected Chinook populations in the Central Valley and also may have affected steelhead populations (NMFS 2011c). Preliminary return data for 2011 from CDFW suggest a strong rebound in return numbers during 2011, with 712 adults returning to the FRFH through April 5th (NMFS 2011c). Based on steelhead returns to Central Valley hatcheries and the redd counts on Clear Creek, the American River, and the Mokelumne River, it appears that naturally-produced steelhead may not have been impacted by poor freshwater and marine rearing conditions as much as hatchery-origin fish during the last several years (NMFS 2011c). However, NMFS (2011c) suggests that this observation may reflect greater fitness of naturally-produced steelhead relative to hatchery fish, and merits further study.

The steelhead DPS includes two hatchery populations — the FRFH and Coleman National Fish Hatchery. Two additional hatchery populations (i.e., Nimbus and Mokelumne River hatcheries) also are present in the Central Valley, but they were founded from out-of-DPS broodstock and are not considered part of the DPS (NMFS 2011c). Recent genetic information suggests that below dam populations of *O. mykiss* are similar genetically throughout the Central Valley and that genetic diversity and population structure may have been lost over time. Garza and Pearse (2008) analyzed the genetic relationships among Central Valley *O. mykiss* populations and found that all below-barrier populations were generally closely related, and that there was a high level
of genetic similarity to Eel River and Klamath River steelhead in all below-barrier population samples. These findings raises an issue about whether or not the steelhead stocks propagated at the Nimbus and Mokelumne River hatcheries should be excluded from the Central Valley steelhead DPS. These two stocks were excluded from the DPS in 2006 because they originated from the Eel River which is not from within the DPS. Because the Eel River strain appears to be widely introgressed in many Central Valley steelhead populations, NMFS (2011c) states that it may be appropriate to re-evaluate whether or not these stocks should be in the DPS based upon the new genetic information.

Using data through 2005, Lindley et al. (2007) found the data were insufficient to determine the status of any of the naturally-spawning populations of Central Valley steelhead, except for those spawning in rivers adjacent to hatcheries. These hatchery influenced populations were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas (NMFS 2011c).

Overall, the status of the Central Valley steelhead DPS appears to have worsened since the 2005 status review when the DPS was considered to be in danger of extinction (Good et al. 2005). Analysis of catch data from the Chipps Island monitoring program suggests that natural steelhead production has continued to decline and that hatchery origin fish represent an increasing proportion of the juvenile production in the Central Valley. Data from the Delta fish salvage facilities also suggests a general decline in the natural production of steelhead (NMFS 2011c). Data on Coleman and FRFH hatchery populations suggest they have declined in the last several years perhaps in response to poor freshwater and ocean habitat conditions. Limited information suggest some individual steelhead populations in the Central Valley are declining in abundance, but more complete data for the Battle Creek population indicate the declines there have been relatively moderate since 2005 and that the population in Clear Creek is increasing (NMFS 2011c).

One continuing area of strength for the Central Valley steelhead DPS is its widespread spatial distribution throughout most watersheds in the Central Valley. All of the factors originally identified as being responsible for the decline of this DPS are still present,
although in some cases they have been reduced by regulatory actions (e.g., NMFS CVP/SWP OCAP Biological Opinion in 2009, actions required by CVPIA). Good et al. (2005) described the threats to Central Valley salmon and steelhead as falling into three broad categories, including: (1) loss of historical spawning habitat; (2) degradation of remaining habitat; and (3) genetic threats from the stocking programs. Cummins et al. (2008) attributed the much reduced biological status of anadromous salmonid stocks in the Central Valley, including steelhead, to the construction and operation of the CVP and SWP. Important conservation efforts have been implemented including the 2009 CVP/SWP biological opinion, CVPIA restoration efforts, and continued efforts to implement the Battle Creek Restoration Project that will eventually open up 42 miles of high quality habitat to steelhead (NMFS 2011c). Although these efforts have provided benefits to steelhead and its habitat in the Central Valley, threats from lost habitat and degraded habitat continue to be important factors affecting the status of this DPS. Impacts to steelhead from harvest, research activities, disease and predation were considered relatively minor factors in previous reviews, and there is little or no evidence indicating impacts from these factors have changed (NMFS 2011c). In contrast, threats from other factors such as hatcheries, drought, poor ocean survival conditions, and climate change have not been addressed and/or they have increased since the 2005 status review and some are likely responsible for the recent declining abundance of the DPS (NMFS 2011c).

In summary, the most recent biological information suggests that the extinction risk of this DPS has increased since the last status review and that several of the listing factors have contributed to the decline, including recent years of drought and poor ocean conditions (NMFS 2011c). According to NMFS (2011c), there continue to be ongoing threats to the genetic integrity of naturally-spawning steelhead from Central Valley steelhead hatchery programs, but it is unclear if or how this factor has influenced the overall viability of the DPS. The best available information on the biological status of the DPS and continuing and new threats to the DPS indicate that its ESA status as a threatened species is appropriate (NMFS 2011c).
4.3.6.2 Lower Yuba River

As with all naturally-spawning populations of steelhead in the Central Valley, Lindley et al. (2007) characterized the steelhead population in the lower Yuba River as data deficient, and therefore did not characterize its viability. Data limitations, particularly regarding abundance and productivity, continue to render problematic quantitative estimation procedures to assess the viability of the steelhead population in the lower Yuba River. Continued monitoring of adult steelhead in the lower Yuba River is providing additional information that is needed to assess extinction risk based on Lindley et al. (2007) criteria regarding population size, recent population decline, occurrences of catastrophes within the last 10 years that could cause sudden shifts from a low risk state to a higher one, and the impacts of hatchery influence. The VSP parameters of abundance, productivity, spatial structure and diversity for the steelhead population in the lower Yuba River are discussed below.

Abundance and Productivity

VAKI Riverwatcher Data

Ongoing monitoring of the adult steelhead population in the lower Yuba River has been conducted since 2003 with VAKI Riverwatcher systems at Daguerre Point Dam. By contrast to Chinook salmon, escapement surveys involving carcass mark-recovery experiments are not performed on steelhead/O. mykiss.

In the lower Yuba River, silhouettes and corresponding photographs were examined for species identification and categorization using methodology similar to that which is described for spring-run Chinook salmon. However, the accurate identification of O. mykiss in the VAKI Riverwatcher is more difficult than it is for Chinook salmon.

By contrast to the identification of Chinook salmon which may be conducted with a single attribute, the identification of steelhead becomes more problematic with the absence of a defining silhouette or a clear digital photograph. Additionally, the silhouettes of steelhead cannot reliably be differentiated from resident rainbow trout, and photo documentation of an individual is problematic because adult steelhead typically immigrate during periods of high flow and associated high turbidity and low visibility.
The VAKI Riverwatcher systems cannot differentiate an individual as a resident form of the species (i.e., rainbow trout) or as anadromous (i.e., steelhead). Additionally, the VAKI Riverwatcher systems cannot directly distinguish between an adult or juvenile *O. mykiss* (RMT 2013).

**Differentiation of Adult Steelhead VAKI Riverwatcher Counts**

The silhouettes and/or electronic images of each fish passage event that was identified as an *O. mykiss* fish passage event allow the VAKI Riverwatcher systems to calculate an approximate length (in centimeters) for the observed fish.

As reported by the RMT (2013), as an initial step in the differentiation of adult steelhead passing upstream of Daguerre Point Dam, the length distribution of all fish identified as *O. mykiss* passing through both the north and south ladders at Daguerre Point Dam over the entire data availability period (January 1, 2004 through February 29, 2012) was plotted and visually examined (*Figure 4-10*). This figure indicates the possible presence of at least six length groups. These groups represent the potential combination of juvenile and adult anadromous *O. mykiss* (steelhead), as well as juvenile and adult resident *O. mykiss* (rainbow trout). However, this length-frequency distribution does not provide information necessary to differentiate between steelhead and rainbow trout.

Beginning March 1, 2009, VAKI Riverwatcher fish identified as *O. mykiss* also were classified as fish with or without clipped adipose fins, based on the inspection of the fish silhouette and photogrammetric representation (digital photographs and/or video imagery). The analysis of the length-frequency distribution of all adipose fin-clipped *O. mykiss* provides a means of differentiating adult steelhead passing upstream of Daguerre Point Dam from all other *O. mykiss*, because all adipose fin-clipped *O. mykiss* are steelhead that were released by a Central Valley hatchery.

The lengths of all fish passing upstream at Daguerre Point Dam that were identified as *O. mykiss* with clipped adipose fins (i.e., all hatchery steelhead) between March 1, 2009 through February 29, 2012 are presented in *Figure 4-11*. Visual examination of the observed length distribution in Figure 4-11 indicates the possible presence of up to five groups of fish. Two of the length categories demarcating the first two possible groups of fish occur at 20 cm (7.9 inches) and 29 cm (11.4 inches).
Figure 4-10. Length distribution of all fish identified by the VAKI Riverwatcher systems as *O. mykiss* passing upstream through the north and south ladders of Daguerre Point Dam from January 1, 2004 through February 29, 2012 (Source: RMT 2013).

Figure 4-11. Length distribution of all fish identified by the VAKI Riverwatcher systems as adipose clipped *O. mykiss* passing upstream through the north and south ladders of Daguerre Point Dam from March 1, 2009 through February 29, 2012 (Source: RMT 2013).
According to CDFG and USFWS (2010), the normal FRFH release schedule includes the release of steelhead yearlings, from January to February, released in the Feather River near Gridley at four fish per pound. Although not readily available from CDFW, other sources indicate that steelhead smolts averaging 4 to 5 fish per pound range in length from approximately 8-9 inches (20-23 cm) (IDFG 1992). The presence of small, adipose fin-clipped steelhead in the lower Yuba River as displayed in Figure 4-11 may be related to releases of yearling FRFH-produced steelhead on the Feather River.

Since 2007, the FRFH has been releasing only steelhead yearlings at various sites along the Feather River, as well as in the Sacramento River at Sutter Slough, and in Butte Creek (Table 4-10). To determine whether fish planted in the lower Feather River may have been detected in the lower Yuba River, an examination of the VAKI Riverwatcher data was conducted for adipose fin-clipped steelhead consistent with the observed potential length-mode demarcation length of 29 cm (11.4 in) (RMT 2013).

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<th>Untagged Adclipped</th>
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<td>Y</td>
<td>P</td>
<td>Feather River Boyds Pump Ramp</td>
<td>CDFG</td>
<td>CDFG</td>
</tr>
</tbody>
</table>

1 Tagged releases refer to releases with coded wire tags
2 Release stage Y indicates yearling releases.
3 Study type E stands for experimental releases, and study type P indicates a production releases.
From February 1, 2010 to February 2, 2011 (i.e., the starting date for the last reported release of adipose fin-clipped juvenile steelhead from the FRFH), 104 adipose fin-clipped juvenile steelhead with lengths less than or equal to 29 cm (11.4 in) were recorded passing upstream of Daguerre Point Dam. Most of these individuals were observed in the VAKI Riverwatcher system during February through April of 2010. Additionally, from February 2, 2011 through January 31, 2012, a total of 1,702 adipose fin-clipped steelhead with lengths less than or equal to 29 cm (11.4 in) were recorded passing upstream of Daguerre Point Dam. While these individuals were observed in the VAKI Riverwatcher system throughout calendar year 2011, they were most frequently observed during April and May of 2011. In other words, most of the observed adipose fin-clipped juvenile steelhead less than or equal to 29 cm (11.4 in) passing upstream of Daguerre Point Dam occurred within a few months after plantings of juvenile steelhead in the Feather River from the FRFH. Additionally, between February 2011 and January 2012, approximately 676 adipose fin-clipped steelhead with lengths less than or equal to 29 cm were recorded passing downstream of Daguerre Point Dam, with the majority of these individuals passing downstream during April through June. Therefore, approximately one-third of the presumed FRFH steelhead that migrated upstream of Daguerre Point Dam during 2011 apparently turned around and migrated back downstream of Daguerre Point Dam shortly after passing upstream of Daguerre Point Dam (RMT 2013).

If the observation of adipose fin-clipped juvenile steelhead passing upstream at Daguerre Point Dam is associated with the release of yearling steelhead from the FRFH into the lower Feather River, then it logically follows that the planted FRFH yearling steelhead would have had to swim 6 miles upstream from the planting location at Boyds Pump Ramp to the mouth of the lower Yuba River, and then an additional nearly 12 miles upstream to reach Daguerre Point Dam. Although this phenomenon may seem somewhat illogical, it has been reported elsewhere (Steiner Environmental Consulting 1987, as cited in RMT 2013) and is an explanation for the observation of adipose fin-clipped juvenile steelhead passing upstream at Daguerre Point Dam, because no marked juvenile steelhead have been reported to be released over this time frame into the lower Yuba River.

The length-frequency distribution of all adipose fin-clipped steelhead observed at Daguerre Point Dam from March 1, 2009 through February 29, 2012 was used to
differentiate between “juvenile” and “adult” steelhead. The second step in the separation of “juvenile” and “adult” steelhead was to fit modeled length-frequency distributions to the observed data to determine a threshold length to separate both fish groups. A detailed description of the analytical processes is provided in RMT (2013).

Unlike the methodology employed for Chinook salmon, the daily counts of adult steelhead passing upstream of Daguerre Point Dam were not corrected for days when the VAKI Riverwatcher systems were not fully operational. The RMT determined it would be inappropriate to attempt to correct the adult steelhead counts due to: (1) the relatively low numbers of adult steelhead recorded during most of the steelhead biological years; and (2) the frequently extended durations when the VAKI Riverwatcher systems were not fully operational during the steelhead immigration season. Instead, the daily counts of adult steelhead passing upstream at Daguerre Point Dam were used to represent the abundance of steelhead, with the understanding that the resultant estimates are minimum numbers, and most of the survey years considerably underestimate the potential number of steelhead because the annual estimates do not include periods of VAKI Riverwatcher system non-operation, and do not consider the fact that not all steelhead migrate past Daguerre Point Dam, due to some spawning occurring downstream Daguerre Point Dam.

**Assessment of Available VAKI Riverwatcher Data**

For assessment purposes, a “steelhead biological year” was identified as extending from August 1 through July 31 each year, because: (1) preliminary review of the VAKI Riverwatcher data indicated a general paucity of upstream migrant *O. mykiss* during early summer; (2) the immigration of adult steelhead in the lower Yuba River has been reported to occur beginning during August (CALFED and YCWA 2005; McEwan and Jackson 1996); and (3) the RMT (2010b) identified the steelhead upstream migration period as beginning during August in the lower Yuba River (RMT 2013).

**Annual Time Series of Steelhead Passing Upstream of Daguerre Point Dam**

Figures 4-12 through 4-16 illustrate the daily counts of adult steelhead passing upstream at Daguerre Point Dam through both the North and South ladders combined, and the
percentage of the daily number of hours when the VAKI Riverwatcher systems were operational at both ladders, during the eight steelhead biological years.

Examination of Figures 4-12 through 4-16 demonstrates that although the VAKI Riverwatcher systems have been in place since June of 2003, reliable estimates of the number of adult steelhead passing upstream at Daguerre Point Dam are essentially restricted to the last two years of available data (2010/2011 and 2011/2012).

Due to system failures, including equipment malfunctions and operationally detrimental environmental conditions (heavy overcast and foggy conditions resulting in lack of photovoltaic charging of the system), the VAKI Riverwatcher systems were partially operational or completely non-operational during several months each year of sampling. Additionally, high flows and turbidities reduced the ability of the system to identify, or prevented the system from identifying, adult steelhead oftentimes when the systems were operational. Although improvements to the system have been made over time, it was not until the most recent system improvements were implemented during the 2010/2011 sampling season that the system began demonstrating sustained reliability in the documentation of steelhead passing upstream of Daguerre Point Dam, over a range of environmental conditions.

Since June 2003, numerous improvements have been implemented to improve the reliability of the VAKI Riverwatcher systems, and particularly their ability to document passage during the steelhead upstream migration season. A chronology of the VAKI Riverwatcher system improvements that have occurred over time are described in RMT (2013).

This suite of improvements to the VAKI Riverwatcher systems at Daguerre Point Dam have resulted in much more reliable estimates of steelhead passing the dam. Correspondingly, the largest number of steelhead recorded immigrating past Daguerre Point Dam occurred during the 2010/2011 sampling season. As a result, it is not reasonable to consider data gathered prior to 2010/2011 to be reliable estimates of the annual number of adult steelhead passing upstream of Daguerre Point Dam (RMT 2013).
Figure 4-12. Daily counts of adult steelhead passing upstream of Daguerre Point Dam (dark green bars), and daily number of hours when the VAKI Riverwatcher systems were operational (light green bars), during the 2003/2004 and 2004/2005 steelhead biological years (August 1 through July 31) (Source: RMT 2013).
Figure 4-13. Daily counts of adult steelhead passing upstream Daguerre Point Dam (dark green bars), and daily number of hours when the VAKI Riverwatcher systems were operational (light green bars), during the 2005/2006 and 2006/2007 steelhead biological years (August 1 through July 31) (Source: RMT 2013).
Figure 4-14. Daily counts of adult steelhead passing upstream of Daguerre Point Dam (dark green bars), and daily number of hours when the VAKI Riverwatcher systems were operational (light green bars), during the 2007/2008 and 2008/2009 steelhead biological years (August 1 through July 31) (Source: RMT 2013).
Figure 4-15. Daily counts of adult steelhead passing upstream of Daguerre Point Dam (dark green bars), and daily number of hours when the VAKI Riverwatcher systems were operational (light green bars), during the 2009/2010 and 2010/2011 steelhead biological years (August 1 through July 31) (Source: RMT 2013).
As stated approximately six years ago by Lindley et al. (2006), there are almost no data with which to assess the status of any of the Central Valley steelhead populations, with the exceptions of the hatchery programs on Battle Creek and the Feather, American and Mokelumne rivers. Therefore, they classified Central Valley steelhead populations as data deficient. As of 2010, CDFG (2010a) stated that steelhead monitoring programs in the Central Valley lack statistical power, are not standardized and in many cases lack dedicated funding.

The relatively short time period encompassed by the reporting of reliable abundance estimates, and in consideration that steelhead may have returned to the lower Yuba River but remained and spawned in the river downstream of Daguerre Point Dam, currently render problematic the determination of abundance or trends in the productivity of the steelhead over recent years (RMT 2013). Continued implementation of the improved VAKI Riverwatcher systems at Daguerre Point Dam is likely to obtain some of the data necessary to allow abundance estimation and productivity evaluation of steelhead in the lower Yuba River. However, presently the lack of multi-year abundance data precludes...
the provision of quantitative values associated with extinction risk assessment, addressing abundance and productivity (RMT 2013).

**Spatial Structure**

Spatial structure and considerations regarding anadromous salmonid viability was presented for spring-run Chinook salmon previously in this BA. The spatial structure considerations, as one of the four VSP parameters, for steelhead are analogous to those for spring-run Chinook salmon previously presented. Namely, spatial structure of morphological units in the lower Yuba River is complex, diverse, and persistent.

**Diversity**

*Phenotypic Considerations*

*O. mykiss* in the lower Yuba River exhibit a high amount of diversity in phenotypic expression and life history strategy. As demonstrated in Figures 4-12 through 4-16, *O. mykiss* categorized as adult steelhead exhibit a broad temporal distribution in passing upstream of Daguerre Point Dam. *O. mykiss* (including steelhead) exhibit highly diverse spatial and temporal distributions in patterns of spawning, and juvenile outmigration (RMT 2013). Moreover, *O. mykiss* in the lower Yuba River exhibit polyphenism, or the occurrence of several phenotypes in a population which may not be due to different genetic types, including expressions of anadromy or residency. A thorough discussion of anadromy vs. residency of *O. mykiss* in the lower Yuba River is provided in RMT (2013).

A polymorphic *O. mykiss* population structure may be necessary for the long-term persistence in highly variable environments such as the Central Valley (McEwan 2001). Resident fish may reduce extinction risk through the production of anadromous individuals that can enhance weak steelhead populations (Lindley et al. 2007). Such considerations may be applicable to the *O. mykiss* populations in the lower Yuba River.

*Genetic Considerations*

Although no fish hatcheries have been located on the Yuba River since 1950, and the lower Yuba River continues to support a persistent population of steelhead, the genetic integrity of these fish is presently uncertain. According to the NMFS Draft Recovery
Plan (NMFS 2009a), the major threat to the genetic integrity of Central Valley steelhead results from past and present hatchery practices. These practices include the planting of non-natal fish, overlap of spawning hatchery and natural fish, and straying of hatchery fish.

The observation of adipose fin clips on adult steelhead passing upstream through the VAKI Riverwatcher system at Daguerre Point Dam demonstrates that hatchery straying into the lower Yuba River occurs. Although no information is presently available regarding the origin of adipose-clipped steelhead observed at the VAKI Riverwatcher system at Daguerre Point Dam, it is reasonable to surmise that they most likely originate from the FRFH.

As previously stated, analysis of the VAKI Riverwatcher data indicates that the percent contribution of hatchery-origin adult upstream migrating fish (represented by the percentage of adipose fin-clipped adult steelhead relative to the total number of adult upstream migrating steelhead, because 100% of FRFH-origin steelhead have been marked since 1996) was approximately 43% for the 2010/2011 biological year, and about 63% for the 2011/2012 biological year (RMT 2013). If hatchery-origin steelhead stray into the lower Yuba River and interbreed with naturally-spawning Yuba River steelhead, then such interbreeding has been suggested to represent a threat to the genetic diversity and integrity of the naturally-spawning steelhead population in the lower Yuba River. Nonetheless, the question remains regarding the implication of straying of hatchery-origin adult steelhead into the lower Yuba River, given past management practices. From 1970 to 1979, CDFW annually stocked 27,270–217,378 fingerlings, yearlings, and sub-catchable steelhead from Coleman National Fish Hatchery into the lower Yuba River (CDFG 1991a). CDFW stopped stocking steelhead into the lower Yuba River in 1979. In addition, as previously discussed, it is possible that some hatchery-reared juvenile steelhead from the FRFH may move into the lower Yuba River in search of rearing habitat. Some competition for resources with naturally spawned steelhead could occur as a result.

Garza and Pearse (2008) studied populations of *O. mykiss* in the Central Valley using molecular genetic techniques to provide insight into population structure in the region.
Genotypes were collected from over 1,600 individual fish from 17 population samples and five hatchery rainbow trout strains. Evaluated fish populations included those from the McCloud River, Battle Creek, Deer Creek, Butte Creek, Feather River, Yuba River, American River, Calaveras River, Stanislaus River and Tuolumne River sub-basins. Analyses included fish collected both above and below barriers to anadromy in some of the study basins (Garza and Pearse 2008).

Phylogeographic trees were used to visually and quantitatively evaluate genetic relationships of Central Valley *O. mykiss* populations both with each other and with other California populations. Genetic diversity was relatively similar throughout the Central Valley. 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. In phylogeographic analyses, above-barrier populations are more similar to San Francisco Bay *O. mykiss* populations than the below-barrier populations in the Central Valley. Because this relationship is expected for steelhead, given their extraordinary historic dependence on short distance migration events (Pearse and Garza 2007), they may represent relatively non-introgressed historic population genetic structure for the region. Other possible explanations for this pattern that rely on complicated, widespread patterns of introgression with hatchery fish are not entirely ruled out, but are highly improbable given that the above-barrier populations also group with moderate consistency into geographically-consistent clusters (e.g. Yuba-Upper and Feather-Upper) in all analyses and also because of the low apparent reproductive success of hatchery trout in streams throughout California (Garza and Pearse 2008).

The analyses also identified possible heterogeneity between samples from different tributaries of the upper Yuba and Feather Rivers, although linkage disequilibrium was lower in these populations. Linkage disequilibrium can be caused by physical linkage of
loci, sampling of related individuals/family structure, and by the sampling of more than one genetically distinct group within a population sample (Garza and Pearse 2008).

In general, although 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 (Garza and Pearse 2008). 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. 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).

The above discussions indicating that below-barrier populations of steelhead in the Central Valley, including the lower Yuba River (particularly in consideration of historic plantings and documented straying) likely do not accurately represent the ancestral population genetic structure. In other words, the current steelhead population in the lower Yuba River likely does not represent a “pure” ancestral genome (RMT 2013).

**Extinction Risk**

As stated approximately six years ago by Lindley et al. (2006), there are almost no data with which to assess the status of any of the Central Valley steelhead populations, with the exceptions of the hatchery programs on Battle Creek and the Feather, American and Mokelumne rivers. Therefore, they classified Central Valley steelhead populations, including the lower Yuba River, as data deficient.

According to NMFS (2009a), data are lacking to suggest that the Central Valley steelhead DPS is at low risk of extinction, or that there are viable populations of steelhead anywhere in the DPS. Lindley et al. (2007) stated that even if there were adequate data on the distribution and abundance of steelhead in the Central Valley, approaches for assessing steelhead population and DPS viability might be problematic because the effect of resident *O. mykiss* on the viability of steelhead populations and the DPS is unknown.
For the lower Yuba River, the data limitations previously discussed preclude multi-year abundance and trend analyses (RMT 2013). However, continued implementation of the improved VAKI Riverwatcher systems at Daguerre Point Dam is likely to obtain some of the data necessary to allow abundance estimation and productivity evaluation of steelhead in the lower Yuba River (RMT 2013). Moreover, the previous discussion regarding the limited applicability of VSP parameters and extinction risk criteria for spring-run Chinook salmon also pertain to steelhead in the lower Yuba River, in consideration of non-independent populations. For additional discussion, see RMT (2013).

4.3.7 Public Review Draft Recovery Plan Considerations

The discussion regarding recovery plan implementation provided for spring-run Chinook salmon in Section 4.2.8 of this BA also directly pertains to steelhead in the Yuba River Basin. Therefore, it is not repeated in this section of this BA.

4.4 Southern DPS of North American Green Sturgeon

The green sturgeon is the most widely distributed member of the sturgeon family Acipenseridae (70 FR 17386). North American green sturgeon are found in rivers from British Columbia south to the Sacramento River, California, and their ocean range is from the Bering Sea to Ensenada, Mexico. In assessing North American green sturgeon status, NMFS determined that two DPSs exist. The northern DPS is made up of known North American green sturgeon spawning (or single stock populations) in the Rogue, Klamath and Eel rivers. In 2005, the southern DPS was believed to contain only a single spawning population in the Sacramento River (70 FR 17386). However, four fertilized green sturgeon eggs collected in 2011 near the Thermalito Afterbay Outlet provide the first documentation of at least some successful spawning in the Feather River (A. Seesholtz, DWR, pers. comm., June 16, 2011).

The Southern DPS of North American green sturgeon (*Acipenser medirostrus*) was listed as a federally threatened species on April 7, 2006 (71 FR 17757) and includes the green sturgeon population spawning in the Sacramento River and utilizing the Sacramento-San
Joaquin River Delta, and San Francisco Estuary. NMFS (2009b) Draft Environmental Assessment for the Proposed Application of Protective Regulations Under Section 4(D) of the Endangered Species Act for the Threatened Southern Distinct Population Segment of North American Green Sturgeon indicated that the Southern DPS of North American green sturgeon faces several threats to its survival, including the loss of spawning habitat in the upper Sacramento River, and potentially in the Feather and Yuba rivers, due to migration barriers and instream alterations.

4.4.1 ESA Listing Status

On October 9, 2009, NMFS (74 FR 52300) designated critical habitat for the Southern DPS of North American green sturgeon. This designated critical habitat includes most of the DPS’s occupied range, including: (1) coastal marine waters from Monterey Bay to the Washington/Canada border; (2) coastal bays and estuaries in California, Oregon, and Washington; and (3) fresh water rivers in the Central Valley, California. In the Central Valley, critical habitat for green sturgeon includes the Sacramento River, lower Feather River, lower Yuba River, the Sacramento-San Joaquin River Delta, and San Francisco Estuary. NMFS (74 FR 52300) defined specific habitat areas in the Sacramento, Feather, and Yuba rivers in California to include riverine habitat from each river mouth upstream to and including the furthest known site of historic and/or current sighting or capture of North American green sturgeon, as long as the site is still accessible. Critical habitat in the lower Yuba River includes the stream channels to the ordinary high water line extending from the confluence with the mainstem Feather River upstream to Daguerre Point Dam.

Section 4(c)(2) of the ESA requires that NMFS review the status of listed species under its authority at least every five years and determine whether any species should be removed from the list or have its listing status changed. In October 2012, NMFS noticed the initiation of the 5-year status review of the Southern DPS of North American green sturgeon (77 FR 64959).

The purpose of the 5-year review is to ensure the accuracy of the listing classification for the Southern DPS of North American green sturgeon. A 5-year review is based on the
best scientific and commercial data available; therefore, NMFS is requesting submission
of any such information on the Southern DPS that has become available since the listing
determination in 2006. To ensure that the 5-year review is complete and based on the
best available scientific and commercial information, NMFS is soliciting new
information from the public, governmental agencies, Tribes, the scientific community,
industry, environmental entities, and any other interested parties concerning the status of
the Southern DPS since the listing determination in 2006 (77 FR 64959).

4.4.2 Critical Habitat Designation

The essential physical and biological habitat features identified for the Southern DPS of
North American green sturgeon include food resources (e.g., benthic invertebrates and
small fish), substrate types (i.e., appropriate spawning substrates within freshwater
rivers), water flow (particularly in freshwater rivers), water quality, water depth,
migratory corridors, and sediment quality. The following summary descriptions of the
current conditions of the freshwater PCEs for the Central Valley steelhead DPS were
taken from the 2009 NMFS OCAP BO (NMFS 2009a) and the 2009 NMFS Draft
Biological and Conference Opinion for the Federal Energy Regulatory Commission’s
(FERC) Relicensing of the California Department of Water Resources Oroville Facilities
(FERC Project No. 2100-134) (NMFS 2009d).

4.4.2.1 Primary Constituent Elements

Freshwater Riverine Systems

Food Resources

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

**Substrate Type or Size**

Suitable freshwater riverine system habitat includes substrates suitable for egg deposition and development (e.g., cobble, gravel, or bedrock sills and shelves with interstices or irregular surfaces to “collect” eggs and provide protection from predators, and free of excessive silt and debris that could smother eggs during incubation), larval development (e.g., substrates with interstices or voids providing refuge from predators and from high flow conditions), and sub-adults and adult lifestages (e.g., substrates for holding and spawning). Stream surveys by USFWS and Reclamation biologists have identified approximately 54 suitable holes and pools between Keswick Dam and the GCID diversion that would support spawning or holding activities for green sturgeon, based on identified physical criteria. Many of these locations are at the confluences of tributaries with the mainstem Sacramento River or at bend pools. Observations of channel type and substrate compositions during these surveys indicate that appropriate substrate is available in the Sacramento River between Keswick Dam and the GCID diversion. Ongoing surveys are anticipated to further identify river reaches in the upper river with suitable substrate characteristics and their utilization by green sturgeon.
**WATER FLOW**

An adequate flow regime (i.e., magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) is necessary for normal behavior, growth, and survival of all lifestages in the upper Sacramento River. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11-19°C) (Cech et al. 2000; Mayfield and Cech 2004; Van Eenennaam et al. 2005; Allen et al. 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning success is more associated with water flow and water temperature than compared with other variables. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs (Brown 2007). Post-spawning downstream migrations are triggered by increased flows, ranging from 6,150-14,725 cfs in the late summer (Vogel 2005) and greater than 3,550 cfs in the winter (Erickson et al. 2002; Benson et al. 2007). The current suitability of these flow requirements is almost entirely dependent on releases from Shasta Dam. High winter flows associated with the natural hydrograph do not occur within the section of the river utilized by green sturgeon with the frequency and duration that occurred during pre-dam conditions.

**WATER QUALITY**

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics necessary for normal behavior, growth, and viability of all green sturgeon lifestages, is required for the proper functioning of the freshwater habitat. Suitable water temperatures include: (1) stable water temperatures within spawning reaches (wide fluctuations could increase egg mortality or deformities in developing embryos); (2) water temperatures within 51.8-62.6°F (optimal range = 57.2-60.8°F) in spawning reaches for egg incubation (March-August) (Van Eenennaam et al. 2005); (3) water temperatures below 68°F for larval development (Werner et al. 2007 as cited in...
NMFS 2009a); and (4) water temperatures below 75.2°F for juveniles (Mayfield and Cech 2004; Allen et al. 2006). Due to the temperature management of the releases from Keswick Dam for winter-run Chinook salmon in the upper Sacramento River, water temperatures in the river reaches utilized currently by green sturgeon appear to be suitable for proper egg development and larval and juvenile rearing. Suitable salinity levels range from fresh water [<3 parts per thousand (ppt)] for larvae and early juveniles [to about 100 days post hatch (dph)] to brackish water (10 ppt) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech 2007). Salinity levels are suitable for green sturgeon in the Sacramento River and freshwater portions of the Delta for early lifestages. Adequate levels of DO are needed to support oxygen consumption by early lifestages (Allen and Cech 2007). Current DO levels in the mainstem Sacramento River are suitable to support the growth and migration of green sturgeon. Suitable water quality also includes water free of contaminants (i.e., pesticides, organochlorines, elevated levels of heavy metals, etc.) that may disrupt normal development of embryonic, larval, and juvenile lifestages of green sturgeon. Legacy contaminants such as mercury still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River Basin.

**WATER DEPTH**

Pools of ≥ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River upstream of the GCID diversion. The significance and purpose of these aggregations are unknown at the present time, although it is likely that they are the result of an intrinsic behavioral characteristic of green sturgeon. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from high water temperatures (Erickson et al. 2002; Benson et al. 2007). As described above, approximately 54 pools with adequate depth have been identified in the Sacramento River upstream of the GCID diversion.
**Migration Corridor**

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

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

Closure of the gates at RBDD from May 15 through September 15 previously precluded all access to spawning grounds above the dam during that time period. However, as previously discussed, the RBDD gates were permanently raised in September 2011.

Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD during May, June, and July. Juvenile green sturgeon are likely subjected to the same predation and turbulence stressors caused by RBDD as the juvenile anadromous salmonids, leading to diminished survival through the structure and waters immediately downstream.

**Sediment Quality**

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

**ESTUARINE HABITAT AREAS**

**FOOD RESOURCES**

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

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

**WATER QUALITY**

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth, and viability of all lifestages. Suitable water temperatures for juvenile green sturgeon should be below 75°F. At temperatures above 75.2°F, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and Cech 2004) and increased cellular stress (Allen et al. 2006). Suitable salinities in the estuary range from brackish water (10 ppt) to salt water (33 ppt). Juveniles transitioning from brackish to salt water can tolerate prolonged exposure to salt water salinities, but may exhibit decreased growth and activity levels (Allen and Cech 2007), whereas sub-adults and adults tolerate a wide range of salinities (Kelly et al. 2007 as cited in Reclamation 2008). Sub-adult and adult green sturgeon occupy a wide range of DO levels, but may need a minimum DO level of at least 6.54 mg O2/l (Kelly et al. 2007 as cited in Reclamation 2008; Moser and Lindley 2007 as cited in Reclamation 2008). Suitable water quality also includes water free of contaminants, as described above. In general, water quality in the Delta and estuary meets these criteria, but local areas of the Delta and downstream bays have been identified as having deficiencies. Water quality in the areas such as the Stockton turning basin and Port of Stockton routinely have depletions of DO and episodes of first flush contaminants from the surrounding industrial and urban watershed. Discharges of agricultural drain water have also been implicated in local elevations of pesticides and other related agricultural compounds within the Delta and the tributaries and sloughs feeding into the Delta.
Discharges from petroleum refineries in Suisun and San Pablo Bay have been identified as sources of selenium to the local aquatic ecosystem (Linville et al. 2002).

**Water Depth**

A diversity of depths is necessary for shelter, foraging, and migration of juvenile, sub-adult, and adult lifestages. Sub-adult and adult green sturgeon occupy deep (≥ 5 m) holding pools within bays and estuaries as well as within freshwater rivers. These deep holding pools may be important for feeding and energy conservation, and may serve as thermal refugia for sub-adult and adult green sturgeon (Benson et al. 2007). Tagged adults and sub-adults within the San Francisco Bay estuary primarily occupied waters with depths of less than 10 m, either swimming near the surface or foraging along the bottom (Kelly et al. 2007 as cited in Reclamation 2008). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 3 to 8 feet deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke 1966). Thus, a diversity of depths is important to support different lifestages and habitat uses for green sturgeon within estuarine areas.

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

**Migration Corridor**

Within the waterways comprising the Delta and bays downstream of the Sacramento River, unobstructed passage is needed for juvenile green sturgeon during the rearing
phase of their life cycle. Rearing fish need the ability to freely migrate from the river through the estuarine waterways of the Delta and bays and eventually out into the ocean. Passage within the bays and the Delta is also critical for adults and sub-adults for feeding and summer holding, as well as to access the Sacramento River for their upstream spawning migrations and to make their outmigration back into the ocean. Within bays and estuaries outside of the Delta and the areas comprised by Suisun, San Pablo, and San Francisco bays, unobstructed passage is necessary for adult and sub-adult green sturgeon to access feeding areas, holding areas, and thermal refugia, and to ensure passage back out into the ocean. Currently, unobstructed passage has been diminished by human actions in the Delta and bays. The CVP and SWP water projects alter flow patterns in the Delta due to export pumping and create entrainment issues in the Delta at the pumping and fish facilities.

Power generation facilities in Suisun Bay create risks of entrainment and thermal barriers through their cooling water diversions and discharges. Installation of seasonal barriers in the South Delta and operations of the radial gates in the Delta Cross Channel facilities alter migration corridors available to green sturgeon. Actions such as the hydraulic dredging of ship channels and operations of large ocean going vessels create additional sources of risk to green sturgeon within the estuary. Hydraulic dredging can result in the entrainment of fish into the dredger’s hydraulic cutterhead intake. Commercial shipping traffic can result in the loss of fish, particularly adult fish, through ship and propeller strikes.

**SEDIMENT QUALITY**

Sediment quality (i.e., chemical characteristics) is necessary for normal behavior, growth, and viability of all lifestages. This includes sediments free of contaminants (e.g., elevated levels of selenium, polycyclic aromatic hydrocarbons [PAHs], and organochlorine pesticides) that can cause negative effects on all lifestages of green sturgeon (see description of sediment quality for riverine habitats above).
4.4.3 Historical Distribution and Abundance

Green sturgeon are widely distributed along the Pacific Coast, have been documented offshore from Ensenada, Mexico, to the Bering Sea, and are found in rivers from British Columbia to the Sacramento River (Moyle 2002). As is the case for most sturgeon, the Southern DPS of North American green sturgeon are anadromous; however, they are the most marine-oriented of the sturgeon species (Moyle 2002).

The historical distribution of green sturgeon in the Sacramento-San Joaquin river basins is poorly documented, but Adams et al. (2007) summarizes information that suggests that green sturgeon may have been distributed above the locations of present-day dams on the Sacramento and Feather rivers (Mora et al. 2009). Historical records from the 1930s indicate that green sturgeon were not listed as either “known to occur” or “presumed to occur” in the Yuba or American Rivers (Sumner and Smith 1939; Evermann and Clark 1931).

According to NMFS (2009a), spawning populations of green sturgeon in North America are currently found in only three river systems: the Sacramento and Klamath rivers in California and the Rogue River in southern Oregon. Data from commercial trawl fisheries and tagging studies indicate that the green sturgeon occupy ocean waters down to the 110 meter contour (Erickson and Hightower 2007). During the late summer and early fall, sub-adults and non-spawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett et al. 1991; Moser and Lindley 2007 as cited in Reclamation 2008). Particularly large concentrations of green sturgeon from both the northern and southern populations occur in the Columbia River estuary, Willapa Bay, Grays Harbor and Winchester Bay, with smaller aggregations in Humboldt Bay, Tillamook Bay, Nehalem Bay, and San Francisco and San Pablo bays (Emmett et al. 1991; Moyle et al. 1992 as cited in Reclamation 2008; Beamesderfer et al. 2007). Lindley et al. (2008) reported that green sturgeon make seasonal migratory movements along the west coast of North America, overwintering north of Vancouver Island and south of Cape Spencer, Alaska. Individual fish from the Southern DPS of green sturgeon have been detected in these seasonal aggregations. Information regarding the migration and habitat use of green sturgeon has recently emerged. Lindley (2006 as cited in NMFS 2009a)
presented preliminary results of large-scale green sturgeon migration studies, and verified past population structure delineations based on genetic work and found frequent large-scale migrations of green sturgeon along the Pacific Coast. This work was further expanded by recent tagging studies of green sturgeon conducted by Erickson and Hightower (2007) and Lindley et al. (2008). To date, the data indicate that green sturgeon are migrating considerable distances up the Pacific Coast into other estuaries, particularly the Columbia River estuary. This information also agrees with the results of previous green sturgeon tagging studies (CDFG 2002), where CDFW tagged a total of 233 green sturgeon in the San Pablo Bay estuary between 1954 and 2001. A total of 17 tagged fish were recovered: 3 in the Sacramento-San Joaquin Estuary, 2 in the Pacific Ocean off of California, and 12 from commercial fisheries off of the Oregon and Washington coasts. Eight of the 12 commercial fisheries recoveries were in the Columbia River estuary (CDFG 2002).

In the lower Feather River, green sturgeon have intermittently been observed (Beamesderfer et al. 2007). NMFS (2008b) states that the presence of adult, and possibly sub-adult, green sturgeon within the lower Feather River has been confirmed by photographs, anglers’ descriptions of fish catches (P. Foley, pers. comm. cited in CDFG 2002), incidental sightings (DWR 2005), and occasional catches of green sturgeon reported by fishing guides (Beamesderfer et al. 2004).

In the mid-1970s, green sturgeon were caught each year on the Feather River, with the majority of catches occurring from March to May and a few additional catches occurring in July and August (USFWS 1995). In 1993, seven adult green sturgeon were captured at the Thermalito Afterbay Outlet, ranging in size from 60.9 to more than 73.2 inches (USFWS 1995). In a broad scale survey from 1999 to 2001, green sturgeon were infrequently observed within the area downstream of the Thermalito Afterbay Outlet and none observed upstream (DWR 2003a). In 2006, four green sturgeon were positively identified by DWR biologist near the Thermalito Afterbay Outlet. Eight additional sturgeon were also observed in the same area but could not be positively identified as green sturgeon (DWR 2007a as cited in Reclamation 2008).
Although adult green sturgeon occurrence in the Feather River has been previously documented, larval and juvenile green sturgeon have not been collected despite attempts to collect larval and juvenile sturgeon during early spring through summer using rotary screw traps, artificial substrates, and larval nets deployed at multiple locations (Seesholtz et al. 2003). Moreover, unspecific past reports of green sturgeon spawning (Wang, 1986; USFWS 1995; CDFG 2002) have not been corroborated by observations of young fish or significant numbers of adults in focused sampling efforts (Niggemeyer and Duster 2003; Seesholz et al. 2003; Beamesderfer et al. 2004). Based on these results, in 2006, NMFS concluded that an effective population of spawning green sturgeon did not exist in the lower Feather River (71 FR 17757). However, four fertilized green sturgeon eggs were collected near the Thermalito Afterbay Outlet on June 14, 2011, thus providing the first documentation of at least some successful spawning in the Feather River (A. Seesholtz, DWR, pers. comm., June 16, 2011).

Historical accounts of sturgeon in the Yuba River have been reported by anglers, but these accounts do not specify whether the fish were white or green sturgeon (Beamesderfer et al. 2004). Since the 1970s, numerous surveys of the lower Yuba River downstream of Englebright Dam have been conducted, including annual salmon carcass surveys, snorkel surveys, beach seining, electrofishing, rotary screw trapping, redd surveys, and other monitoring and evaluation activities. Over the many years of these surveys and monitoring of the lower Yuba River, only one confirmed observation of an adult green sturgeon has occurred prior to 2011. The NMFS September 2008 Draft Biological Report, Proposed Designation of Critical Habitat for the Southern Distinct Population Segment of North American Green Sturgeon (NMFS 2008a) states that of the three adult or sub-adult sturgeon observed in the Yuba River below Daguerre Point Dam during 2006, only one was confirmed to be a green sturgeon, and that “Spawning is possible in the river, but has not been confirmed and is less likely to occur in the Yuba River than in the Feather River. No green sturgeon juveniles, larvae, or eggs have been observed in the lower Yuba River to date.”

As part of ongoing sturgeon monitoring efforts in the Feather River Basin under the AFRP, Cramer Fish Sciences conducted roving underwater video surveys in the lower Feather and lower Yuba rivers using a drop-down camera suspended from a motorized
boat. On May 24, 25 and 26, 2011, underwater videographic monitoring was conducted in the lower Yuba River downstream of Daguerre Point Dam. Although results are preliminary, a memorandum dated June 7, 2011 Cramer Fish Sciences (2011) stated that they observed what they believed were 4-5 green sturgeon near the center of the channel at the edge of the bubble curtain below Daguerre Point Dam. The sturgeon were observed either on a gravel bar approximately 1.5 m deep, or in a pool approximately 4 m deep immediately adjacent to the gravel bar. Photographs taken by Cramer Fish Sciences (2011) were forwarded to green sturgeon experts. Olaf P. Langness, Sturgeon and Smelt Projects, Washington Department of Fish and Wildlife Region 5, expressed the opinion that the photographs were of green (rather than white) sturgeon. Also, David Woodbury, NMFS Sturgeon Recovery Coordinator, expressed his opinion that the fish in the photographs were green sturgeon.

During 2012, underwater videography also was used in an attempt to document the presence of green sturgeon downstream of Daguerre Point Dam, but no observations of green sturgeon were made.

YCWA (2013) examined the potential occurrence of green sturgeon in the lowermost 24 miles of the Yuba River based on detections of acoustically-tagged green sturgeon in the Yuba River. The examination included coordination with agencies and organizations involved with green sturgeon research in the Central Valley, and collection of available information and data regarding the presence and use of the Yuba River by green sturgeon. YCWA collaborated with DWR's Feather River Program, the California Fish Tracking Consortium (CFTC), and CDFW's Heritage and Wild Trout and Steelhead Management and Recovery Programs to examine whether any of the acoustically-tagged green sturgeon were found in the lower Yuba River. The CFTC is tracking 217 green sturgeon acoustically tagged in the Central Valley, and DWR's Feather River Program has acoustically tagged 2 green sturgeon in the lower Feather River.

None of the 217 green sturgeon acoustically-tagged in the Central Valley were detected in the Yuba River, with the exception of one fish tagged by DWR in the Feather River. This individual fish was detected once on September 6, 2011 in the Yuba River by the CDFW’s lowermost acoustic receiver located at the confluence of the Yuba and Feather river.
That fish also was detected upstream in the Feather River earlier on the same day and downstream in the Sacramento River on the evening of September 6, 2011. Therefore, the fish apparently only entered the mouth of the lower Yuba River for a very brief period of time before continuing its downstream migration in the Feather and Sacramento rivers.

### 4.4.4 General Life History and Habitat Requirements

Limited information regarding green sturgeon distribution, movement and behavioral patterns, as well as lifestage-specific habitat utilization preferences, is available for the Sacramento and Feather rivers.

#### 4.4.4.1 Adult Immigration, Holding and Emigration

Green sturgeon in the Sacramento River have been documented and studied more widely than they have in either the Feather or the Yuba rivers. Green sturgeon adults in the Sacramento River are reported to begin their upstream spawning migrations into freshwater during late February, before spawning between March and July, with peak spawning believed to occur between April and June (Adams et al. 2002). NMFS (2009) reports that, based on recent data gathered from acoustically tagged adult green sturgeon, these fish migrate upstream during May as far as the mouth of Cow Creek, near Bend Bridge on the Sacramento River.

For the Sacramento River, NMFS (2009) reports that adult green sturgeon prefer deep holes (≥ 5 m depth) at the mouths of tributary streams, where they spawn and rest on the bottom. After spawning, the adults hold over in the upper Sacramento River between RBDD and the GCID diversion until November (Klimley 2007). Heublein et al. (2006, 2009) reported the presence of adults in the Sacramento River during the spring through the fall into the early winter months, holding in upstream locations before their emigration from the system later in the year. Green sturgeon downstream migration appears to be triggered by increased flows and decreasing water temperatures, and occurs rapidly once initiated (NMFS 2009). Some adult green sturgeon rapidly leave the system following their suspected spawning activity and re-enter the ocean in early summer.
(Heublein 2006). NMFS (2009) states that green sturgeon larvae and juveniles are routinely observed in rotary screw traps at RBDD and the GCID diversion, indicating that spawning occurs upstream of both these sites.

Before the studies conducted by UC Davis, there were few empirical observations of green sturgeon movement in the Sacramento River (Heublein et al. 2009). The study by Heublein et al. (2009) is reportedly the first to describe the characteristics of the adult green sturgeon migration in the Sacramento River, and to identify putative regions of spawning habitat, based on the recorded movements of free-swimming adults.

The Sacramento River adjacent to the GCID diversion routinely contains a large aggregation of green sturgeon during summer and fall months, although the GCID aggregation site is atypical of over-summering habitats in other systems, being an area of high water velocity (Heublein et al. 2009). The GCID site is over five meters deep, with structural current refuges and eddy formations. It is possible that green sturgeon occupy lower-velocity subsections of the site, although observations of green sturgeon capture, and manual tracking estimates, indicate that green sturgeon are found in, or in very close proximity to, high velocity areas (Heublein et al. 2009).

4.4.4.2 Adult Spawning

Adult green sturgeon are believed to spawn every two to five years (Beamesderfer et al. 2007). Upon maturation of their gonadal tissue, but prior to ovulation or spermiation, the adult fish enter freshwater and migrate upriver to their spawning grounds (NMFS 2009a). Heublein et al. (2009) observed that green sturgeon enter San Francisco Bay in March and April and migrate rapidly up the Sacramento River to the region between GCID and Cow Creek. The fish lingered at these regions at the apex of their migration for 14 to 51 days, presumably engaged in spawning behavior, before moving back downriver (Heublein et al. 2009).

To investigate adult immigration, spawning or juvenile nursery habits of green sturgeon in the upper Sacramento River, Brown (2007) developed a study to identify green sturgeon spawning locations and dates in the upper Sacramento River. Using a depth finder, study sites were selected at locations upstream of deeper holes in higher velocity
water in the Sacramento River (Brown 2007). The study was originally designed in 1997 using the prevalent methodology at the time (e.g., artificial substrate mats) for the capture of eggs and larvae of white sturgeon. Brown (2007) reports that later findings from artificial spawning and larval rearing of green sturgeon (Van Eenennaam et al. 2001) indicate that green sturgeon eggs may be less adhesive than eggs from other acipenserids, possibly reducing the effectiveness of artificial substrate sampling.

Brown (2007) suggested that spawning in the Sacramento River may occur from April to June, and that the potential spawning period may extend from late April through July, as indicated by the rotary screw trap data at the RBDD from 1994 to 2000.

Heublein et al. (2009) stated that, in contrast to the behavior of green sturgeon observed during 2004–2005, the majority of out-migrants detected in 2006 displayed an entirely different movement strategy. Nine of the ten tagged fish detected that year exited the system with no extended hold-over period and with no apparent relation to flow increases, eight leaving before July 4th and the last on August 22nd. Heublein et al. (2009) suggested that the rapid out-migration of green sturgeon in 2006, and the reduced aggregation period at the GCID site could be a result of consistently higher flows and lower temperatures than in previous study years. Alternatively, this could be an unusual behavior, related to unknown cues, that has not been documented in green sturgeon before this study (Heublein et al. 2009).

The apex detections of individual fish indicate reaches and dates when spawning might have occurred during the study conducted by Heublein et al. (2009). They reported that spawning may have occurred between May and July, and that high water velocities and extensive bedrock habitat were found in all of the apex detection reaches. Furthermore, water temperatures did not exceed 62.6°F in these reaches during this study, which would have permitted normal green sturgeon larval development (Van Eenennaam et al. 2005 as cited in Heublein et al. 2009).

The Sacramento River currently hosts the only known spawning population of green sturgeon (Poytress et al. 2010). During 2009, four spawning sites of green sturgeon were confirmed in the upper Sacramento River (Poytress et al. 2010). Three confirmed sites
from 2008 surveys were reconfirmed and one of three newly sampled sites in 2009 was confirmed by the presence of green sturgeon eggs on artificial substrate mats.

During 2010, five spawning sites of green sturgeon were confirmed within a 60 river kilometer reach of the upper Sacramento River, California (Poytress et al. 2011). As stated by Poytress et al. (2010), spawning events occurred several river kilometers upstream and downstream of the RBDD before and after the June 15th seasonal dam gate closure. Spawning occurred directly below RBDD within two weeks after the gate closure. The temporal distribution pattern suggested by 2009 sampling results indicates spawning of Sacramento River green sturgeon occurs from early April through late June (Poytress et al. 2010). Sampling conducted during 2010 suggested that spawning of Sacramento River green sturgeon occurs from early April through mid-June (Poytress et al. 2011). During 2010 sampling, depths for eggs collected from all of the sites combined ranged from 2.4 to 10.9 m (7.9 to 35.8 ft) with an average of 6.9 m (22.6 ft). Sacramento River flows and water temperatures at sites located above RBDD during the estimated spawning period ranged from 166 to 459 m3s-1 (5,862 cfs to 16,209 cfs), with an average of 293 m3s-1 (10,347 cfs), and 52.0°F to 57.9°F during the estimated spawning period. Sacramento River flows and temperatures at sites located below RBDD during the estimated spawning period ranged from 268 to 509 m3s-1 (9,464 cfs to 17,975 cfs), with an average of 349 m3s-1 (12,324 cfs), and 52.9°F to 60.1°F during the estimated spawning period (Poytress et al. 2011).

The habitat requirements of green sturgeon are not well known. Eggs are likely broadcast and externally fertilized in relatively fast water and probably in depths greater than three meters (Moyle 2002). Preferred spawning substrate is likely large cobble where eggs settle into cracks, but spawning substrate can range from clean sand to bedrock (Moyle 2002). Spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett et al. 1991; Moyle et al. 1995). Eggs likely adhere to substrates, or settle into crevices between substrates (Van Eenennaam et al. 2001; Deng et al. 2002). Both embryos and larvae exhibited a strong affinity for benthic structure during laboratory studies (Van Eenennaam et al. 2001; Deng et al. 2002; Kynard et al. 2005), and may seek refuge within crevices, but use flat-
surfaced substrates for foraging (Nguyen and Crocker 2007 as cited in NMFS 2009a).

4.4.4.3 Embryo Incubation

Green sturgeon larvae hatch from fertilized eggs after approximately 169 hours of incubation at a water temperature of 59°F (Van Eenennaam et al. 2001; Deng et al. 2002), which is similar to the sympatric white sturgeon development rate (176 hours). Van Eenennaam et al. (2005) indicated that an optimum range of water temperatures for egg development was between 57.2°F and 62.6°F. Water temperatures over 73.4°F resulted in 100% mortality of fertilized eggs before hatching. Water temperatures above 68°F are reportedly lethal to green sturgeon embryos (Cech et al. 2000; Beamesderfer and Webb 2002).

Newly hatched green sturgeon are approximately 12.5 to 14.5 mm long. After approximately 10 days, larvae begin feeding and growing rapidly. Green sturgeon larvae do not exhibit the initial pelagic swim-up behavior characteristic of other Acipenseridae. They are strongly oriented to the bottom and exhibit nocturnal activity patterns. Under laboratory conditions, green sturgeon larvae cling to the bottom during the day, and move into the water column at night (Van Eenennaam et al. 2001). After six days, the larvae exhibit nocturnal swim-up activity (Deng et al. 2002) and nocturnal downstream migrational movements (Kynard et al. 2005). Exogenous feeding starts at approximately 14 days (23 to 25 mm) (Van Eenennaam et al. 2001).

4.4.4.4 Juvenile Rearing

Green sturgeon larvae do not exhibit the initial pelagic swim–up behavior characteristic of other acipenseridae. They are strongly oriented to the bottom and exhibit nocturnal activity patterns (NMFS 2009a). After 6 days, the larvae exhibit nocturnal swim-up activity (Deng et al. 2002) and nocturnal downstream migrational movements (Kynard et al. 2005). Juvenile fish continue to exhibit nocturnal behavior beyond the metamorphosis from larvae to juvenile stages (NMFS 2009a). Kynard et al. (2005) laboratory studies indicated that juvenile fish continued to migrate downstream at night for the first six months of life. Observations made during nocturnal sampling in the Sacramento River
indicate a possible preference of larvae for mid-channel environments or swift water velocity areas (Poytress et al. 2010). When ambient water temperatures reached 8°C (46.4°F), downstream migrational behavior diminished and holding behavior increased (Kynard et al. 2005). This data suggests that 9 to 10 month old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds (NMFS 2009a).

Post-migrant larvae are benthic, foraging up- and downstream diurnally with a nocturnal activity peak (NMFS 2009a). Foraging larvae select open habitat, not structure habitat, but continue to use cover during the day (NMFS 2009a).

As reported in Corps (2007a), metamorphosis to the juvenile stage is complete at 45 days, and juveniles continue to grow rapidly, reaching 300 mm in one year. Juveniles spend from one to four years in fresh and estuarine waters and disperse into salt water at lengths of 300 to 750 mm (Corps 2007a).

The primary diet for juvenile green sturgeon reportedly consists of small crustaceans, such as amphipods and opossum shrimp (CDFG 2001). As juvenile green sturgeon develop, they reportedly eat a wider variety of benthic invertebrates, including clams, crabs, and shrimp (CDFG 2001).

Green sturgeon juveniles tested under laboratory conditions had optimal bioenergetic performance (i.e., growth, food conversion, swimming ability) between 59°F and 66.2°F under either full or reduced rations (Mayfield and Cech 2004).

Larvae and juvenile green sturgeon appear to be nocturnal (Cech et al. 2000), which may protect them from downstream displacement (LCFRB 2004). Green sturgeon larvae and juveniles (up to day 84) forage day and night, but activity is reported to peak at night. At day 110 to 118, juvenile green sturgeon move downstream at night, and habitat preference suggests that juveniles prefer deep pools with low light and some rock structure (Kynard et al. 2005).

Wintering juveniles forage actively at night between dusk and dawn and are inactive during the day, seeking the darkest available habitat (Kynard et al. 2005).
Rearing habitat preferences of green sturgeon larvae and juveniles in the Sacramento River are poorly understood (Stillwater Sciences 2007). However, additional information about habitat use is available for white sturgeon populations, which has been used as a proxy for green sturgeon.

The seemingly random foraging patterns used by young sturgeon are probably a result of their poor ability to use visual cues to locate and capture food. Juveniles of other species of sturgeon have been shown to be non-visual feeders (Sbikin 1974), and it is generally assumed that most sturgeon use other senses than vision when feeding (Buddington and Christofferson 1985). This means that the success sturgeon have with mobile prey could be dependent on the amount of light available for prey to detect their approach (Utter et al. 1985). A non-visual predatory strategy would be an advantage to sturgeon when feeding on large populations of visually oriented prey species in habitats that are often turbid (Miller 1978, as cited in Utter et al. 1985). A dependence on sensory systems other than vision would also be advantageous when foraging at night or in areas too deep for light penetration. A random searching pattern is characteristic of all ages of juvenile sturgeon that were observed in laboratory and hatchery settings (Utter et al. 1985).

Olfactory cues are important for sturgeon when feeding on odorous food types. Sturgeon have large olfactory rosettes with both ciliated and microvillus receptors (Hara 1972, as cited in Utter et al. 1985), and Utter et al. (1985) observed that sturgeon behavior is instantaneously affected by contact with food odors. Sturgeon will often stop after detecting an odor and begin circling the general area in an attempt to contact the food item (Utter et al. 1985).

Tagged adult and subadult green sturgeon in the San Francisco Bay estuary primarily occupied waters over shallow depths of less than 10 m, either swimming near the surface or foraging along the bottom (Kelly et al. 2007 as cited in Reclamation 2008). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 1–3 m deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke 1966).
4.4.4.5 Juvenile Emigration

Juvenile green sturgeon migrate downstream and feed mainly at night. Juvenile green sturgeon are taken in traps at the RBDD and the GCID diversion in Hamilton City, primarily in the months of May through August. Peak counts occur in the months of June and July (68 FR 4433). Juvenile emigration may reportedly extend through September (Environmental Protection Information Center et al. 2001).

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

4.4.4.6 Lifestage-Specific Water Temperature Suitabilities

Since the RMT prepared its November 2010 water temperature objectives memorandum, additional water temperature monitoring in the lower Yuba River has been conducted by the RMT. The RMT (2013) developed the following representative green sturgeon lifestage-specific periodicities and primary locations for water temperature suitability evaluations.

- Adult Immigration and Holding (mid-February through April) – Daguerre Point Dam and Marysville
- Spawning and Embryo Incubation (March through July) – Daguerre Point Dam and Marysville
- Post-Spawning Holding (March through November) – Daguerre Point Dam and Marysville
- Juvenile Rearing and Outmigration (Year-round) – Daguerre Point Dam and Marysville
Green sturgeon lifestage-specific WTI values are provided in Table 4-11.

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<tr>
<th>Lifestage</th>
<th>Water Temperature Range</th>
<th>Jan</th>
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<td>Adult Immigration and Holding</td>
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<td>Spawning and Embryo Incubation</td>
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<td>Post-Spawning Holding</td>
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<td>Juvenile Rearing and Outmigration</td>
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Recent water temperature monitoring data in the lower Yuba River are available for the period extending from 2006 into June 2013, during which time operations have complied with the Yuba Accord. Figure 4-17 displays water temperature monitoring results from October 2006 through June 2013 at Daguerre Point Dam and Marysville water temperature gages, with the upper end of the green sturgeon lifestage-specific water temperature index value ranges. Water temperature monitoring over the past six years demonstrated that water temperatures remain below the upper WTI values for all lifestages of green sturgeon at Daguerre Point Dam, and for most lifestages at the Marysville Gage. The upper end of the WTI value range for post-spawning adult holding (i.e., 61°F) was exceeded at the Marysville Gage during a portion of this lifestage evaluation period, and the upper end of the WTI range for spawning and incubation was exceeded slightly for a very brief period of time during 2007 and 2013.
4.4.5 Limiting Factors, Threats and Stressors

4.4.5.1 DPS

Limiting factors and threats to the Southern DPS of North American green sturgeon, both natural and anthropogenic, are presented according to the following five ESA listing factors.

**Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range**

**(Reduction in Spawning Habitat, Alteration of Habitat)**

**Reduction in Spawning Habitat**

Access to historical spawning habitat has been reduced by construction of migration barriers, such as major dams, that block or impede access to the spawning habitat. The principal factor for the decline of green sturgeon reportedly comes from the reduction of green sturgeon spawning habitat to a limited area of the Sacramento River (70 FR 17391). Although existing water storage dams only block access to about 9% of historically available green sturgeon habitat, Mora et al. (2009) suggest that the blocked areas historically contained relatively high amounts of spawning habitat because of their
upstream position in the river system. Adams et al. (2007) hypothesized that significant
amounts of historically-utilized spawning habitat may be blocked by Shasta Dam and
Oroville Dam on the Feather River, reducing the productive capacity and simplifying the
spatial structure of the Sacramento River green sturgeon population.

Keswick Dam is an impassible barrier blocking green sturgeon access to what are thought
to have been historic spawning grounds upstream (70 FR 17386). Spawning currently
appears to be limited to the upper portion of the mainstem Sacramento River downstream
of Keswick Dam. In addition, a substantial amount of what may have been historical
spawning and rearing habitat in the Feather River upstream of Oroville Dam has also
been lost (70 FR 17386).

**ALTERATION OF HABITAT**

Green sturgeon habitat in the mainstem Sacramento River and the Delta has been greatly
modified since the mid-1800s. Based on NMFS (2010d), the following examples
illustrate relationships between threats to green sturgeon and specific types of habitat
alteration:

- Hydraulic gold mining resulted in the removal of gravel and the deposition of
  mercury-laced fine sediment within streams, rivers, and the Bay/Delta estuary.

- Agricultural practices have converted tidal and seasonal marshlands and
  continue to release contaminants into Central Valley waterways.

- Levees have been created extensively along the Sacramento River and the
  Delta, resulting in the removal of riparian vegetation and the reduction of
  channel complexity.

- Historical reclamation of wetlands and islands, channelization and hardening of
  levees with riprap have reduced and degraded in- and off-channel intertidal and
  sub-tidal rearing habitat for green sturgeon.

- The hydrographs of the Sacramento River and its tributaries have been
  substantially altered from unimpaired conditions, and may no longer favorably
  correspond with green sturgeon lifestage periodicities.
In-river water diversions alter flow and potentially entrain larval/juvenile green sturgeon.

Introduced and invasive species have likely modified trophic relationships in both freshwater and estuarine habitats, which may have resulted in increased predation on young green sturgeon, as well as reduced growth and fitness as a result of feeding on non-optimal prey resources.

Flows

NMFS (2005c) and USFWS (1995) found a strong correlation between mean daily freshwater outflow (April to July) and white sturgeon year class strength in the Sacramento-San Joaquin Estuary (these studies primarily involve the more abundant white sturgeon; however, the threats to green sturgeon are thought to be similar), indicating that insufficient flow rates are likely to pose a significant threat to green sturgeon (71 FR 17757). Low flow rates affect adult migration and may cause fish to stop their upstream migration or may delay access to spawning habitats. Also, it was posited that low flow rates could dampen survival by hampering the dispersal of larvae to areas of greater food availability, hampering the dispersal of larvae to all available habitat, delaying the transportation of larvae downstream of water diversions in the Delta, or decreasing nutrient supply to the nursery, thus stifling productivity (NMFS 2005c). Very little information is available on the habitat requirements and utilization patterns for early lifestages of green sturgeon (Mora et al. 2009).

Stranding due to flow reduction also may pose a threat to green sturgeon in the Sacramento River system. Green sturgeon that are attracted by high flows in the Yolo Bypass move onto the floodplain and eventually concentrate behind Fremont Weir, where they are blocked from further upstream migration (DWR 2005). As the Yolo Bypass recedes, these sturgeon become stranded behind the flashboards of the weir and can be subjected to heavy illegal fishing pressure. Sturgeon can also be attracted to small pulse flows and trapped during the descending hydrograph (Harrell and Sommer 2003).
**Water Temperatures**

The installation of the Shasta Dam temperature control device in 1997 is thought to have reduced the previous problems related to high water temperatures in the upper Sacramento River, although Shasta Dam has a limited storage capacity and cold water reserves could be depleted in long droughts (NMFS 2007). Water temperatures at RBDD have not been higher than 62°F since 1995 (NMFS 2007) and have been within the green sturgeon egg and larvae optimum range for growth and survival of 59 to 66°F (Mayfield and Cech 2004). According to Reclamation (2008), water temperatures in the Feather River appear adequate for spawning and egg incubation, contrary to previous concerns that releases of warmed water from Thermalito Afterbay are one reason neither green nor white sturgeon are found in the river in low-flow years (CDFG 2002; SWRI 2003). In some years, water temperatures downstream of the Thermalito Outlet are inadequate for spawning and egg incubation, which has been suggested as a reason why green sturgeon are not found in the river during low flow years (DWR 2007). However, post-Oroville Dam water temperatures are cooler than historic river temperatures during the summer months when early lifestages are likely to be present in the lower Feather River (DWR 2005a in Reclamation 2008). Prior to the construction of the Oroville Dam, water temperatures in the Feather River at Oroville averaged 65-71°F from June through August for the period of 1958-1968 (DWR 2004c). After Oroville Dam construction, water temperatures in the Feather River at the Thermalito Afterbay averaged 60-65°F from June through August for the period of 1993-2002 (DWR 2004c). It is likely that high water temperatures (greater than 63°F) may deleteriously affect sturgeon egg and larval development, especially for late-spawning fish in drier water years (70 FR 17386).

**DELAYED OR BLOCKED MIGRATION**

It has been suggested that the primary effect of construction of large water-storage reservoirs in the Sacramento–San Joaquin river basin has been to curtail the distribution of green sturgeon within the DPS (Mora et al. 2009). For example, water storage dams are hypothesized to be a major factor in the decline of green sturgeon in the Sacramento River (Adams et al. 2007). The existence and ongoing effects of these dams may have reduced the amount and altered the spatial distribution of spawning, rearing and holding.
habitat available and by restriction to the mainstem Sacramento River, resulting in green sturgeon becoming more vulnerable to environmental catastrophes (Mora et al. 2009).

Other potential adult migration barriers to green sturgeon have been reported to include the Sacramento Deep Water Ship Channel locks, Fremont Weir, Sutter Bypass, and the DCC Gates on the Sacramento River, and Shanghai Bench and Sunset Pumps on the Feather River (71 FR 17757).

DWR (2005) reported that the lock connecting the Sacramento River Deep Water Ship Channel with the Sacramento River blocks the migration of all fish from the deep water ship channel back to the Sacramento River. Thus, if green sturgeon enter the Sacramento River Deep Water Ship Channel, they will be unable to continue their migration upstream in the Sacramento River.

Green sturgeon are attracted by high floodwater flows into the Yolo Bypass, but are restricted from entering the Sacramento River by the Fremont Weir (DWR 2005). Sturgeon also may be attracted to small pulse flows into the Yolo Bypass, and isolated during the descending hydrograph (Harrell and Sommer 2003).

Green sturgeon can become entrained in the Sutter Bypass during storm flow events. During April 2011, several sturgeon (green and white) were stranded behind the Tisdale Weir on the Sutter Bypass when storm flows receded. CDFW, in collaboration with UC Davis, organized a fish rescue operation and returned the sturgeon to the Sacramento River.

According to NMFS (2010d), the DCC, located near Walnut Grove, California, was constructed in 1951 to facilitate the transfer of fresh water from the Sacramento River to the federal and state pumps located in the south Delta. Flow from the Sacramento River into the DCC is controlled by two radial arm gates that can be opened or closed depending on water quality, flood protection, and fish protection requirements. When the gates are open, Sacramento River water is diverted into the Mokelumne and San Joaquin rivers. The gates are closed in fall to protect migrating salmonids, then are opened the following spring. Thirty-percent of the tagged adult green sturgeon migrating down the Sacramento River after spawning entered the DCC (Israel et al. 2010). Most of these fish were able to successfully negotiate their way through the Delta and reach the Pacific
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Ocean. However, four fish were detected in the south Delta, with only one surviving to reach the Pacific Ocean. Juvenile green sturgeon may also be entrained into the interior delta during the summer when the DCC is open. Further studies are necessary to investigate the threat this alternative route through the Delta poses for these fish (NMFS 2010d).

NMFS (2009d) stated that potential physical barriers to adult green sturgeon migration in the Feather River are located at Shanghai Bench (RM 25) and at the Sutter Extension Water District’s Sunset Pumps (RM 39). Although Shanghai Bench was breached during 2011, it is uncertain whether or not it still imposes a migration barrier or impediment to adult green sturgeon. Each of these barriers could impede adult upstream migration during low flows (USFWS 1995a). Impediments to migration may cause fish to stop their natural upstream migration or may delay access to spawning habitats (Moser and Ross 1995). Natural (Shanghai Bench) and man-made (Sunset Pumps) impediments to upstream movements in the Feather River during low flow years might also limit significant spawning activities of green sturgeon above these obstacles to wet, high flow water years when they are most likely to be able to pass these obstacles (Beamesderfer et al. 2004).

**IMPAIRED WATER QUALITY**

Exposure of green sturgeon to toxics has been identified as a factor that can lower reproductive success, decrease early lifestage survival, and cause abnormal development, even at low concentrations (USFWS 1995). Contamination of the Sacramento River increased substantially in the mid-1970s when application of rice pesticides increased (70 FR 17386). Additionally, water discharges containing metals from Iron Mountain Mine, located adjacent to the Sacramento River, have been identified as a factor affecting survival of sturgeon downstream of Keswick Dam. However, treatment processes and improved drainage management in recent years have reduced the toxicity of runoff from Iron Mountain Mine to acceptable levels. It has been reported that white sturgeon may accumulate PCBs and selenium (White et al. 1989 as cited in Reclamation 2008). While green sturgeon spend more time in the marine environment than white sturgeon and, therefore, may have less exposure, the NMFS BRT for North American green sturgeon
concluded that contaminants also pose some risk for green sturgeon. However, this risk has not been quantified or estimated (NMFS 2007).

Additionally, events such as toxic oil or chemical spills in the upper Sacramento River could result in the loss of both spawning adults and their progeny, and lead to year-class failure (BRT 2005).

**DREDGING AND SHIP TRAFFIC**

Hydraulic suction dredging is conducted in the Sacramento and San Joaquin rivers, navigation channels within the Delta, and Suisun, San Pablo, and San Francisco bays. Juvenile green sturgeon residing within the Delta and the San Francisco Bay Estuary may be entrained during hydraulic suction dredging, which is conducted to maintain adequate depth within navigation areas or to mine sand for commercial use (NMFS 2010d). Additionally, the disposal of dredged material at aquatic sites within the estuary might bury green sturgeon or their prey, and expose green sturgeon to elevated levels of contaminated sediments (NMFS 2010d).

**OCEAN ENERGY PROJECTS**

According to NMFS (2010d), projects that harness the ocean’s energy are currently being considered along the entire west coast. Potential concerns for green sturgeon include, but are not limited to, exposure to electromagnetic field (EMF) emissions, blade strikes, turbine entrainment, and ocean energy facilities functioning as fish aggregation devices. One of the primary concerns involves the exposure of green sturgeon to EMF generated from project cables, turbine structures, and junction boxes, because green sturgeon use electroreceptors for feeding and perhaps migration, and these activities may be affected by EMF.

NMFS (2010d) suggested that the proposed installation and operation of energy-generating turbines at the mouths of several estuaries, including San Francisco Bay, may lead to injury and mortality as a result of potential blade strikes in association with turbine operation. Additionally, wave buoy and tidal turbine arrays may act as artificial reefs (e.g., DuPont 2008) or fish aggregation devices for marine mammals, fish, and invertebrates. If so, related changes to the local marine community, predator-prey
interactions (i.e., increased presence of sea lions), or the distribution and abundance of marine species around ocean energy installation sites are also possible, and these sites are within the migratory corridors of green sturgeon (NMFS 2010d).

COMMERCIAL, RECREATIONAL, SCIENTIFIC, OR EDUCATIONAL OVERUTILIZATION

While this factor was not considered the primary factor causing the decline of the Southern DPS of North American green sturgeon, it is believed that past and present commercial and recreational fishing is likely to pose a threat to green sturgeon (71 FR 17757).

Commercial, tribal, and recreational fishing probably had negative impacts on green sturgeon in the past. Current fishing regulations in Washington, Oregon, and California prohibit retention of green sturgeon in all commercial and recreational fisheries, although a small number of tribes still retain green sturgeon captured in some coastal bays and estuaries (NMFS 2010d).

Coastal groundfish trawl fisheries have been substantially reduced since the 1990s due to increasingly restrictive management measures (NMFS 2010d). These include reduced trip limits, increased gear restrictions, and a vessel buyback program, all of which are expected to reduce green sturgeon bycatch. Recent modifications to existing fishing regulations have almost certainly reduced overall green sturgeon take, but the impact of discard mortality and sublethal effects of capture remain unknown (NMFS 2010d).

As a long-lived, late maturing fish with relatively low fecundity and only periodic spawning, the green sturgeon is particularly susceptible to threats from overfishing (Musick 1999 as cited in Reclamation 2008). Green sturgeon are vulnerable to recreational sport fishing with the Bay-Delta estuary and Sacramento River. Green sturgeon are primarily captured incidentally in California by sport fishermen targeting the more desirable white sturgeon, particularly in San Pablo and Suisun bays (Emmett et al. 1991). Since the listing of the Southern DPS of green sturgeon, new federal and state regulations, including the June 2, 2010 NMFS take prohibition (75 FR 30714), mandate that no green sturgeon can be taken or possessed in California (CDFG 2007a). If green sturgeon are caught incidentally and released during fishing for white sturgeon, the event must be reported to CDFW. The level of hooking mortality that results following release
of green sturgeon by anglers is unknown. CDFG (2002) indicates that sturgeon are highly vulnerable to the fishery in areas where sturgeon are concentrated, such as the Delta and Suisun and San Pablo Bays in late winter and the upper Sacramento River during spawning migration. In March 2010, CDFW prohibited fishing for either white or green sturgeon within the upper mainstem Sacramento River between Keswick Dam and Butte Bridge (Hwy 162) in an effort to protect adult green sturgeon during their spawning runs (NMFS 2010d).

The demand for sturgeon caviar continues to increase both nationally and globally, and enforcement to protect sturgeon from poaching within the Central Valley is a high priority (CDFG 2002), as indicated by the number of sturgeon poaching operations that have been discovered there in recent years (NMFS 2010d). However, the degree to which poaching of green sturgeon occurs is largely unknown.

Poaching (illegal harvest) of sturgeon is known to occur in the Sacramento River, particularly in areas where sturgeon have been stranded (e.g., Fremont Weir), as well as throughout the Bay-Delta. Catches of sturgeon are thought to occur during all years, especially during wet years. The small population of green sturgeon inhabiting the San Joaquin River experiences heavy fishing pressure, particularly from illegal fishing (USFWS 1995). Areas just downstream of Thermalito Afterbay Outlet, Cox’s Spillway, and several barriers impeding migration on the Feather River may be areas of high adult mortality from increased fishing efforts and poaching.

Poaching pressure is expected to remain high because of the increasing demand for caviar, coupled with the decline of other sturgeon species around the world, primarily the beluga sturgeon (71 FR 17757). Presently, however, poaching rates in the rivers and estuary and the impact of poaching on green sturgeon abundance and population dynamics are unknown.

The amount of green sturgeon take associated with scientific research has recently become a concern. NMFS (2010d) suggested that any project (or suite of projects) that allows green sturgeon to be taken be carefully reviewed and evaluated.
DISEASE AND PREDATION

A number of viral and bacterial infections have been reported for sturgeon in general (Mims et al. 2002), however specific issues related to diseases of green sturgeon have not been studied or reported. Therefore, it is not known if disease has played a role in the decline of the Southern DPS of green sturgeon.

The significance of predation on each lifestage of green sturgeon has not been determined. There has been an increasing prevalence of nonnative species in the Sacramento and San Joaquin rivers and the Delta (CDFG 2002) and this may pose a significant threat (NMFS 2010d). Striped bass, an introduced species, may affect the population viability of Chinook salmon (Lindley et al. 2004), and probably preys on other species, such as sturgeon (Blackwell and Juanes 1998). It is likely that sea lions consume green sturgeon in the San Francisco Bay estuary, but the extent to which this occurs is unknown (NMFS 2010d).

INADEQUACY OF EXISTING REGULATORY MECHANISMS

Inadequacy of existing regulatory mechanisms has contributed significantly to the decline of green sturgeon and to the severity of threats they currently face (NMFS 2010d). During the process of developing the 4(d) rule for the Southern DPS of green sturgeon (70 FR 17386), NMFS noted several Federal, State, and local regulatory programs that have been implemented to help reduce historical risk, including the AFRP of the CVPIA and the CALFED ERP. However, growing conflicts between the protection of other species (e.g., Sacramento River winter-run Chinook salmon and sea lions) may prove problematic for green sturgeon (NMFS 2010d). Although some effort has been made to improve habitat conditions across the range of the Southern DPS of green sturgeon, less progress has been accomplished through regulatory mechanisms to reduce threats posed by water diversions or blocked passage to spawning habitat (NMFS 2010d).
**Other Natural or Man-Made Factors Affecting the Species’ Continued Existence (Non-Native Invasive Species, Entainment)**

**Non-Native Invasive Species**

This factor was not considered a primary factor in the decline of the Southern DPS of green sturgeon. However, non-native species are an ongoing problem in the Sacramento and San Joaquin rivers and the Delta (CDFG 2002). One risk for green sturgeon associated with the introduction of non-native species involves the replacement of relatively uncontaminated food items with those that may be contaminated (70 FR 17386). Sturgeon regularly consume overbite and Asian clams, which is of particular concern because of the high bioaccumulation rates of these clams (Doroshov 2006 in BDCP 2010). The significance of this threat to green sturgeon is unclear (NMFS 2007). Green sturgeon also are likely to experience predation by introduced species including striped bass, but the actual impacts of predation have yet to be estimated (70 FR 17392). Introductions of non-native invasive plant species such as water hyacinth and Brazilian waterweed have altered habitat and have affected local assemblages of fish within the Bay-Delta estuary (Nobriga et al. 2005), and may also affect green sturgeon through habitat alteration and potential increased predation rates on juveniles.

**Entrainment**

Larval and juvenile green sturgeon entrainment or impingement from screened and unscreened agricultural, municipal, and industrial water diversions along the Sacramento River and within the Delta is still considered an important threat (71 FR 17757). The threat of screened and unscreened agricultural, municipal, and industrial water diversions in the Sacramento River and Delta to green sturgeon is largely unknown because juvenile sturgeon are often not identified and current CDFW and NMFS screen criteria do not address sturgeon. Based on the temporal occurrence of juvenile green sturgeon and the high density of water diversion structures along rearing and migration routes, NMFS (2005) found the potential threat of these diversions to be serious and in need of study.

In 1997, NMFS and CDFW developed screening criteria designed to prevent entrainment and impingement of juvenile salmonids. Similar criteria for larval and juvenile green sturgeon have not been developed and, although discussions regarding their development
are occurring, there has been no timeline created for when guidelines will be available (NMFS 2010d).

The largest diversions within the Delta are the SWP and CVP export facilities, located in the southern Delta. Juvenile and sub-adult green sturgeon are recovered year-round at the CVP/SWP facilities, and have higher levels of salvage during the months of July and August compared to the other months of the year. The reason for this distribution is unknown. Based on salvage data, it appears that green sturgeon juveniles are present in the Clifton Court Forebay year round, but in varying numbers. NMFS (2009a) expects that predation on green sturgeon during their stays in the forebay is minimal, given their size and protective scutes, but this has never been verified.

4.4.5.2 Lower Yuba River

Given the extremely infrequent sightings of green sturgeon in the lower Yuba River, and the lack of green sturgeon life history information for the lower Yuba River, the foregoing discussion regarding threats and stressors for the DPS is assumed to be generally applicable to the lower Yuba River.

Moreover, according to NMFS (2008a), the lower Yuba River downstream of Daguerre Point Dam is subject to the same management considerations as the lower Feather River, which include operation of dams and water diversion operations resulting in the alteration of water flow and reduced water quality, in-water construction or alterations (e.g., bridge repairs, gravel augmentation, bank stabilization), and NPDES activities and other activities resulting in non-point source pollution (e.g., agricultural pesticide application, agricultural runoff and outfalls).

4.4.6 Summary of the Current Viability of the Southern DPS of North American Green Sturgeon

Although McElhany et al. (2000) specifically addresses viable populations of salmonids, NMFS (2009a) suggested that the concepts and viability parameters in McElhany et al. (2000) also could be applied to the Southern DPS of green sturgeon. Therefore, NMFS (2009a) applied the concept of VSP and reviewed population size, abundance, spatial
distribution and diversity in the 2009 NMFS OCAP BO, and also applied the VSP concepts to green sturgeon in the 2009 Oroville FERC Relicensing NMFS BO (2009d).

**4.4.6.1 DPS**

**ABUNDANCE**

Currently, there are no reliable data on population sizes and population trends are lacking. The Oroville FERC Relicensing BO (NMFS 2009d) stated that the only existing information regarding changes in abundance of green sturgeon includes changes in the numbers of green sturgeon salvaged at the federal and state facilities in the South Delta. NMFS (2009d) stated that, before 1986, an average of 732 green sturgeon were taken annually at the John E. Skinner Fish Collection Facility. From 1986 to 2006, the average per year was 47. NMFS (2009d) also stated that for the Harvey O. Banks Pumping Plant, the average number prior to 1986 was 889, and from 1986 to 2001 the average was 32. In consideration of increased water exports in recent years, NMFS (2009d) concluded that the abundance of green sturgeon has declined.

According to NMFS (2009a), the current population status of green sturgeon is unknown. Based on captures of green sturgeon during surveys for the sympatric white sturgeon in the San Francisco Bay estuary, NMFS (2009a) suggested that the population is relatively small, ranging from several hundred to a few thousand adults. However, these estimates are very uncertain, and limited by the inherent biases of the sampling methods (NMFS 2009a).

Green sturgeon in the Sacramento River have been documented and studied more widely than those in either the Feather River or the Yuba River. In general, sturgeon year class strength appears to be episodic with overall abundance and dependent on a few successful spawning events. Genetic techniques were used to estimate the number of green sturgeon spawners contributing to juvenile production between 2002 and 2006 in the upper segment of spawning habitat above RBDD. Based upon these techniques, it was estimated that between 10 and 28 individuals contributed to juvenile production (Israel and May 2010). Because populations appear to be not in equilibrium, conclusions
regarding equilibrium dynamics are uncertain given the lack of information (NMFS 2010d).

Green sturgeon occasionally range into the Feather River, but numbers are low. NMFS (71 FR 17757) concluded that an effective population of spawning green sturgeon does not exist in the Feather River at the present time.

**PRODUCTIVITY**

There is insufficient information to evaluate the productivity of green sturgeon (NMFS 2009d). Recruitment data for green sturgeon are essentially nonexistent (NMFS 2009a). Incidental catches of larval green sturgeon in the mainstem Sacramento River and juvenile fish at the CVP and SWP pumping facilities in the South Delta suggest that green sturgeon are successful at spawning, but that annual year class strength may be highly variable (Beamesderfer et al. 2007; Adams et al. 2002). Recent declines in the number of larvae captured in the RSTs near the RBDD may indicate a reduction in spawning success in the past several years, with resulting depressions in the year class strengths for those years. However, green sturgeon are iteroparous and long-lived, so that spawning failure in any one year may be rectified in a succeeding spawning year (NMFS 2009a).

**SPATIAL STRUCTURE**

Historical green sturgeon spawning habitat may have extended up into the three major branches of the upper Sacramento River above the current location of Shasta Dam - the Little Sacramento River, the Pit River, and the McCloud River (NMFS 2009a; NMFS 2009d). Additional spawning habitat is believed to have once existed above the current location of Oroville Dam on the Feather River (NMFS 2009a). The Southern DPS of green sturgeon population has been relegated to a single spawning area, which is, for the most part, outside of its historical spawning area.

According to NMFS (2009a), the reduction of green sturgeon spawning habitat into one reach on the Sacramento River between Keswick Dam and Hamilton City has increased the vulnerability of this spawning population to catastrophic events. One spill of toxic materials into this reach of river, similar to the Cantara Loop spill of herbicides on the
upper Sacramento River, could remove a significant proportion of the adult spawning
broodstock from the population, as well as reduce the recruitment of the exposed year
class of juvenile fish. Additionally, extended drought conditions could imperil the
spawning success for green sturgeon, particularly those that are restricted to the river
reaches below RBDD (NMFS 2009a).

DIVERSITY

Diversity, both genetic and behavior, provides a species the opportunity to track and
adapt to environmental changes. The reduction of the Southern DPS of green sturgeon
population to one extant spawning population has reduced the potential variation of life
history expression and genetic diversity within this population (NMFS 2009d). In
addition, the closed gate configuration at RBDD from mid-May to September may have
altered the genetic diversity of the population by separating the population into upstream
and downstream spawning groups based on run timing (NMFS 2009a).

Green sturgeon stocks from the northern and southern DPSs are genetically differentiated
(Israel et al. 2004; Israel et al. 2009). Genetic differentiation is moderate and statistically
similar between the southern and northern DPSs (NMFS 2010d). However, the genetic
diversity of the Southern DPS is not well understood (NMFS 2009d).

SUMMARY OF THE CURRENT VIABILITY OF THE SOUTHERN DPS OF NORTH AMERICAN GREEN
STURGEON

The Southern DPS of green sturgeon is at substantial risk of future population declines
(Adams et al. 2007). The principal threat to green sturgeon in the Southern DPS is the
reduction in available spawning habitat due to the construction of barriers on Central
Valley rivers (NMFS 2009d). According to NMFS (2009a), the potential threats faced by
the green sturgeon include enhanced vulnerability due to the reduction of spawning
habitat into one concentrated area on the Sacramento River, lack of good empirical
population data, vulnerability of long-term cold water supply for egg incubation and
larval survival, loss of juvenile green sturgeon due to entrainment at the project fish
collection facilities in the South Delta and agricultural diversions within the Sacramento
River and the Delta, alterations of food resources due to changes in the Sacramento River
and Delta habitats, and exposure to various sources of contaminants throughout the basin
to juvenile, sub-adult, and adult lifestages. In summary, NMFS (2009d) concluded that the Southern DPS of green sturgeon remains at a moderate to high risk of extinction.

A recent study (Thomas et al. 2013) provided additional analysis regarding population-level impacts due to stranding of green sturgeon. During April 2011, 24 green sturgeon were rescued that had been stranded behind two weirs (Fremont and Tisdale) along the Sacramento River. Those 24 green sturgeon were acoustically tagged and their survival and migration success to their spawning grounds was analyzed. Additionally, population viability modeling and analysis was conducted to show the potential impacts of stranding and the benefits of conducting rescues at the population level. Population viability analyses of rescue predicted a 7% decrease below the population baseline model over 50 years as opposed to 33% without rescue (Thomas et al. 2013).

4.4.6.2 Lower Yuba River

As previously discussed, very few observations of green sturgeon have occurred in the Yuba River historically or in recent years. The few occasions when confirmed observations have occurred were downstream of Daguerre Point Dam and consisted of adult green sturgeon. Green sturgeon acoustic tag detections do not indicate substantive use of the Yuba River (YCWA 2013).

Monitoring and studies of green sturgeon in the Delta, the Sacramento River and its tributaries continue to be undertaken by a variety of agencies implementing numerous different programs. The CFTC continues to monitor acoustically tagged green sturgeon throughout the system, and fixed-station acoustic monitors and roving hydrophonic surveys continue to be conducted on the lower Yuba River by both the RMT and CDFW’s Heritage and Wild Trout and the Steelhead Management and Recovery Programs. The AFRP is continuing to fund ongoing sturgeon videographic monitoring efforts in the Feather River Basin, including the lower Yuba River. Additionally, the Sturgeon IEP Project Work Team coordinates green sturgeon research, disseminates information and is overseeing the development of a green sturgeon population model, and the Corps’ LTMS for the Placement of Dredged Material in the San Francisco Bay Region Program includes green sturgeon tracking, evaluation of susceptibility to suction dredging and development of entrainment models. Available results from these and other
programs may provide additional information regarding green sturgeon in the Central Valley and lower Yuba River. However, despite the contribution resulting from these and other studies conducted to date, knowledge of the population biology and dynamics of green sturgeon remains limited.

Limited information regarding green sturgeon abundance, distribution, movement and behavioral patterns, as well as lifestage-specific habitat utilization preferences, is available for the Sacramento and Feather rivers. According to NMFS (2009a), the current population status of the Southern DPS of North American green sturgeon is unknown. Currently, there are no reliable data on population sizes, and population trends are lacking (NMFS 2009d). There is insufficient information to evaluate the productivity of green sturgeon (NMFS 2009d), and recruitment data for green sturgeon are essentially nonexistent (NMFS 2009a). Essentially no information regarding these topics is available for the lower Yuba River.

Hence, it is not practicable to attempt to apply the VSP concepts developed for salmonids to green sturgeon in the lower Yuba River. Moreover, the lack of information pertaining to abundance, productivity, habitat utilization, life history and behavioral patterns in the lower Yuba River, due to infrequent sightings over the past several decades, does not provide the opportunity for reliable alternative methods of viability assessment of green sturgeon in the lower Yuba River.

### 4.4.7 Recovery Considerations

In November 2009, NMFS (74 FR 58245) announced its intent to develop a recovery plan for the Southern DPS of North American green sturgeon. NMFS is required by the ESA to develop and implement recovery plans for the conservation and survival of ESA-listed species. As part of the process, NMFS will be coordinating with state, Federal, tribal, and local entities in California, Oregon, Washington, Canada, and Alaska to develop the recovery plan.

Presently, NMFS is in the process of preparing the draft recovery plan, and has prepared an outline of the plan (NMFS 2010d). As stated in the outline, the goal is to set out a
A plan to conserve and recover green sturgeon by identifying actions that may improve its potential for recovery. These include, but are not limited to, the following:

- Improve existing research and initiate novel research and monitoring on distribution, status, trends, and lifestage survival of the Southern DPS of green sturgeon at the population level.
- Establish better inter- and intra-agency coordination regarding scientific research conducted on green sturgeon under ESA sections 7, 10, and 4(d).
- Evaluate the significance of green sturgeon bycatch in commercial fisheries through the implementation of directed surveys.
- NMFS Office of Law Enforcement (OLE) should monitor and collaborate with state enforcement agencies along the west coast related to illegal retention of green sturgeon in recreational fisheries.
- NMFS OLE should collaborate with CDFW wardens to address sturgeon poaching in the Central Valley.
- Assess the potential for establishing independent spawning populations in areas outside of the mainstem Sacramento River (e.g., Feather, Yuba, Russian rivers, as well as tributaries of San Joaquin River).
- Address the need to develop a multiple species water flow and temperature management plan for Shasta, Keswick, Oroville and Englebright dams.
- Address the application of pesticides (Carbaryl and others) and herbicides applied to control burrowing shrimp and non-native plants in estuaries.
- Identify and prioritize potential contaminants of concern in the Central Valley.
- Ensure that screens are placed on water diversions on the upper mainstem Sacramento River below Keswick Dam and that they are designed to be protective of larval and juvenile green sturgeon. Research on screening criteria should be initiated as soon as feasible.
- Continue to support the removal of the Red Bluff Diversion Dam.
Monitor hydraulic suction dredges for potential entrainment of juvenile green sturgeon.

Determine the impact of non-native species.

Determine if electromagnetic fields produced by offshore energy projects alter green sturgeon migration patterns.

The draft recovery plan outline (NMFS 2010d) further states that recovery actions will be refined in the recovery plan and will be specific to several regions, including the Sacramento River, the Delta/Estuary, and coastal marine areas, which include several estuaries/bays. Actions specific to lifestages in each region will be identified to address more localized factors that currently suppress potential for recovery for green sturgeon (NMFS 2010d).
5.0 Environmental Baseline

The regulations governing ESA consultations (50 CFR §402.02) define “Environmental Baseline” as follows: "The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process.” The ESA Consultation Handbook explains that the Environmental Baseline should provide an “analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area” (USFWS and NMFS 1998). While the Environmental Baseline includes ongoing effects, it does not include the future effects of the Proposed Action under review. The assessment of “future” effects of the Proposed Action is included in Chapter 7.0 of this BA.

The Environmental Baseline for this BA adopts the NMFS (2005) Recommendations for the Contents of Biological Assessments and Biological Evaluations pertinent to the Environmental Baseline. The Environmental Baseline analysis in this BA therefore:

- Provides information on past, present and future state, local, private, or tribal activities in the action area – specifically, the positive or negative impacts those activities have had on the species or habitat in the area in terms of abundance, reproduction, distribution, diversity, and habitat quality or function.

- Includes the impacts of past and present Federal actions.

- Describes the impacts of the past existence and operation of the action under consultation (for continuing actions).

- Presents all known and relative effects on the population (e.g., fish stocking, fishing, hunting, other recreation, illegal collecting, private wells, development, grazing, local trust programs).
Includes impacts to the listed and proposed species in the action area that are occurring, and that are unrelated to the Proposed Action (e.g., poaching, road kills from off-road vehicle use, trespass).

The purpose of this Environmental Baseline chapter is to use the best available science to summarize the status of the species and critical habitat, and analyze the effects of factors affecting the species and critical habitat within the Action Area of the lower Yuba River. The species’ current status is described in relation to the risks presented by the continuing effects of all previous actions and resource commitments that are not subject to further exercise of Federal discretion (WSDOT 2013). For projects that may affect designated critical habitat, the environmental baseline should include a detailed description of the current functional condition of the individual PCEs within the action area. The condition of the environmental baseline will influence the effects analysis in that the effects on the critical habitat in the action area to the proposed action will depend, in part, on existing environmental conditions (WSDOT 2013).

Because previous ESA consultations related to the Corps’ activities have intermingled effects of the Proposed Action with potential stressors and impacts of the Environmental Baseline, the analysis provided in this BA attempts to more clearly distinguish between the potential effects to listed fish species that are attributable to the Environmental Baseline, compared to those that are expected to occur as a result of the Proposed Action (see Chapter 7.0). Additionally, because the scope of the Action Area has changed, relative to earlier consultations, some areas that may have previously been associated with Environmental Baseline effects are now described in the Status of the Species (see Chapter 4). Specifically, because the most upstream extent of the Action Area for this BA is located immediately downstream of the Narrows II Powerhouse, which corresponds with the gravel augmentation component of the Proposed Action, Englebright Dam is not included in the Action Area and therefore is not included in the Environmental Baseline. As stated in WSDOT (2013), "The baseline discussion should summarize the actions that have (and continue to) occur in the action area and describe how these actions have influenced environmental conditions and the status of the species in the action area [emphasis added]."
USFWS and NMFS (1998) explain that the Environmental Baseline should provide an “analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area.” While the Environmental Baseline includes ongoing effects, it does not include the future effects of the Proposed Action under review.

Distinguishing between the effects of an ongoing action and the environmental baseline can be a complex task for many ongoing water projects. The ESA presents different challenges for civil works projects that have already been constructed and that are now being operated and maintained by the Corps. Many of those projects were planned, designed, and built before the ESA was enacted in 1973, and sometimes the listed species or designated critical habitats were not present in the area until after the Corps’ projects were built.

The Corps’ responsibilities, as well as its ability to conduct activities at Daguerre Point Dam on the lower Yuba River, are primarily governed by the facilities’ respective authorized purposes (see Appendix A regarding Corps’ Authorities). Consequently, the Corps’ actions that are proposed and evaluated in this BA and that could potentially affect (positively or negatively) listed fish species or critical habitat in the Action Area of the lower Yuba River are limited.

Due to the Corps’ limited authority and discretion regarding the operations of facilities associated with this Proposed Action, distinguishing between effects of the Proposed Action and effects of the Environmental Baseline in this BA is not overly complex. Future effects to listed species that are solely attributable to the presence of pre-existing facilities that the Corps does not have authority to change should be included in the Environmental Baseline. USFWS and NMFS (1998) explain in detail how future effects from an existing dam are considered part of the environmental baseline when the USFWS and NMFS consult on later, related actions.

According to USFWS and NMFS (1998)… "Ongoing effects of an existing dam are already included in the Environmental Baseline and would not be considered an effect of the proposed action under consultation." This applies to the effects of the physical
structure of the dam and the effects of past operations, but not to the future activities over which the action agency has discretion.

With the possible exception of effects of fish ladder performance that are associated with discretionary routine operations and maintenance activities, the Corps does not have the ability to lessen other stressors associated with at Daguerre Point Dam. Therefore, it is appropriate that most of the ongoing effects from the stressors attributable to the presence of Daguerre Point Dam and the non-discretionary operations and maintenance activities to maintain the dam are associated with the Environmental Baseline that has led to the current status of the species.

5.1 2012 NMFS BO RPA and RPMs

NMFS issued three different BOs (two final and one interim) regarding the Corps’ activities at Englebright and Daguerre Point dams between March 2002 and November 2007. All three BOs concluded that the Corps’ activities in operating and maintaining the two dams did not jeopardize listed fish species in the lower Yuba River. The third BO, issued on November 21, 2007, ultimately prompted litigation that was adjudicated before another court in the Eastern District. Following that decision, the Corps voluntarily reinitiated formal consultation with NMFS during October 2011 on the Corps’ ongoing operation and maintenance of Englebright Dam and Daguerre Point Dam and associated facilities. During January 2012, a Final BA (referred to herein as the 2012 BA) was prepared to, among other things, analyze the effects of that action on listed species and designated critical habitat. NMFS issued its Final BO (2012 BO) and jeopardy opinion on February 29, 2012 regarding the effects of Englebright Dam and Daguerre Point Dam on the Yuba River in Yuba and Nevada Counties, California on threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, the threatened Southern DPS of North American green sturgeon, and their designated critical habitat.

According to the August 12, 2013 Memorandum and Order of the United States District Court, Eastern District of California, in Case No. 2:13-cv-00042-MCE-CKD, unlike its predecessors, the 2012 NMFS BO concluded that the Corps’ 2012 Proposed Action adversely affected the concerned fish because it blocked access to suitable habitat above
Englebright Dam for spring-run Chinook salmon and steelhead. The 2012 NMFS BO concluded that continued inaccessibility to upstream habitat would likely jeopardize the continued existence of those listed species. The 2012 BO included an RPA that modified the Proposed Action to avoid jeopardizing the species and adversely modifying their critical habitat. The RPA was divided into eight categories containing almost 60 specific actions to be implemented by the Corps.

As discussed in Chapter 1, the Corps sent a letter to NMFS on July 3, 2012 acknowledging receipt of the 2012 BO (see Appendix B). Although the Corps conditionally accepted the RPA described in the BO, the Corps expressed serious concerns about various aspects of the BO that needed to be resolved. The Corps determined it could not implement certain actions in the RPA. Also, according to the ESA Consultation Handbook (USFWS and NMFS 1998), when characterizing the environmental baseline, an agency action can be removed from the environmental baseline analysis if “a Biological Opinion for the proposed action (not an ongoing action) is no longer valid because reinitiation of consultation is required and the action agency has been so informed in writing by the Services, or has requested that the Services reinitiate consultation.” The Corps formally requested reinitiation of consultation proceedings under Section 7 of the ESA on February 26, 2013. For these reasons, the actions specified in the 2012 BO are not included in the Environmental Baseline for this BA.

5.2 Characterization of the Environmental Baseline

The Environmental Baseline is characterized by the existing physical features and habitat conditions in the Action Area. Because the construction and the continued existence of Daguerre Point Dam have resulted in effects that have contributed to the current status of the species within the Action Area, these effects are considered to be part of the Environmental Baseline. The existing status of listed species in the Action Area associated with the Environmental Baseline is described in Chapter 4.0 of this BA.
5.2.1 Physical Features

5.2.1.1 Daguerre Point Dam

The Rivers and Harbor Act of June 13, 1902 authorized the construction of the Yuba River Debris Control Project, of which Daguerre Point Dam is a part (Corps 2001). Construction of Daguerre Point Dam was funded through a 50/50 cost share between the California Debris Commission and the State of California.

The original purpose of the Daguerre Point Dam was to create a basin for the storage of debris originating from the operation of hydraulic equipment for gold mining in the Yuba River watershed. Since the cessation of hydraulic mining operations, Daguerre Point Dam has retained the debris stored behind the dam and prevented it from being washed into the Feather and Sacramento Rivers to the detriment of associated navigation and flood control facilities. The dam was not intended for, nor does it provide for, the control of floods (Corps 2001).

**HISTORY/BACKGROUND**

Hydraulic mining in the Yuba River watershed during the mid-1800s contributed large quantities of sediment to the river. About 600 million cubic yards of material exposed by hydraulic mining had entered the Yuba River between 1849 and 1909 (Hagwood 1981). The sediment deposited in the channel raised the channel bed to the point that in 1868 it was higher than the streets in Marysville. Subsequent flooding of Marysville in the late 1800s led to attempts to mitigate the adverse effects of hydraulic mining (Corps 2005).

Efforts to control sediment came together with a project known as the “1898 Project”. This project involved controlling sediment with several small dams and building gravel berms to confine the low-water channel (Ayers 1997 as cited in DWR and Corps 2003a). In 1901, the California Debris Commission approved a plan to construct four barrier dams, build a settling basin, and build training walls. The plan was authorized by the Rivers and Harbor Act of 1902 (Hagwood 1981).

The major features of the "1898 Project" included: (1) storage of the mining debris within the bed of the Yuba River; (2) control of the low water channel within well-defined limits; and (3) the erection of several barriers of modest size across the bed of the river,
specifically: (a) Barriers No. 1 and No. 2 to be located about 3 miles east of the mouth of
Dry Creek; (b) a barrier to be built just below the mouth of Dry Creek; (c) a barrier to be
placed at Daguerre Point; (d) construction of a settling basin about 3 miles by 1½ miles
wide on the south side of the river; and (e) the building of gravel berms below the basin
to confine the river channel within well-defined limits (Hagwood 1981).

The first attempt to constrain mine tailings and debris in the lower Yuba River was made
using a structure referred to as Barrier No. 1, located about 1 mile downstream of the
Parks Bar Bridge and 4.5 miles upstream of Daguerre Point (Hunerlack et al. 2004;
Sumner and Smith 1939 as cited in Hagwood 1981). Work on Barrier No. 2, located
about a half mile above Barrier No. 1, was initiated during September 1903, and work on
Barrier No. 1 commenced shortly thereafter (Hagwood 1981). Unusually high water
came down the Yuba River in November 1903, and destroyed much of the work
completed. Barrier No. 1, re-constructed in 1905, was 14 feet high and constrained
1,690,000 cubic yards of gravel that were transported in the river channel during the
winter and spring of 1906 (Gilbert 1917 as cited in Yoshiyama et al. 2001). Of this total,
920,000 cubic yards were constrained upstream of the barrier during the January 1906
flood alone. Barrier No. 1 probably hindered salmon upstream movement until it failed
the following year when floods destroyed it during March 1907 (Sumner and Smith 1939
as cited in Hagwood 1981). Many acres of farmlands were repeatedly destroyed by
flooding and silting in the Yuba River watershed, and properties in the cities of
Marysville were threatened frequently by the rise of the riverbed (Hunerlack et al. 2004).
When the flood subsided, the engineers decided to cease construction at the Barrier No. 1
site, and instead proposed to complete a barrier at Daguerre Point (the fourth dam of the
original proposal) and the settling basin immediately below. The gravel berms below the
Daguerre Point cut also were to be completed. The gravel berms built on the south side
of the river were completed by the Yuba Consolidated Gold Fields and the Marysville
Gold Dredging Company as part of their gold dredging operations. Finally, the Yuba
Consolidated Gold Fields Company also built a rock levee which took the place of
Barriers No. 1 and No. 2 (Hagwood 1981). In other words, the "1898 Project" was
revised so as to concentrate the Commission's effort at and near Daguerre Point
(Hagwood 1981).
The California Debris Commission constructed the original Daguerre Point Dam in 1906 as part of the later Yuba River Debris Control Project (Corps 2001). Daguerre Point Dam was constructed in a cut above and to the north of the original Yuba River channel. The bedrock under Daguerre Point Dam is a portion of the Daguerre Point Terrace, a feature that facilitated the construction of a low dam at a relatively low cost. Over the next few years, the cut through Daguerre Point was completed and a concrete inlet wall, or spillway, was constructed. Gravel berms extending about 12,000 feet on each side of the river below the cut were built. The entrance gates to the settling basin were constructed, most of its enclosing levees were built, and the outlet works were practically completed when this part of the project was found no longer necessary and was abandoned under authority of the River and Harbor Act of June 25, 1910. The settling basin itself was never constructed. The land acquired for the settling basin, together with the intake and outlet works, was then sold (Hagwood 1981).

Daguerre Point Dam was completed in May of 1906, but the river was not diverted over the dam until 1910 (Corps 2007). Daguerre Point Dam rapidly filled to capacity with sediment and debris that moved downstream during flooding in 1911 (Hunerlach et al. 2004). The “1898 Project”, as modified, was completed in 1935 (Hagwood 1981). By that time, three gravel berms existed, having a total length of approximately 85,100 feet which provided two 500-foot channels. The result of the work on the Yuba River in and around Daguerre Point has held back millions of cubic yards of mining debris in the Yuba River which would otherwise have passed into the navigable channels of the Feather and Sacramento Rivers (Hagwood 1981).

After its construction, Daguerre Point Dam was reported to be a partial or complete barrier to salmon and steelhead for many years because of the lack of functional fish ladders (Mitchell 2010). However, although the dam made it difficult for spawning Chinook salmon and steelhead to migrate upstream, salmon reportedly did surmount that dam in occasional years because they were observed in large numbers in the North Yuba River at Bullards Bar during the early 1920s (Yoshiyama et al. 2001). Two fishways, one for low water and the other for high water, were constructed at Daguerre Point Dam prior to the floods of 1927-1928 (Clark 1929; CDFG 1991a), the fish ladders were destroyed, and were not replaced until 1938, leaving a 10-year period when upstream fish passage at
Daguerre Point Dam was blocked (CDFG 1991). That 10-year period coincided with the drought of 1928 through 1934, which raised water temperatures below Daguerre Point Dam much higher than those tolerated by Chinook salmon (Mitchell 1992 as cited in NMFS 2012). These conditions probably caused the extirpation of spring-run Chinook salmon from the lower Yuba River (Mitchell 1992 as cited in NMFS 2012). On the southern end of the dam, a fish ladder was constructed in 1938 and consisted of 8- by 10-foot bays arranged in steps with about 1 foot of difference in elevation between steps. However, it was generally ineffective (Sumner and Smith 1939). Two functional fish ladders were installed in 1951 by the State of California and it was stated that “With ladders at both ends, the fish have no difficulty negotiating this barrier at any water stage” (CDFG 1953).

Precipitation regimes in the region are highly variable in timing and quantity, with unpredictable autumn rainfall and occasional winter deluges producing a considerable part of the average annual runoff (USGS gage data 1858-2009). The flood of February 1963, estimated at about 120,000 cfs, washed out a section of Daguerre Point Dam between the mid-stream stations. During the summer of 1964, the Corps met with the USFWS and CDFG to develop criteria for the reconstruction and modification of the existing fishways at Daguerre Point Dam. Repairs were made in 1964 to Daguerre Point Dam and to the southern fish ladder, but before modifications could be made to the northern ladder, the flood of December 1964 washed out a portion of the dam that had not been reconstructed and eroded the underlying rock foundation to an estimated depth of 15 to 25 feet (Corps 2007). The floods of 1964 also washed out nearly all of the sediments and debris that had accumulated behind the dam up to that time. The flood of December 1964, estimated at about 180,000 cfs, also washed out the retaining walls of the Hallwood-Cordua diversion structure, completely destroyed the fish ladder headwork on the north as well as a large part of the original fish ladder, but the portion of the fish ladder completed with the rehabilitation from the 1963 floods of the dam was still intact (Dettmer, Memo For Record, 1964). Temporary repairs of the damage were made in February and March 1965. Extensions to the fish ladders were added, and slide gates, which also permit the passage of fish, were added to both upstream ends of the ladders in 1965 (Corps 2007). “Permanent repair of Daguerre Point Dam abutment and fish
facilities was completed in October 1965 at a cost of $447,808 with Federal and required State contributed funds on a matching basis." (ERDC 2008).

**PHYSICAL FACILITIES DESCRIPTION**

The current configuration of Daguerre Point Dam is a reinforced, overflow concrete ogee ("s-shaped") spillway with concrete apron and concrete abutments. The ogee spillway section is 575 feet wide and 25 feet tall (NMFS 2007).

There is no reservoir associated with Daguerre Point Dam. The dam is a low-head dam across the Yuba River. In addition to the dam structure, there are two fish ladders, each with a control gate. The two fish ladders utilize the hydraulic head created by the dam due to the influence of the dam preventing additional channel incision above the dam. The purpose of these two fish ladders is to permit salmon and steelhead access upriver to the seasonal spawning areas. There are no recreation facilities located at Daguerre Point Dam.

Daguerre Point Dam is the primary diversion point for water entering the Hallwood-Cordua Canal and the South Canal, which supply the water districts located north and south of the lower Yuba River, respectively. Water levels in the Hallwood-Cordua and South canals are manually controlled year-round using board weirs. Minimum water levels are maintained to ensure there is enough pressure for any user to divert water when needed (R. McDaniel, pers. comm. 2006 in YCWA et. al. 2007). While water elevations in these primary conveyances remain constant, the flow rates through these conveyances may change with changes in agricultural demands. The amounts of groundwater pumping by farmers have no effects on surface water levels in the primary conveyances. Even during seasons when farmers are implementing groundwater conjunctive use measures, water levels are maintained in the primary conveyances for those districts or farmers that are not participating in the conjunctive use programs.

**FISH LADDERS AND FISH PASSAGE**

Under the Environmental Baseline, there are numerous issues associated with anadromous fish passage at Daguerre Point Dam. NMFS (2007) stated that passage conditions at Daguerre Point Dam are considered to be inadequate for Chinook salmon and steelhead throughout much of the year due to the design of the existing ladders.
When high flow conditions occur during winter and spring, adult spring-run Chinook salmon and steelhead reportedly can experience difficulty in finding the entrances to the ladders because of the relatively low amount of attraction flows exiting the fish ladders, compared to the magnitude of the sheet-flow spilling over the top of Daguerre Point Dam. In addition, the NMFS (2007) stated that the angles of the fish ladder entrance orifices and their proximities to the plunge pool also increase the difficulty for fish to find the entrances to the ladders.

As previously described in this BA, other configuration and design features of the fish ladders and passage facilities that reportedly could either delay or impede anadromous salmonid access to spawning and rearing areas above the dam include: (1) the control gate, acting as a submerged orifice, is only passable at low flows (actual flow data are unavailable) during the summer and fall; (2) the ladders become clogged with debris; (3) insufficient attraction flows during non-overflow operational conditions; (4) unfavorable within-bay hydraulic characteristics, particularly associated with debris collection; (5) unfavorable fish ladder geometric configurations; and (6) sedimentation and unfavorable habitat conditions associated with egress from the fish ladders.

The Corps installed locking metal grates on 33 unscreened bays of the Daguerre Point Dam fish ladders in response to the Interim Remedy Order issued by the Court on July 25, 2011. Because the fish ladder bays are not uniformly sized, each metal grate needed to be custom fabricated by hand (Figure 5-1). Due to concerns expressed by both NMFS and CDFW, the Court then reconsidered the requirement to put grates over the bays on the lowermost section of the south fish ladder at Daguerre Point Dam. Consequently, grates were not installed over the lower eight bays of the south fish ladder at Daguerre Point Dam.

NMFS (2007) suggested that the biological consequences to anadromous salmonids of blockage or passage delays include changes in spawning distribution, increased adult prespawning mortality, and decreased egg viability, which may result in the reduction of the abundance and productivity of the listed species.

However, DWR and Corps (2003) stated that there is no direct evidence that holding below the dam when the fish ladders are not fully functional affects the condition of
salmon during their migration, except that repeated attempts to pass over the dam probably result in injury from contact with the rough concrete surface of the dam face. Moreover, short-term delays in spawning migration are not inherently problematic, and salmon and steelhead health and/or egg viability may not be adversely affected by short-term delays (DWR and Corps 2003). It has been suggested that water temperatures in the pool below Daguerre Point Dam may be higher than optimum for all salmonids during the warmer parts of the year, especially during low flow conditions in late summer, and that water temperature effects may adversely impact egg viability (DWR and Corps 2003). However, the RMT recently evaluated the potential effects of water temperatures on spring-run Chinook salmon, fall-run Chinook salmon and steelhead, by lifestage, using the mean monthly water temperature modeling conducted for the 2007 Lower Yuba River Accord EIR/EIS and water temperature monitoring data conducted from 2006 - 2012. The RMT (2013) included evaluation of water temperatures at Daguerre Point Dam during the spring-run Chinook salmon adult upstream immigration and holding lifestage, which addressed considerations regarding both water temperature effects to pre-spawning adults and egg viability, characterized as extending from April through August, and concluded that water temperatures were suitable.

Concern has been expressed that if emigrating salmon and steelhead juveniles encounter high water temperatures in the reach below Daguerre Point Dam, they cannot return to the lower-temperature habitat upstream because their passage is blocked by the dam (DWR and Corps 2003). However, this concern was raised prior to implementation of the Yuba Accord minimum flow schedules and associated water temperatures (initiated as Pilot Programs in 2006 and 2007, and now being implemented through the permanent changes made to YCWA’s water-right permits in 2008). The RMT (2013) also included an evaluation of water temperatures at Daguerre Point Dam and at the Marysville Gage on the lower Yuba River during the year-round juvenile rearing period for spring-run Chinook salmon and steelhead, and found that water temperatures remained at suitable levels.
Figure 5-1. Installation of metal grates on the Daguerre Point Dam fish ladder bays during August 2011 (Corps 2011).
NMFS (2007) and other documents (NMFS 2002; CALFED and YCWA 2005) suggest that juvenile salmonids may be adversely affected by Daguerre Point Dam on their downstream migrations, because Daguerre Point Dam creates a large plunge pool at its base, which provides ambush habitat for predatory fish in an area where emigrating juvenile salmonids may be disoriented after plunging over the face of the dam into the deep pool below. The introduced predatory striped bass and American shad have been observed in this pool (CALFED and YCWA 2005). It has been suggested that the rates of predation of juvenile salmonids passing over dams in general, and Daguerre Point Dam in particular, may be unnaturally high (NMFS 2007). However, DWR and Corps (2003) stated that there is no substantial evidence of predation on emigrating juvenile salmon by warmwater fish, and that temperature and habitat conditions in the lower Yuba River are not conducive to the establishment of significant populations of such fish, except perhaps in the Marysville area. Daguerre Point Dam may influence predation rates on emigrant juvenile anadromous salmonids, although DWR and Corps (2003) stated that there are no data indicating that such predation is significant, whether predation at the dam is offset by lower predation rates downstream, or even what percentage of juvenile salmonids are taken by predators. Presently, there are limited studies or data regarding predation rates on juvenile anadromous salmonids in the vicinity of Daguerre Point Dam relative to elsewhere in the lower Yuba River.

An additional issue associated with fish passage at Daguerre Point Dam relates to the abundance and distribution of rearing juvenile anadromous salmonids relative to predators. Most juvenile Chinook salmon and steelhead rearing has been reported to occur above Daguerre Point Dam (Beak 1989; CDFG 1991; SWRI et al. 2000). Kozlowski (2004) observed age-0 *O. mykiss* throughout the entire study area, with highest densities in upstream habitats and declining densities with increasing distance downstream from the Narrows. Approximately 82% of juvenile *O. mykiss* were observed upstream of Daguerre Point Dam. Kozlowski (2004) suggested that the distribution of age-0 *O. mykiss* appeared to be related to the distribution of spawning adults. The higher abundance of juvenile salmonids above Daguerre Point Dam may be due to larger numbers of spawners, greater amounts of more complex, high-quality cover, and lower
densities of predators such as striped bass and American shad, which reportedly are generally restricted to areas below the dam (YCWA et al. 2007).

The population viability assessments, which addressed population abundance and productivity of the listed species, were previously presented in Chapter 4 of this BA. It is uncertain the extent to which the design, operational and maintenance activities have incrementally contributed to the current status of the species, including their viabilities and extinction risks. However, potential effects on the populations associated with Daguerre Point Dam passage considerations were inherently included in the viability assessments.

Daguerre Point Dam was not designed for green sturgeon and is therefore a complete barrier to upstream passage because green sturgeon are unable to ascend the fish ladders on the dam, or otherwise pass over or around the structure. The scarcity of information on green sturgeon in the lower Yuba River makes it difficult to determine how these fish are utilizing the habitat in the river, or for what purpose green sturgeon are entering the river.

According to NMFS (2007), it is possible that the plunge pool below Daguerre Point Dam or other deep holes downstream of the dam provide suitable habitat for green sturgeon spawning. It is unlikely that any green sturgeon alive today could have been spawned above Daguerre Point Dam, and are attempting to return to their natal spawning habitat above the dam, because the dam has been in place longer than the expected maximum life span (60 to 70 years (Moyle 2002)) of green sturgeon.

At the time that the Daguerre Point Dam fish ladders were reconstructed in 1965, the fish passage facility and ladder design were developed following USFWS and CDFG provided criteria. If the ladders were to be reconstructed today, the Corps anticipates that the design would be considerably different, given the advances in fisheries biology, engineering, and technology that have occurred over the past 48 years, as well as changes in fisheries management objectives resulting from new species listings (e.g., green sturgeon) under the ESA.
In this BA, a distinction is made between effects on listed species attributable to designs of facilities that have been operational since 1965, and effects associated with the Corps authorized activities associated with the fish ladders. The Corps has the authority and discretion to lessen adverse effects associated with O&M of the fish ladders and sediment removal upstream of Daguerre Point Dam, removal of sediment and woody debris from the fish ladders themselves, and minor adjustments to the hydraulic performance of the ladders. Therefore, effects to listed species associated specifically with these activities are characterized as effects of the Proposed Action. All other effects associated with design of the ladders and the facilities are part of the Environmental Baseline.

**Operations and Maintenance Activities**

The Corps past operational criteria required that the fish ladders be physically closed when water elevations reached 130 feet, or when flows were slightly less than 10,000 cfs (SWRCB 2003), and to keep them closed until the water receded to an elevation of 127 feet (CALTED and YCWA 2005). However, current operation of the fish ladder gates differs from past operations in that the Corps coordinates with NMFS and CDFW to keep the gates open at all flow levels.

In 2003, the Corps first installed a log boom at the north ladder exit to divert debris away from the ladder. In June 2010, CDFW installed flashboards in the lower bays of the south fish ladder in an effort to improve attraction flows to the south ladder (Grothe 2011). Since completing this work, CDFW reported that the number of fish moving through the south ladder increased compared to numbers recorded prior to installation of the flashboards.

On October 20, 2010, CDFW advised the Corps that staff from the Pacific States Marine Fisheries Commission (PSMFC) had documented as many as a dozen fall-run Chinook salmon that had jumped out of the south fish ladder over the previous 4 to 6 weeks. That same day, Corps staff placed plywood boards over the bay from which the fish reportedly jumped as a temporary measure to prevent any more fish from escaping the ladder. By email dated November 5, 2010, Duane Massa, a project manager for PSMFC, provided additional information to the Corps regarding the incident. According to Mr. Massa, PSMFC maintenance logs indicated that six fall-run Chinook salmon carcasses were
observed outside the south fish ladder over a period of four weeks (September 27, 2010 –
October 26, 2010) rather than one dozen as initially reported. No further incidences of
fish escaping the ladder were reported during 2010 (D. Massa, PSMFC, pers. comm.
2010). More recently, in response to the Interim Remedy Order issued by the Court on
July 25, 2011, during the summer of 2011, the Corps proceeded with installation of
locking metal grates on 33 unscreened bays. Due to concerns expressed by both NMFS
and CDFW, the Court then reconsidered the requirement to put grates over the bays on
the lowermost section of the south fish ladder at Daguerre Point Dam (Figure 5-2 and
Figure 5-3). Consequently, grates were not installed over the lower eight bays of the
south fish ladder at Daguerre Point Dam.

The fish ladder upstream exit periodically becomes ineffective due to sediment buildup in
the channel, which acts as a barrier that prevents upstream fish migration. As an example
of the maintenance activities typically conducted, CDFW observed fall-run Chinook
salmon migration problems resulting from a clogged channel at the north fish ladder
upstream exit during fall of 1999. The Corps, in cooperation with CDFW, excavated the
entire area just upstream from the ogee spillway, as well as two deeper channels running
diagonally from each ladder upstream toward the middle of the river channel. The gravel
bar that blocked access from the south ladder also was cleared to allow access to the river
channel (Corps 2001). During 2009, the Corps dredged the upstream side of Daguerre
Point Dam to provide egress from the fish ladders and continued fish passage
opportunity.

Gravel buildup can itself block fish passage, as well as further reduce attraction flows in
the fish ladders at Daguerre Point Dam. As discussed in the July 8, 2010 Order of the
United States District Court, Eastern District of California, in Case No. Civ. S-06-2845
LKK/JFM, the Corps has implemented a plan to ensure that a minimum 30 foot wide by
3 foot deep channel remains open to facilitate fish passage and avoid blocking
attraction flows.
Figure 5-2. North fish ladders at Daguerre Point Dam (Corps 2012c).

Figure 5-3. South fish ladders at Daguerre Point Dam (Corps 2012c).
In late August 2010, the Corps removed sediment that had accumulated on the north side of the channel upstream of Daguerre Point Dam (Grothe 2011), and the material that was removed was disposed of above the ordinary high water mark. Again during August 2011, the Corps removed sediment that had accumulated upstream of Daguerre Point Dam and placed that excavated material above the ordinary high water mark. The Corps also inspected the sediment depth upstream from Daguerre Point Dam and cleared sediment and gravel from the channels upstream of the dam and along the upstream face of the dam on August 7, 2012. Because the Yuba River was too deep at that time, the gravel was moved to the downstream gravel bar in late October 2012 (D. Grothe, Corps, pers. comm. 2013).

**DAGUERRE POINT DAM FISH PASSAGE IMPROVEMENT STUDIES**

In 1994, the Yuba River Technical Working Group and the USFWS identified fish passage issues at Daguerre Point Dam (DWR and Corps 2003). As a result, a preliminary evaluation of measures and alternative concepts to improve fish passage was conducted by the Corps and others.

Initiated by the State Legislature and the California Bay-Delta Program agencies in 1999, the Fish Passage Improvement Program (FPIP), an element of the ERP, is a partnership-building effort to improve and enhance fish passage in Central Valley rivers and streams (DWR 2005a). The program works with other local, State, and Federal agencies and stakeholders to plan and implement projects to remove barriers that impede migration and spawning of anadromous fish. FPIP does not provide for screening diversions.

In 1999, CALFED established the Upper Yuba River Studies Program, a stakeholder-driven collaborative process to discuss fish passage. Also in 1999, the AFRP funded a project to develop fish screen and diversion bypass feasibility alternatives at the Hallwood-Cordura Irrigation District Diversion.

In 1999, USFWS funded a Corps Preliminary Fish Passage Improvement Study of fish passage alternatives at Daguerre Point Dam (Corps 2001). Initiated in 2001, DWR and the Corps undertook the preparation of a joint Draft EIR/EIS to evaluate the Daguerre Point Dam Fish Passage Improvement Project on the Yuba River.
According to CALFED and YCWA (2005), the USFWS Fish Passage Improvement Study identified the following concerns with Daguerre Point Dam’s fishways for upstream migration of adult fish:

- The fish ladder control gate entrance, acting as a submerged orifice, is more passable at low flows during summer and fall rather than at high flows during winter and spring
- The fish ladder exit sometimes becomes unusable due to clogging by woody and non-woody debris
- Fish may have difficulty finding the orifice during high flows
- The fish ladders are narrow and have low flow capacities

The passage study also identified the following concerns for emigration of juvenile anadromous fish:

- Emigration may be impeded during low flows
- Pools immediately upstream and downstream harbor piscivorous fish
- Fish may be injured or killed by passing over the dam
- Water diversion operations may trap fish

The Daguerre Point Dam Fish Passage Improvement Project aims to improve upstream and downstream passage for all lifestages of native anadromous fish, while keeping water interests whole and with no increase in downstream flood risks (DWR 2011). Historically, DWR has had a cost sharing agreement with the Corps on any fish passage improvement or studies regarding Daguerre Point Dam. Stakeholders and partner agencies were developing a restoration prioritization plan, and implementing other actions to improve habitat conditions in the lower Yuba, including separate actions implemented through the Lower Yuba River Accord.

Several documents related to the Daguerre Point Dam Fish Passage Improvement Project have been completed. These documents include: (1) a draft of the Daguerre Point Dam Fish Passage Improvement Project Alternative Concepts Evaluation, released in September 2003; (2) a stakeholder review draft of the Analysis of Potential Benefits to
Salmon and Steelhead from Improved Fish Passage at Daguerre Point Dam released in March 2003; and (3) a stakeholder review draft of the Daguerre Point Dam Fish Passage Improvement Project 2002 Water Resources Study for DWR and the Corps, released in June 2003 (DWR 2011).

In 2008, NMFS awarded a contract to evaluate options for fish passage in the Yuba River (DWR 2011). The main goal of that study was to identify and describe potential fish passage facilities for the reintroduction of spring-run Chinook salmon and steelhead in the upper Yuba River watershed. The study included fish passage option considerations at Daguerre Point Dam (NMFS 2010).

**DIVERSIONS IN THE VICINITY OF DAGUERRE POINT DAM**

As development intensified within the Yuba River Basin during the early 1950s, the lower Yuba River and Daguerre Point Dam took on a new purpose. The people of Yuba and Sutter counties recognized the demand for securing, utilizing, and distributing available water resources for the impending domestic and agricultural development. The function of Daguerre Point Dam subsequently evolved to provide additional benefits for water supply purposes (DWR and Corps 2003b). There are three water diversions associated with Daguerre Point Dam, which utilize the elevated head created by the dam, or the influence of the dam in the prevention of additional river channel incision, to gravity-feed their canals. The three diversions are the Hallwood-Cordua diversion, the South Yuba/Brophy diversion, and the Browns Valley Irrigation District (BVID) diversion (**Figure 5-4**).

Diverters using these facilities divert water under their own water rights, purchase water from YCWA, or do both. YCWA has contractual agreements to deliver water to these irrigation districts, and the three diversions have a combined capacity of 1,085 cfs. As with the Yuba River Development Project, the Corps does not regulate water right diversions or control: (1) whether or not water is diverted from the lower Yuba River

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1 The “elevated head” at Daguerre Point Dam is created by the hydraulic conditions associated with water being impounded behind (i.e., upstream) of the dam. The Corps has no control over the in-river flows, and has no discretionay control over the “head” for local water users in the vicinity of Daguerre Point Dam.
through the three agricultural diversions near Daguerre Point Dam (i.e., Hallwood-Cordua, South Yuba-Brophy, and BVID); (2) the quantity and timing of those diversions; or (3) the ultimate use of the water once diverted (Corps 2012b). From the primary conveyances, the irrigation districts use smaller ditches to supply water to their customers according to the following seasonal considerations:

- **Irrigation Season**, April 1 through October 15
- **Waterfowl/Straw Management Season**, October 15 through January 31
- **Maintenance Season**, January 31 through April 1

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

**HALLWOOD-CORDUA NORTH CANAL**

Hallwood Irrigation Company and Cordua Irrigation District divert water from the Hallwood-Cordua Diversion (also referred to as the “North Canal”) under pre-1914 and post-1914 appropriative water rights and contracts with YCWA. The license issued by the Secretary of War to the Hallwood Irrigation Company and the Cordua Irrigation District (formerly the Stall Ditch Company) in 1911 allow Hallwood and Cordua to continue their diversions of water from the Yuba River, which pre-dated the construction of Daguerre Point Dam.

Cordua Irrigation District is located in an area covering approximately 11,400 acres. Cordua Irrigation District’s first surface water deliveries from the lower Yuba River began in the late 1890s, with receipt of water deliveries under the YCWA contract beginning in October 1971 (YCWA 2008). Rice is the primary crop, which is irrigated primarily by surface water diverted under a combination of water rights (totaling 60,000 acre-feet per year) and under a contract with YCWA (for 12,000 acre-feet per year), for an annual surface water supply of up to 72,000 acre-feet.
Figure 5-4. Non-Federal water diversion facilities in the vicinity of Daguerre Point Dam on the lower Yuba River.
The Hallwood-Cordua Diversion (Figure 5-5), a gravity flow diversion facility located on the north bank of the lower Yuba River at Daguerre Point Dam, has a diversion capacity of 625 cfs (SWRCB 2001). The diversion was originally screened in 1972, and later modified in 1977 (CALFED and YCWA 2005). The Hallwood-Cordua fish screen located in the North Canal utilized a V-shaped perforated plate screen constructed, operated and maintained by CDFW. A bypass system diverted fish captured by the screen into a collection tank, and collected fish were returned to the river either through a pipeline or by truck (SWRCB 2001). CDFW initially operated the fish screen in the North Canal, located approximately one-quarter mile down the canal from the river, for intermittent periods during the Chinook salmon juvenile emigration period of April through June (SWRI et al. 2000).

The original design and operation of the Hallwood-Cordua fish screen resulted in the losses of significant numbers of fish (SWRCB 2001). During some years, the fish screen was not operated at all, which resulted in occasions when reportedly up to a million juvenile salmonids were entrained in the diversion (CALFED and YCWA 2005). When operational, the CDFW screen was reported to be effective in preventing the entrainment and impingement of juvenile salmonids, but salmonid losses reportedly did occur as a result of predation in the intake channel between Daguerre Point Dam and the CDFW fish screen. In addition, predation resulted from the removal of the screen by CDFW during the emigration period of juvenile steelhead (YCWA et al. 2000).

Figure 5-5. Hallwood-Cordua Diversion. Image on the left shows the control gate headworks on the north abutment of Daguerre Point Dam. Image on the right shows the current v-shaped screen (Source: YCWA 2013b).
According to SWRCB (2001), the number of Chinook salmon entrained at a diversion facility is related to the percent of river flow that is diverted. SWRCB (2001) reported that an analysis of the daily North Canal fish screen trap records for 1972 to 1991 by the USFWS showed that the number of juvenile salmonids entering the trap was directly related to the percent of river flow diverted. Fish losses also occurred at the fish trapping facility that returned fish from the diversion canal to the river. The long distance between the diversion channel intake and the fish screen, low bypass flows, and excessive handling of the fish stopped by the screen all contributed to the loss of salmonids at the Hallwood-Cordua fish screen (SWRCB 2001).

In 1999, CDFW began an outmigration study of juvenile salmonids using a rotary screw trap located in the lower Yuba River near Hallwood Boulevard. CDFW reported that significant numbers of juvenile Chinook salmon, including spring-run Chinook salmon, were captured in the traps, and recently emerged steelhead also were present throughout the summer months (SWRCB 2001). Steelhead as small as 24 mm were observed in July, with 27 and 37 mm fish observed during August and September. Based on the size and numbers of juvenile steelhead and Chinook salmon present throughout the year, it was determined that large numbers of fish were vulnerable to entrainment at the Hallwood-Cordua Diversion. In addition, CDFW stated that the 5/32 inch mesh size of the Hallwood-Cordua fish screen was much larger than the 3/32 inch mesh recommended by CDFW and NMFS (SWRCB 2001). The ineffectiveness of the screen in salvaging fry-size fish was evident when comparing catches at the screen with catches in the rotary screw trap during the same period. During periods when catches of fry-size fish were still high in the rotary screw trap, the fish screen was capturing no fish in that size range. In addition, the approach velocities at approximately 25% of the screen area exceeded approach velocities that were, and still are, recommended by NMFS and CDFW. CDFW recommended installation of a fish screen at the Hallwood-Cordua diversion that meets the criteria established by NMFS and CDFW for protection of juvenile Chinook salmon and steelhead (SWRCB 2001).

Consequently, the Hallwood-Cordua fish screen was replaced with a screen that more closely conforms to CDFW and NMFS criteria in 2001. This screen is at the same
location, but has appropriate openings and sweeping and approach velocities to facilitate
direct return of screened fish back to the river below Daguerre Point Dam. Additionally,
the fish screen is operated for the entire diversion season (NMFS 2002). Although this
fish screen does not meet all of CDFW and NMFS criteria, the rehabilitation efforts
included the installation of the proper-sized screening material and have allowed
continuous operation of the screen throughout the irrigation season along with the direct
return of screened fish back to the river below the dam (NMFS 2007). The Corps was
not involved in the 2001 Hallwood-Cordua fish screen replacement, nor does the Corps
operate or maintain the fish screen facility or have discretionary control over it.
Therefore, the effects of operation and maintenance of the fish screen facility at the
Hallwood-Cordua diversion location at Daguerre Point Dam is not part of the Proposed
Action and is therefore included as part of the Environmental Baseline.

**SOUTH YUBA/Brophy DIVERSION CANAL AND FACILITIES**

Approximately 1,000 feet upstream of Daguerre Point Dam on the south side of the river,
the South Yuba/Brophy Diversion Canal and Facilities divert water through an excavated
channel from the Yuba River's south bank. The South Yuba/Brophy diversion facility
includes a 450-foot long porous rock weir fitted with a fine-mesh barrier (geotextile
cloth) within the weir, intended to protect juvenile fish from becoming entrained into the
canal (Corps 2007).

The South Yuba/Brophy Diversion Canal and Facilities was constructed in the mid-
1980s. Prior to construction of the diversion headworks, the rate at which water could be
diverted was limited by flows in the lower Yuba River and the percolation rate through
the dredge spoil gravel mounds (USFWS 1990).

The South Yuba Water District encompasses about 9,800 acres of land, with the primary
crops consisting of rice and pasture (YCWA 2008). The South Yuba Water District
began receiving surface water jointly with Brophy Water District in 1983.

Brophy Water District serves approximately 17,200 acres of land, with rice being the
dominant irrigated crop, distantly followed by pasture and field crops (YCWA 2008).
Since 1985, all water from the lower Yuba River used by the Brophy Water District has been delivered through the South Canal under contract with YCWA.

The South Yuba/Brophy diversion headworks are located above Daguerre Point Dam on the Yuba River, adjacent to the Yuba Goldfields, roughly 9 miles northeast of Marysville, California (Demko and Cramer 2000a). The diversion headworks consist of an intake channel and bypass channel (collectively called the diversion channel), a porous rock gabion, a diversion pond behind the rock gabion and an irrigation canal existing at the diversion pond (Figure 5-6). The South Yuba/Brophy Diversion Canal and Facilities (or the South Canal) is a gravity flow diversion with a current diversion capacity of 380 cfs (SWRCB 2001), and it is authorized to divert water at a rate of up to 600 cfs (DWR and Corps 2003).

Water flows from the mainstem of the lower Yuba River into the diversion channel (side channel of the Yuba River) where it percolates through the porous rock gabion and surrounding gravel deposits into the diversion pond (Corps 2001).

Figure 5-6. Diversion headworks area for the South Yuba/Brophy Diversion Canal and Facilities.
The pond has a surface area of about 3 acres. The rock gabion consists of cobble size rock, and is roughly 400 feet long, ranging in width from roughly 30 feet at the base to 10 feet at the top. A fine-meshed, geotextile fabric was placed a few feet inside the riverside of the rock gabion during construction to prevent juvenile salmonids from passing through the rock gabion (Corps 2001).

At the far south end of the pond into which water percolates (approximately 300 feet away from the rock gabion) three 5-feet diameter pipes withdraw water from the pond to the main irrigation canal (Demko and Cramer 2000a).

Gates at the entrance of each pipe allow the flow of water to be controlled manually (Corps 2001). The pipes extend underground approximately 450 feet from the southwest corner of the diversion pond to the head of the main irrigation canal. Water can also enter the main irrigation canal by natural seepage. At times when water demand in the irrigation districts is low, the demand can be met entirely from seepage (around 100 cfs) into the canal (Demko and Cramer 2000a). The diversion channel and the head control structure require regular maintenance to remove accumulated gravel and debris deposited during high flows (USFWS 1990).

Some of the water that enters the diversion channel remains in the channel as it passes the rock gabion and flows back to the lower Yuba River through a lower portion of the diversion channel referred to as the bypass channel. The bypass channel extends roughly 450 feet from the downstream end of the rock gabion to the box culvert, which is located about 270 feet upstream of Daguerre Point Dam.

The diversion system and the percolation water outfall system are directly connected at an eight foot culvert and check structure located in a dredge pond near the river diversion facility (USFWS 1990). During the irrigation season (April-November), headboards are placed in the check structure to increase pond storage and capture percolation flows for conveyance. The headboards are pulled during the non-irrigation season to reduce pond storage and allow percolation water to return to the river via the culvert and outfall. The Corps has no involvement in these activities. As of 1990, USFWS (1990) reported that a seasonal dam located near the culvert protects the culvert structure during high winter flow conditions. When percolation flows exceed the capacity of the culvert, the seasonal
dam was designed to blow-out and allow the high flows to bypass the culvert and return to the lower Yuba River via the outfall channel. This seasonal dam and blow-out feature also provided for winter-time flood protection of the various structures and activities occurring in the Goldfields Area (USFWS 1990).

Although the diversion structure addressed CDFW fish screening requirements at the time of construction in 1985, fish screening requirements have changed over time and the diversion structure does not meet current NMFS and CDFW screening criteria. Screening criteria issues associated with the diversion structure include potential non-compliance with: (1) screen space size (i.e., 3/32 inch mesh size); (2) screen porosity; (3) uniformity of approach velocity; (4) sweeping flow; and (5) cleaning frequency. Additional issues associated with the diversion structure include predation in the channel that leads to the diversion and at the face of the rock weir, and overtopping of the weir and subsequent entrainment of juvenile salmonids behind the weir.

The interstitial spaces between the rocks of the levee are larger than the maximum 3/32 inches required by NMFS fish screening criteria (CALFED and YCWA 2005). The fine mesh barrier imbedded within the rock gabion was designed to prevent fry or juvenile salmonids from passing through the gabion. However, it has been suggested that flows, at times, reportedly are not sufficient to sweep fry along the face of the rock gabion and, as a result, fry may become impinged or entrained into the diversion (CALFED and YCWA 2005).

NMFS (2007) also discussed the effects on salmonids of the South Yuba/Brophy Diversion Canal and Facilities, and stated that the fine-meshed, geotextile fabric buried within the rock gabion weir at this diversion “may meet the opening size criteria (if it is still intact) but there is obviously no sweeping flow along the face of this fabric inside of the weir and therefore any fry which encounter this mesh, instead of being swept along the face of the fabric, would be more likely to become impinged on the fabric and perish.” NMFS (2007) also noted that several studies have suggested that the structure does not exclude juvenile salmonids from being entrained into this diversion.

By agreement with CDFW, at least 10% of the water diverted into the diversion channel is required to bypass the rock gabion and flow back to the river, to allow migrant fish
entering the diversion channel to return to the river. However, it has been reported that
the 10% bypass flow has not always been met historically (NMFS 2002). In September
2010, YCWA replaced the two 48-inch culverts located at the downstream terminus of
the bypass channel with a concrete box culvert and then restored the site. YCWA
undertook the project to improve water flow at various river stages, reduce debris
loading, and reduce maintenance. Installation of the concrete box culvert also was
necessary to efficiently accommodate new flow metering equipment to measure the flow
returning to the Yuba River from the diversion channel. YCWA installed a downlooking
acoustic Doppler flow meter was installed in the access port in the box culvert, and the
flow meter was connected to the data monitoring and communication equipment located
in the concrete building at the south abutment of Daguerre Point Dam. These
improvements were made to ensure that the 10% return flows occur in the future pursuant
to the stipulated settlement and order in the SYRCL v. NMFS case. High flows during
the winter and spring of 2010/2011 resulted in the deposition of sediment and debris
requiring clearance and maintenance of the box culvert and immediate vicinity, prior to
the installation of the flow monitoring equipment.

In addition, predation of juvenile anadromous salmonids in the pool located within the
diversion channel in front of the porous rock gabion has been raised as an issue by
CDFW and NMFS. Construction of the porous rock gabion has resulted in a relatively
wide, deep pool directly in front of the rock gabion characterized by reduced water
velocities, which potentially could delay the continued downstream migration of juvenile
salmonids (NMFS 2002). The pool also reportedly provides holding and ambush habitat
for predatory fish such as Sacramento pikeminnow (NMFS 2002).

The issues of predation, impingement, and entrainment at the South Yuba/Brophy
Diversion Canal and Facilities have been the subject of numerous evaluations over the
past many years. A brief summary of the various studies and resultant findings is
presented in chronological order hereas follows.

Pursuant to the 1984 Agreements between the South Yuba Water District and the Brophy
Water District and CDFW, South Yuba/Brophy built Alternative No. 4, which stipulated
additional criteria including “c. A return diversion will provide for returning at least 10%
of the quantity diverted back into the river." In 1988, CDFG (1988a) conducted a mark-recapture study to: (1) evaluate the effectiveness of the rock gabion; and (2) determine whether bypass flows were at least 10% of the diverted quantity.

The mark-recapture survey was conducted using a fyke net located in the upstream portion of the diversion channel, and two additional fyke nets located near the downstream terminus of the bypass channel. During the first treatment period, which began on May 11, 1988, a total of 4,746 salmon were captured in the upstream fyke net, whereas a total of 2,684 salmon were captured during the second treatment period (CDFG 1988a). The recapture rate at the downstream fyke nets after 72 hours approached zero. According to CDFG (1988a), the results of this mark-recapture study showed that less than 95% of the marked fish made it through the bypass canal, potentially because of the large predator (Sacramento pikeminnow) populations that existed in the diversion channel. CDFG (1988a) suggested that losses of juvenile salmonids at the South Yuba/Brophy diversion were between 40 and 60%. However, Cramer (1992) used the observed capture efficiency estimates to expand the number of marked fish recovered by CDFG (1988a) and found that estimated survival from the mouth of the diversion channel all of the way to the bypass exit was substantially higher than the estimates given by CDFG (1988a) and likely exceeded the 95% survival criterion stipulated by CDFW. During this study, Sacramento pikeminnow were observed feeding on juvenile salmonids as they attempted to migrate out of the diversion channel (CDFG 1988a). Flow measurements were taken by a SWRCB engineer, with assistance from CDFW and USFWS, at the following locations: (1) the inflow to South Yuba/Brophy Diversion Canal and Facilities (downstream of the intake fyke); and (2) the return flow to the lower Yuba River in the bypass canal (just downstream of the upper bypass fyke). Bypass flows exceeded 10% of the diverted flows of water during both treatment periods (CDFG 1988a).

Juvenile salmonids have been collected behind the rock gabion. These fish either passed through the mesh barrier or were washed over the top of the rock gabion during high flows (NMFS 2002). Juvenile sampling surveys have had mixed results in capturing salmon behind the rock gabion fish screen (USFWS 1990). An electrofishing survey of...
the diversion pond was conducted by CDFW in March 1987. Although juvenile salmonids were found in the pond behind the rock gabion prior to this study, salmonids were not captured when the pond was electrofished (CDFG 1988a). However, Preston (1987 as cited in CDFG 1988a) stated that three juvenile Chinook salmon were captured behind the gabion prior to diversions from the river. In that year, flows in the lower Yuba River reportedly did not exceed 2,000 cfs that could over-top the present height of the gabion, and allow for fish to pass over the gabion (USFWS 1990).

In April 1989, USFWS seined 31 juvenile Chinook salmon ranging in size from 46 to 70 mm fork length in the diversion pond area behind the rock gabion (USFWS 1990; SWRCB 2001). These fish reportedly had become trapped in the pond prior to any diversion. Although this was the only date USFWS seined the diversion pond, USFWS also observed several hundred juvenile salmonids feeding in the same area on May 5, 1989. After diversions began about May 10, 1989, USFWS (1990) did not observe any Chinook salmon in the diversion pond.

The entire back side of the rock gabion fish screen was observed during a scuba dive survey on May 11, 1989 (USFWS 1990). Water depth at the base of the gabion was approximately 20 feet with water visibility about 6 feet. The rock material was consistent in size and placement along the entire screen face. USFWS (1990) did not observe any unusually large sized openings that would allow for unimpeded flow through the gabion. An unknown amount of water was being diverted from the river through the gabion, and this diversion did not create any noticeable head differential between the pool in front of the gabion and the pool behind. The gabion appeared to be fairly fish tight (USFWS 1990). USFWS (1990) concluded that the salmon collected in 1989 behind the gabion most likely were washed into the pond during early March when river flows exceeded 20,000 cfs and over-topped the gabion structure. Although USFWS (1990) did not directly observe the flooding of the gabion, based on the accumulation of woody debris and dead leaves in small shrubs along the top of the gabion, it appeared that about 1 to 2 feet of water flowed over the north end of the structure. Flow measurements at Marysville from 1969 to 1989 indicate that flows that overtop the levee (exceeding 20,000 cfs) have occurred numerous times in eight of those 20 years (SWRCB 2001).
To determine whether juvenile fish were passing through the rock gabion, Demko and Cramer (1992 as cited in Corps 2001) installed a fyke net on the outfall of the diversion pipe that enters the South Yuba/Brophy irrigation canal. They sampled continuously whenever water was diverted, from the day water diversions began on May 7 through July 22, and captured 17 juvenile Chinook and 2 steelhead fry during the sampling period. However, all Chinook salmon caught in the irrigation canal were substantially larger than those migrating down the river at the same time, and Demko and Cramer (1993) concluded that the large juvenile Chinook could not have passed through the interstitial spaces in the rock gabion at the time they were captured. They deduced, as did the USFWS in the 1988 study (USFWS 1990), that fish were not passing through the porous dyke, but rather that a small number of fish passed into the diversion pond during winter during times of high flows that over-topped the rock gabion (Corps 2001). However, CDFW suggested that the fyke net, constructed of 1/8 inch mesh, used in the study may not have been efficient for small salmonids and SWRCB (2001) suggested that the number of small juvenile steelhead entering the irrigation canal, therefore, may have been significantly underestimated. Regardless of the manner in which fish entered the diversion pond, SWRCB (2001) suggested that fish, including listed species, continued to be lost from the lower Yuba River fishery at the rock gabion.

In August 1993, Demko and Cramer (1993) observed nineteen 20 cm and larger pikeminnow in the diversion channel that were large enough to be predators of juvenile Chinook salmon. However, Cramer (2000 as cited in Corps 2001) reviewed all studies performed at the South Yuba/Brophy diversion, and found that none of the research by USFWS, CDFW or fisheries consultants had indicated that juvenile Chinook became disoriented upon entering the diversion channel, or that abnormally high predation on juvenile Chinook salmon occurred in the diversion channel.

SWRCB (2001) stated that during the 2000 SWRCB hearing, USFWS presented data showing that bypass flows in the return channel were at times less than 10% of the water diverted, and recommended that higher bypass flows be maintained. SWRCB (2001) also stated that because there was no way to prevent water from entering the diversion channel when water was not being diverted into the South Canal for irrigation, losses at
the diversion facilities due to predation and other factors occur even when no water is being diverted for beneficial use (SWRCB 2001). USFWS presented evidence to the SWRCB that deposition and accumulation of gravel and debris in the diversion channel as a result of floods or other events can adversely affect flow and migration of juvenile salmon through the diversion facility (SWRCB 2001).

On July 8, 2004, representatives of CDFW and NMFS made a series of water velocity measurements along the face of the permeable rock gabion that separates the lower Yuba River from the headgates for the South Yuba/Brophy diversion. The purpose of the flow measurements was to characterize the flow conditions along the upstream face of the rock gabion. The flow along the upstream face of the rock gabion appeared to be irregular and complex in all three components of the velocity measurements (NAFWB 2004). According to NAFWB (2004), this was probably due to roughness of the gravel/cobble surface, irregularities in the rock gabion profile, differences in the permeability along the length of the rock gabion, and variations in the plugging of the upstream face of the rock gabion. Approach velocities varied from -0.054 feet per second (fps) to 0.686 fps with mean velocity of 0.052 fps. One approach velocity measurement exceeded 0.33 fps. Sweeping velocities varied from -0.167 fps to 1.034 fps with mean velocity of 0.260 fps. Two sweeping velocity measurements exceeded 0.67 fps. The head loss across the rock gabion was approximately 0.9 feet on the day of the measurements (NAFWB 2004).

On August 30, 2011, PSFMC personnel and YCWA representatives conducted a reconnaissance survey to investigate the presence/absence of predatory fish in the South Yuba/Brophy diversion channel. A jet boat was used to navigate through the diversion channel, initially entering from the upstream point of the diversion channel and drifting downstream to the box culvert at the lower end of the diversion channel (Figure 5-6). During the first pass, six fish, preliminarily identified as pikeminnow, ranging from approximately 16 to 20 inches in length were observed at about the mid-way point of the diversion channel. Three additional pikeminnow also approximately 16 to 20 inches in length were observed during a second pass, which was taken in an upstream direction from the box culvert crossing to the upstream point of the diversion channel. The jet boat then drifted down to the lower portion of the diversion channel and then slowly powered
upstream. At approximately the mid-point of the diversion channel, pikeminnow were observed darting ahead of the boat and continued to do so until 13 pikeminnow were observed darting ahead of the boat into a relatively deep, fast flowing section at the upstream end of the diversion channel.

During May and June of 2012, field studies were conducted to investigate potential sources of juvenile Chinook salmon and steelhead mortality associated with the South Yuba/Brophy Diversion Canal and Facilities, including: (1) predation due to a concentration of predators in the diversion canal; and (2) entrainment or impingement caused by fish becoming trapped in the permeable rock gabion.

The data suggest that the diversion channel does not support a unique concentration of predators (Bergman et al. 2013). Adult pikeminnow densities were not significantly different between the diversion channel and the mainstem lower Yuba River adjacent to the diversion. Similarly, previous snorkeling surveys conducted in the diversion channel found relatively low abundances of adult Sacramento pikeminnow, with only 12 fish observed in 1988 (CDFG 1988a) and 19 in 1993 (Demko and Cramer 1993).

According to Bergman et al. (2013), approach velocities (perpendicular) and sweeping velocities (parallel) varied along the upstream side of the permeable rock gabion, and ranged from -0.15 to 0.17 meters per second (m/s) and -0.15 to 0.31 m/s, respectively (Figure 5-7). Although variable along the face of the rock gabion, approach velocities were relatively low, with only 15 of 147 locations having approach velocities above 0.06 m/s, and 0.17 m/s being the highest velocity observed. Sweeping velocities were lower at the up-river and down-river ends of the rock gabion (-0.14 to 0 m/s) and consistently higher in the middle of the gabion. The observed variability is likely due to the roughness of the gravel/cobble substrate, irregularities in the gabion profile, and differences in the permeability along the rock gabion, as was previously concluded by CDFG (2004, as cited in Bergman et al. 2013).

Bergman et al. (2013) concluded that present operations at the diversion facility provide adequate bypass flows to create positive sweeping velocities along the rock gabion, and measured approach velocities satisfied NMFS approach velocity standards except at a
bend at the upstream end of the rock gabion, where an eddy draws water up-river (Bergman et al. 2013). The end of the gabion where an eddy draws water up-river was identified because this anomalous area of higher approach velocities did not meet the NMFS (2011d) criteria of providing “nearly uniform” flow distribution along the face of a screen and, thus, may increase susceptibility of juvenile salmonids to impingement or entrainment. To improve these conditions, Bergman et al. (2013) state that re-grading the upstream entry into the diversion channel by “smoothing out” the pronounced bend could provide more uniform flow distribution along the face of the rock gabion.

Underwater video showed no evidence for impingement or entrainment risk to juvenile salmonids along the permeable rock gabion, and little risk even to larval fish much smaller than the juvenile salmonids. The interstitial spaces along the rock gabion and the back side of cobbles were used as temporary cover by juvenile salmonids. Bergman et al. (2013) also observed that juvenile salmonids moved freely along the river bottom between cobbles, without indication of being drawn into the interstices within the rock gabion.
Daily bypass flows measured during 2012 were consistently above 10% of the diverted flow, and bypass flows ranged from 40 to 80 cfs (Bergman et al. 2013). According to Bergman et al. (2013), present operations provide adequate bypass flows to create positive sweeping velocities along the rock gabion.

**Wheatland Project**

The Wheatland Water District (WWD) is located in Yuba County in the southeastern portion of the South Yuba Basin, with much of the district located between Best Slough and Dry Creek, east of Highway 65 (YCWA 2008). Wheatland’s service area contains about 10,400 acres, which are dominated by orchards, pasture, and rice. Historically, agricultural water demands were met with groundwater. The intense groundwater use in this area resulted in declining groundwater levels and deteriorating groundwater quality, forcing the abandonment of several wells. The project was jointly financed by YCWA, WWD and a grant from DWR. Completed in 2010, a canal was built to enable YCWA to provide water from the South Canal to WWD. Providing surface water in-lieu of groundwater pumping is intended to improve local groundwater conditions within the district and the surrounding areas, including the City of Wheatland, which is currently entirely dependent on groundwater (YCWA 2008).

The Yuba Wheatland In-Lieu Groundwater Recharge and Storage Project (Wheatland Project) supplies surface water from the YCWA South Canal to agricultural lands within the WWD and the Brophy Water District in southern Yuba County (YCWA 2012a). This surface water supply is intended to improve the water quality and water supply reliability to farmers who mainly rely on groundwater to grow crops such as fruit, nuts, rice and pasture for cattle. The project also is intended to recharge depleted groundwater aquifers and provide opportunities for conjunctive use of surface and groundwater supplies to enhance the reliability of YCWA’s water system (YCWA 2012a).

YCWA diverts water from the lower Yuba River through the South Yuba/Brophy diversion structure located near Daguerre Point Dam and conveyed via the South Canal to the WWD’s service area in southern Yuba County. Many of the ongoing effects associated with the existence of the South Yuba/Brophy Diversion Canal and Facilities may appropriately be considered stressors under the Environmental Baseline. Updated
demand projections indicate that annual water deliveries to the Wheatland Project in the future are projected to increase up to about 35,000 to 36,000 acre-feet, depending on water year type. Projected future Wheatland Project demands are represented in modeling simulations for future Cumulative Conditions (for additional detail, see Chapter 7 and Appendix F).

Through a separate environmental process, YCWA is developing a fisheries improvement project at the South Yuba/Brophy Diversion Canal and Facilities that is investigating and addressing potential NMFS and CDFG fisheries compliance issues. Potential construction-related effects to listed species and their critical habitats in the lower Yuba River associated with YCWA’s proposed fisheries improvement project at the South Yuba/Brophy Diversion Canal and Facilities will be evaluated and addressed through a separate ESA consultation process. The Corps is not responsible for the operations or maintenance of the diversion facility or any appurtenant facilities, and the Corps will not be responsible for these activities in the future.

**Browns Valley Irrigation District Diversion**

Formed in 1888, BVID is an agricultural water purveyor that delivers water to over 1,300 agricultural water users encompassing about 55,000 acres of land along the Sierra Nevada foothills and the eastern edge of the Sacramento Valley floor (YCWA 2008). In addition to other water sources, BVID has a contract with YCWA authorizing diversions of 9,500 acre-feet per year from the lower Yuba River at BVID’s Pumpline Diversion Facility (Pumpline Facility) to supplement BVID’s water rights diversions. BVID has received deliveries from YCWA since October 1971 (YCWA 2008). BVID may divert up to 25,687 acre-feet annually.

In 1964, BVID built the Pumpline Facility (Figure 5-8) on the north bank of the lower Yuba River about 0.75 mile upstream (i.e., 4,200 feet) of Daguerre Point Dam (SWRI 2003). The Pumpline Facility has a diversion capacity of 80.2 cfs (CALFED and YCWA 2005). In 1990, BVID ceased diversions from the Yuba River at locations other than the Pumpline Facility. For many years, the (Pumpline Facility) was unscreened until a new fish screen was completed in 1999.
Figure 5-8. BVID diversion facility, including the fish screen and diversion forebay (Source: YCWA 2013b).

1. Inflow to the canal depends on sufficient head at the point of diversion. The presence of Daguerre Point Dam serves to prevent additional down-cutting, or incision, of the Yuba River and therefore contributes to the maintenance of sufficient head at the BVID point of diversion. Diverted water enters an excavated side channel, passes through the fish screen described in the following paragraph and is then pumped up into the canal supplying the BVID service area. The Pumpline Facility diversion uses pumps located on the north bank of the river to divert water through an excavated side channel and up into the canal at rates estimated up to 100 cfs. Water bypassing the fish screen continues through the side channel and reenters the lower Yuba River upstream of Daguerre Point Dam.

2. In 1999, a new state-of-the-art fish screen was installed at the Pumpline Facility that meets NMFS and CDFW screening criteria (SWRCB 2001; NMFS 2002; CALFED and YCWA 2005). Funding for design and construction of the screen was obtained from DWR, the Reclamation’s CVPIA Anadromous Fish Screen Program, the California Urban Water Agencies Category III Account, PG&E, and YCWA. BVID contributed manpower and equipment to the construction and assumed the obligation to operate and maintain the fish screen (SWRCB 2001). The SWRCB (2001) determined that the new fish screen at the Browns Valley Pumpline Diversion Facility provided adequate
protection for juvenile salmonids, and that BVID should continue to operate and maintain the new fish screen in compliance with NMFS and CDFW criteria.

The BVID diversion is not licensed by the Corps, and it has no direct physical link to Corps property. Although there is no apparent nexus with the Corps, BVID’s Browns Valley Pumpline Diversion Facility was either included in the project description or discussed under effects of the Proposed Action in the 2000 Corps BA, 2002 NMFS BO, 2007 Corps BA, and 2007 NFMS BO. However, because the BVID diversion is not licensed by the Corps and it has no direct physical link to Corps property, there are no permits, licenses, or easements associated with the Corps’ operation and maintenance of Daguerre Point Dam. Therefore, the Browns Valley Pumpline Diversion Facility and associated effects of diversion on the listed species and their habitat in the lower Yuba River are included in the Environmental Baseline, and not in the Proposed Action.

5.3 Physical Habitat

During the period of hydraulic gold mining in the 1800s, vast quantities of sand, gravel, and cobble entered the Yuba River (Gilbert 1917 as cited in Yoshiyama et al. 2001) and deposited throughout the system. This human impact completely transformed the river. Daguerre Point Dam was constructed at the downstream end of an enormous gravel deposit, and about 16 miles of “gravel berms” were erected to channelize the river by piling gravel on both the north and south banks, as well as down the center of the river in some places to create two channels. These activities were two of the major features of the “1898 Project”, which was completed in 1935 (Hagwood 1981). By that time, three gravel berms existed, having a total length of 85,100 feet which provided two 500-foot-wide channels. In 1944, the California Debris Commission issued a permit to the Yuba Consolidated Gold Fields to dredge a 600-foot-wide channel and build gravel berms to take the place of the pair of 500-foot-wide channels completed in 1935 (Hagwood 1981). The effect of the gravel berms was to keep the river from spreading in its floodplain and to turn this stretch of the lower Yuba River into a channel that conveys water downstream to serve agricultural and municipal users (Gustaitis 2009). Downstream of Daguerre Point Dam, the Yuba River has resumed a meandering course through the fluvial tailings.
Down-cutting of the streambed downstream of Daguerre Point Dam has exposed the bedrock of Daguerre Point (Hunerlach et al. 2004).

The Corps has not issued any permits, licenses, or easements to other parties, and does not conduct inspection or maintenance activities associated with the gravel berms (R. Olsen, Corps, pers. comm. 2011). Consequently, the Corps is not responsible for operations and maintenance of the gravel berms along the lower Yuba River. Because the Corps does not have the ability to lessen any effects on listed species habitat availability associated with dynamic fluvial/geomorphologic processes in the floodplain of the lower Yuba River located between the gravel berms, and because the Corps is not proposing any actions pertaining to the gravel berms, any such effects are appropriately considered part of the Environmental Baseline and not the Proposed Action.

5.3.1 Fluvial Geomorphology

Fluvial geomorphologic processes in the lower Yuba River downstream of Englebright Dam continue to represent adjustments to the tremendous influx of hydraulic mining debris, and the construction of Englebright Dam. Since the construction of Englebright Dam, the lower Yuba River continues to incise and landform adjustments continue to occur - as illustrated by Pasternack (2008), who estimated that about 605,000 yds$^3$ of sediment (primarily gravel and cobble) were exported out of Timbuctoo Bend from 1999 to 2006. The lower Yuba River is adjusting toward its historical geomorphic condition, by going back to the pre-existing state prior to hydraulic gold mining (Pasternack 2010).

The lower Yuba River has been subjected to additional in-channel human activities such as: (1) the formation of the approximately 10,000-acre Yuba Goldfields in the ancestral migration belt; (2) the relocation of the river to the Yuba Goldfield’s northern edge and its isolation from most of the Goldfields by large “gravel berms” of piled-up dredger spoils; (3) mechanized gold mining facilitated by bulldozers beginning in about 1960 in the vicinity of the confluence with Deer Creek, changing the lower Yuba River geomorphology (Pasternack et al. 2010); (4) bulldozer debris constricting the channel significantly and inducing abrupt hydraulic transitioning; and (5) mining operations
combined with the 1997 flood which caused angular hillside rocks and “shot rock” debris to be deposited on top of the hydraulic-mining alluvium in the canyon (Pasternack 2010).

All of these activities have influenced physical habitat conditions in the lower Yuba River downstream of Englebright Dam. Physical conditions related to fisheries habitat in the lower Yuba River have been studied over many years. With respect to the spawning lifestage, Fulton (2008) found spawning habitat conditions to be very poor to nonexistent in the Englebright Dam Reach. Spring-run Chinook salmon individuals immigrating into the Yuba River each year attempt to spawn in the Englebright Dam Reach, which historically was characterized by a paucity of suitable spawning gravels. However, gravel augmentation funded by the Corps in the Englebright Dam Reach over the past several years has spurred spawning activity and Chinook salmon redd construction in this reach (see Chapter 2 for additional discussion). The net result is an increase in the spatial distribution of spawning habitat availability in the river, particularly for early spawning (presumably spring-run) Chinook salmon (RMT 2013). Farther downstream, spawning habitat does not appear to be limited by an inadequate supply of gravel in the lower Yuba River due to ample storage of mining sediments in the banks, bars, and dredger-spoil gravel berms (RMT 2013).

According to NMFS (2009), river channelization and confinement has led to a decrease in riverine habitat complexity and a decrease in the quantity and quality of juvenile rearing habitat. Also according to NMFS (2009), attenuated peak flows and controlled flow regimes have altered the lower Yuba River’s geomorphology and have affected the natural meandering of the river downstream of Englebright Dam.

As reported by RMT (2013), the Yuba River downstream of Englebright Dam has complex river morphological characteristics. Evaluation of the morphological units in the Yuba River as part of the spatial structure analyses indicates that, in general, the sequence and organization of morphological units is non-random, indicating that the channel has been self-sustaining of sufficient duration to establish an ordered spatial structure (RMT 2013). In addition, the Yuba River downstream of Englebright Dam exhibits: (1) lateral variability in its form-process associations; (2) complex channel geomorphology; and (3) a complex and diverse suite of morphological units. The
complexity in the landforms creates diversity in the flow hydraulics which, in turn, contributes to a diversity in habitats available for all riverine lifestages of anadromous salmonids in the Yuba River downstream of Englebright Dam (RMT 2013).

NMFS (2009) further stated that in the lower Yuba River, controlled flows and decreases in peak flows has reduced the frequency of floodplain inundation resulting in a separation of the river channel from its natural floodplain. However, as reported by RMT (2013), despite some flow regulation the channel and floodplain in the lower Yuba River are highly connected, with floods spilling out onto the floodplain more frequently than commonly occurs for unregulated semi-arid rivers. Some locations exhibit overbank flow well below 5,000 cfs, while others require somewhat more than that. In any given year, there is an 82% chance the river will spill out of its bankfull channel and a 40% chance that the floodway will be fully inundated. These results demonstrate that floodplain inundation occurs with a relatively high frequency in the lower Yuba River compared to other Central Valley streams which, in turn, contributes to a diversity in habitats available for anadromous salmonids (RMT 2013).

5.3.2 Waterway 13 and the Yuba Goldfields Fish Barrier Project

Located along the Yuba River near Daguerre Point Dam, the Yuba Goldfields consist of more than 8,000 acres of dredged landscape and represent one of the largest tracts of mining debris in northern California (Hunerlach et al. 2004). Historical records from the Yuba Goldfields indicate that dredging near Daguerre Point Dam took place on a nearly continuous basis from 1904 through 1968. Since 1904, dredging has been the principal form of mining in the Yuba Goldfields. Mining company records indicate that extensive areas were re-dredged as technology improved, allowing deeper digging. The area of the present Yuba River channel upstream of Daguerre Point Dam was dredged primarily during 1916-1934. Water flowing through the gravels creates large tracts of ponds throughout the mined landscape (Hunerlach et al. 2004).

As a result of the high permeability of the Goldfield’s rocky soil, water from the Yuba River freely migrates into and through the Goldfields, forming interconnected ponds and
canals throughout the undulating terrain (DWR 1999). This high permeability causes water levels in the ponds and canals to rise and fall according to the stage of the Yuba River. Generally, water from the Yuba River enters the Goldfield area from above Daguerre Point Dam, then migrates down-gradient through the Yuba Goldfields. A portion of this migrating water eventually returns to the Yuba River approximately one mile downstream of Daguerre Point Dam via an outlet canal, referred to as Waterway 13, the origin of which is uncertain. This outlet canal helps to drain water out of the Goldfields to the Yuba River, which prevents high water levels from adversely impacting current mining and aggregate operations (DWR 1999).

During the fall of 1988 and the winter and spring of 1989, adult fall/late fall-run Chinook salmon and American shad were observed in the area of the Yuba Goldfields (USFWS 1990). It was suggested that these fish were attracted into the area via the outfall channel referred to as Waterway 13. In 1989, the Red Bluff Fisheries Assistance Office conducted a fishery investigation in the Yuba Goldfields area near Daguerre Point Dam on the lower Yuba River. Several hundred fall-run Chinook were observed spawning in the open access channel in December 1988. In the 1980s, it was discovered that adult anadromous fish (Chinook salmon, American shad, and steelhead) had migrated into the interconnected ponds and canals of the Yuba Goldfields via the area’s outlet canal. USFWS (1990) also observed a pair of spawning late fall-run Chinook salmon during March 1989.

Salmon spawning habitat in the Yuba Goldfields was observed in several interconnecting stream channels between ponds, and numerous fall-run Chinook salmon redds were observed (USFWS 1990). From February through April 1989, USFWS (1990) captured 241 juvenile Chinook salmon in the Yuba Goldfields ponds with beach seines at five sample sites located in ponds downstream of the spawning area. In May 1989, juvenile sampling was terminated when reduced flows through the ponds prevented access to the sampling sites. The juveniles ranged in size from about 30 to 65 mm, with the average fork length about 40 mm (USFWS 1990). It was suggested that these small individuals would have a poor chance of survival because increasing water temperatures during May
would likely increase predation rates from the numerous adult squawfish and bass observed in the ponds (USFWS 1990).

SWRCB (2000) reported that on various occasions CDFW staff also observed from a few fish to several hundred adult fall-run Chinook salmon attracted up through the outfall into the Yuba Goldfields in the late 1990s. Attraction of adult fall-run Chinook salmon was of concern because there is a general lack of spawning habitat in the Yuba Goldfields, and water temperatures in the Yuba Goldfields can be unsuitable, especially in the lower ends where water discharges into the lower Yuba River (SWRCB 2000). Additionally, fish habitat within the ponds and canals is not conducive to anadromous fish survival because food supply is limited, predator habitat is extensive, and water quality conditions, especially water temperature, are poor (DWR 1999).

There have been several past attempts at taking actions to preclude anadromous salmonids from entering the Yuba Goldfields (SWRCB 2000). In the early 1980s, a large grate was placed on the outfall of Waterway 13 to preclude fish from entering the Yuba Goldfields. However, no one maintained the grate and it was damaged by debris. Thus, adult salmon and steelhead continued to access the Yuba Goldfields. During the January 1997 floods, flows through the Yuba Goldfields became so high that they washed out the structure (SWRCB 2000). The entry point remained open for several years. Realizing that adult fish were once again entering the Yuba Goldfields, CDFW worked with a local aggregate company to install a temporary aggregate berm to exclude adult fish, which was effective for several years. However, any time there is high water in the Yuba Goldfields, the barrier can be breached and activities to replace that barrier cannot begin until the summer or late spring (SWRCB 2000).

The USFWS provided funding for an investigation through the AFRP, and engineering design and environmental evaluation of an adult fish barrier in Waterway 13 that would meet the resource needs of CDFW, USFWS, and NMFS, as well as the needs of the Goldfields' owners - Western Aggregates and Cal-Sierra Development was conducted (SWRCB 2000). Design objectives for a fish barrier located in the Yuba Goldfields outlet canal included the following: (1) prevent adult anadromous fish from entering the Yuba Goldfields; (2) not increase water elevations within the Yuba Goldfields; (3)
require minimal maintenance; and (4) allow for passage or removal of debris (DWR 1999). The primary project objective was to prevent adult anadromous fish from entering the Yuba Goldfields through the outlet canal. The outlet canal is especially important during periods of high flows, when the outlet canal must be able to pass high flows in order to prevent flooding in nearby low-lying areas. It is also important that flows not be greatly restricted during non-flood conditions. If flows during these periods are restricted, water elevations within the Yuba Goldfields rise, adversely affecting Yuba Goldfields mining operations. Consequently, a project needed to be designed to accommodate high flows exiting the Yuba Goldfields. In addition, this project needed to be low maintenance and allow for the passage or removal of debris (DWR 1999). Outlet canal flows during summer and fall months were estimated to range from five to 50 cfs, whereas canal flows during winter and spring months can exceed 1,000 cfs (DWR 1999).

In 2002, the BLM signed a Finding of No Significant Impact for the Yuba Goldfields Fish Barrier Replacement Project. The BLM approved the replacement of the original structure in the same location as the previous structure. The construction of a temporary rock embankment was completed in September 2003 (Figure 5-9). In May 2005, heavy rains and subsequent flooding breached the structure at the east (upstream facing) end. AFRP funding was available to repair the “plug” (i.e., temporary aggregate berm) but, because there was no project proponent to do the necessary work, YCWA facilitated the effort but did not accept any responsibility for construction, operation or maintenance (C. Aikens, YCWA, pers. comm. 2011). A "leaky-dike" barrier (Figure 5-10) intended to serve as an exclusion device for upstream migrating adult salmonids was constructed at the outfall of Waterway 13 (AFRP 2010).

Although most of the area encompassing the Yuba Goldfields is located on private land, it has been determined that the rock weir plug on Waterway 13 is located on Corps property. However, the Corps does not have any operations or maintenance responsibilities for the earthen “plug” and Waterway 13, nor has it issued any permits or licenses for it. Thus, operation and maintenance of Waterway 13 is part of the Environmental Baseline, and is not part of the Proposed Action.
Figure 5-9. Yuba Goldfields barrier located at the outfall of Waterway 13 (Source: AFRP 2011).

Figure 5-10. Location of the Waterway 13 “leaky-dike” barrier prior to it washing out during the spring of 2011 due to high flows through the Yuba Goldfields.
During the spring of 2011, high flows (~30,000 cfs) in the lower Yuba River and high flows through the Yuba Goldfields once again caused the “leaky-dike” barrier at the entrance to Waterway 13 to wash out. In response to this recent loss of the “leaky-dike” barrier at Waterway 13, the Corps conducted a real estate investigation and determined that Waterway 13 is located on lands that are under the Corps’ jurisdiction. As a separate action unrelated to this ESA consultation, the Corps will work with local stakeholders and resource agencies to identify potential biological concerns associated with Waterway 13 and will support the development of measures to repair the barrier. If needed in the future, the Corps will collaborate with the stakeholders involved to develop a shared agreement (e.g., a right-of-way or easement) that would provide access to those parties that would conduct future maintenance activities that may become necessary if and when the fish barrier at Waterway 13 washes out again in the future. However, because these activities would occur in the future, and a project has not been proposed at this time, Waterway 13 activities are not part of the Proposed Action.

5.3.3 Riparian Vegetation

Most of the original plant communities along the lower Yuba River have been significantly altered from pristine conditions (Corps 1977 as cited in CDFG 1991). Although little has been written specifically about the ancestral riparian forests of the lower Yuba River, it is believed that the banks of the lower Yuba River and its adjacent natural levees once were covered by riparian forest of considerable width. It has been suggested that most riverine floodplains in the Central Valley supported riparian vegetation to the 100-year floodplain, and it is likely that the Yuba River was no exception (CDFG 1991).

In its Final Biological and Conference Opinion for the Yuba River Development Project License Amendment (FERC No. 2246), NMFS (2005b) reports that “The deposition of hydraulic mining debris, subsequent dredge mining, and loss/confinement of the active river corridor and floodplain of the lower Yuba River which started in the mid-1800’s and continues to a lesser extent today, has eliminated much of the riparian vegetation along the lower Yuba River. In addition, the large quantities of cobble and gravel that
remained generally provided poor conditions for re-establishment and growth of riparian vegetation. Construction of Englebright Dam also inhibited regeneration of riparian vegetation by preventing the transport of any new fine sediment, woody debris, and nutrients from upstream sources to the lower river. Subsequently, mature riparian vegetation is sparse and intermittent along the lower Yuba River, leaving much of the bank areas unshaded and lacking in large woody debris.

To determine the cumulative change over time in total vegetative cover and riparian vegetation cover in the lower Yuba River, YCWA compared aerial photographs from 1937 and 2010. Over this time period, riparian vegetation cover in the Englebright Dam site decreased over time, and the Narrows study site exhibited little detectable change over time. For the remaining study sites distributed throughout the lower Yuba River, riparian vegetation cover increased over time. Dramatic increases in riparian vegetation cover were observed for the Dry Creek and Parks Bar study sites.

Riparian habitats support the greatest diversity of wildlife species of any habitat in California, including many species of fish within channel edge habitats (CALFED 2000a as cited in RMT 2013). Furthermore, more extensive and continuous riparian forest canopy on the banks of estuaries and rivers can stabilize channels, provide structure for submerged aquatic habitat, contribute shade, overhead canopy, and instream cover for fish, and reduce water temperatures (CALFED 2000a as cited in RMT 2013).

Although fish species do not directly rely on riparian habitat, they are directly and indirectly supported by the habitat services and food sources provided by the highly productive riparian ecosystem. Riparian communities provide habitat and food for species fundamental to the aquatic and terrestrial food web, from insects to top predators. As stated in CALFED and YCWA (2005), riparian vegetation, an important habitat component for anadromous fish, is known to provide: (1) bank stabilization and sediment load reduction; (2) shade that results in lower instream water temperatures; (3) overhead cover; (4) streamside habitat for aquatic and terrestrial insects, which are important food sources for rearing juvenile fishes; (5) a source of instream cover in the form of woody material; and (6) allochthonous nutrient input. Riparian vegetation on
floodplains can provide additional benefits to fish when the floodplain is inundated, by providing velocity and predator refugia.

In 2012, YCWA conducted a riparian habitat study in the Yuba River from Englebright Dam to the confluence with the Feather River (YCWA 2013). Field efforts included descriptive observations of woody and riparian vegetation, cottonwood inventory and coring, and a LWM survey. The RMT contracted Watershed Sciences Inc. to use existing LiDAR to produce a map of riparian vegetation stands by type. The resulting data was subject to a field validation and briefly summarized in WSI (2010 as cited in RMT 2013) and the data were also utilized in YCWA (2013).

Based on field observations, YCWA (2013) reported that all reaches supported woody species in various lifestages - mature trees, recruits, and seedlings were observed within all reaches. Where individuals or groups of trees were less vigorous, beaver (*Castor canadensis*) activity was the main cause, although some trees in the Marysville Reach appeared to be damaged by human camping.

The structure and composition of riparian vegetation was largely associated with four landforms. Cobble-dominated banks primarily supported bands of willow shrubs with scattered hardwood trees. Areas with saturated soils or sands supported the most complex riparian areas and tended to be associated with backwater ponds. Scarps and levees supported lines of mature cottonwood and other hardwood species, typically with a simple understory of Himalayan blackberry or blue elderberry shrubs. Bedrock dominated reaches had limited riparian complexity and supported mostly willow shrubs and cottonwoods.

The longitudinal distribution of riparian species in the lower Yuba River downstream of the Englebright Dam shows a trend of limited vegetation in the confined, bedrock areas, with increased vegetation in the less-confined, alluvial areas downstream, which is within expected parameters (Naiman et al. 2005 as cited in YCWA 2013). The increase in hardwood diversity and cover downstream of Daguerre Point Dam may be associated with sediment, as reaches above the Daguerre Point Dam have greater scour, while the downstream reaches have more deposition (YCWA 2012a).
Cottonwoods are one of the most abundant woody species in the Action Area, and the most likely source of locally-derived large instream woody material due to rapid growth rates and size of individual stems commonly exceeding 2 feet in diameter and 50 feet in length. Cottonwoods exist in all life stages including as mature trees, recruits, or saplings, and as seedlings. Cottonwoods are more abundant in downstream areas of the Action Area relative to upstream. Of the estimated 18,540 cottonwood individuals/stands, 12% are within the bankfull channel (flows of 5,000 cfs or less), and 39% are within the floodway inundation zone (flows between 5,000 and 21,100 cfs).

The RMT conducted a LiDAR survey of the lower Yuba River from Highway 20 to the confluence, and digitized the patches of vegetation in recent aerial imagery of Timbuctoo Bend and the Englebright Dam Reach (Pasternack 2012). With respect to having sufficient riparian vegetation to provide ecological functionality, the RMT conducted paired hydrodynamic modeling of the lower Yuba River in which one set of models lacks vegetation and the other represents the actual lower Yuba River vegetation pattern and height as best as possible. As shown at the 2011 Lower Yuba River Symposium and in RMT meeting presentations, vegetation was found to significantly affect the hydraulics of the lower Yuba River and, thus, may be deemed present in a significant quantity relative to that functionality (Pasternack 2012).

YCWA (2013) assessed the riparian communities in the Yuba River downstream of the Englebright Dam as healthy and recovering from historical disturbance. Historical aerial photograph analysis indicates that vegetation cover has increased over time, with short-term decreases associated with stochastic flow events, which are normal for riparian systems, and anthropogenic channel changes. Although the riparian vegetation is healthy (plants have high vigor and are present in all age classes), the vegetation communities tend to be simplistic in structure. Riparian communities are seral, establishing first with simplistic herb and shrub layers, then canopies of hardwood trees, and becoming more complex over time. Indicative of early seral stages, the assessed riparian communities tended to be simplistic in both lateral and horizontal stratification, with limited pockets of diverse and well-stratified riparian forests (YCWA 2013). As an example, bands of willows on the floodplains, with some alder and cottonwood recruits, are early in the
seral process and still capturing sediment or developing soils to support more productive systems. However, these areas on the floodplains may not become more complex, as they are likely to be scoured during peak flow events (YCWA 2013). Areas dominated by cottonwood trees with only herbaceous understories (e.g., those found on levees), are likely a sign of interrupted riparian development, and maintenance of the levees may have prevented the natural stages of the riparian community to develop.

5.3.4 Large Woody Material

LWM creates both micro- and macro-habitat heterogeneity by forming pools, back eddies. Instream object cover provides structure, which promotes hydraulic complexity, diversity and microhabitats for juvenile salmonids, as well as escape cover from predators. The extent and quality of suitable rearing habitat and cover, including SRA, generally has a strong effect on juvenile salmonid production in rivers (Healey 1991 as cited in CALFED and YCWA 2005). LWM also contributes to the contribution of invertebrate food sources, and micro-habitat complexity for juvenile salmonids (NMFS 2007). Snorkeling observations in the lower Yuba River have indicated that juvenile Chinook salmon had a strong preference for near-shore habitats with LWM (JSA 1992).

LWM mapping was conducted from the fall 2011 through the fall of 2012 as part of YCWA’s FERC relicensing efforts. YCWA also conducted field surveys in the spring of 2013 to collect LWM data for pieces found exclusively within bankfull widths. The LWM observed in study sites tended to accumulate in one of three distributions within the active channel: (1) in the bands of willow (Salix sp.) shrubs near the wetted edge; (2) dispersed across open cobble bars; and (3) stranded above normal high-flow indicators (YCWA 2012a). Bands of woody vegetation, dominated by willow shrubs, were present along the cobble bars and floodplains at various distances from the wetted channel. The shrubs acted as a capture point for much of the LWM, creating tall piles of small woody debris and LWM against the upstream side of the vegetation and around the base of the shrubs. On open cobbles of bars in the alluvial reaches, YCWA observed LWM and smaller woody debris deposited at high flow lines (Figure 5-11); this distribution comprised the smallest number of LWM pieces. A great deal of LWM was observed at
flood heights, either far from the wetted channel in depressions, in stands of riparian forests, or in areas with reduced floodplains. Piles accumulated on top of boulders or rip-rap at flood flow levels. The majority of the wood surveyed at flood flow levels was highly degraded (YCWA 2012a). Most pieces of LWM were found to be mobile (not stabilized to resist high flows) and few pieces were observed to have channel forming influences (greater than one square meter) including the capture of other woody debris (Figure 5-12).

The majority of the LWM located within bankfull areas appeared to have floated in, with less LWM appearing to have fallen from the bank. The largest pieces of LWM were cottonwoods that fell from erosional banks.

Pasternack (2012) states that because the lower Yuba River floodway is so wide that on the falling limb of a flood, the LWM gets scattered over a vast area, with disproportionate concentrations racked behind flow obstructions, racked throughout vegetation patches, and lining the water’s edge demarking peak flood stages. Pasternack (2012) further states that there is ample roughness along the fringe to catch very large pieces of wood, but the lower Yuba River is so wide and deep during flood conditions that LWM cannot produce log jams relative to the scale of the system. Piles of LWM (Figures 5-13 and 5-14) also were found to accumulate on top of boulders or rip-rap at flood flow levels (YCWA 2013).

5.3.5 Other Environmental Baseline Considerations

Instream flow requirements are specified for the lower Yuba River at the Smartsville Gage (RM 23.6), located approximately 2,000 feet downstream from Englebright Dam, and at the Marysville Gage (RM 6.2). Downstream of the Smartsville Gage, accretions, local inflow, and runoff contribute, on average, approximately 200 TAF per year to the lower Yuba River (JSA 2008).
Figure 5-11. LWM and smaller woody debris deposited downstream from Englebright Dam at a high flow line in the Timbuctoo Bend study site, looking downstream on the south side of the lower Yuba River (YCWA 2013).

Figure 5-12. Example of mobile LWM downstream from Englebright Dam at a mid-channel bar looking downstream at the Hallwood study site in the lower Yuba River (YCWA 2013).
Figure 5-13. LWM accumulated downstream from Englebright Dam against the lower portion of the gravel berms that line the north side of the lower Yuba River in the Dry Creek study site at flood flow levels (YCWA 2013).

Figure 5-14. LWM and smaller woody debris accumulated downstream from Englebright Dam on rip-rap at flood flow heights in the Parks Bar study site on the lower Yuba River (YCWA 2013).
The hydrology and fluvial geomorphology of the lower Yuba River have been altered through anthropogenic influences. Construction of numerous upstream reservoirs has considerably altered the hydrologic regime of the lower Yuba River. The effects of water storage and subsequent releases for irrigation have been to reduce month-to-month flow variations in the river and have shifted the pattern of peak and minimum flows (DWR and Corps 2003). Upstream dams have reduced the magnitude of more frequently occurring flood flows (i.e. 1.5 to 20 year return period floods) (cbec and McBain & Trush 2010). However, larger magnitude, less frequent floods still occur, and cause the lower Yuba River to respond to geomorphic processes.

The two major tributaries to the lower Yuba River are Deer Creek and Dry Creek. Located about 1.2 miles downstream of Englebright Dam, Deer Creek flows into the lower Yuba River at approximately RM 22.7. A significant falls exists approximately 500 feet upstream of the mouth of Deer Creek, which is likely impassable during drier years, but steelhead have been found above the falls during wetter years with high runoff (CDFG 1991). Deer Creek flows are regulated at Lake Wildwood (CALFED and YCWA 2005).

Located about 10.3 miles downstream of Englebright Dam, Dry Creek flows into the lower Yuba River at RM 13.6, approximately two miles upstream of Daguerre Point Dam (JSA 2008). The flow in Dry Creek is regulated by BVID’s operation of Merle Collins Reservoir, located on Dry Creek about 8 miles upstream from its confluence with the Yuba River.

5.3.5.1 Regulatory Requirements

Flow releases through the powerplants at Englebright Dam are subject to provisions of various permits, licenses and contracts, including water rights permits and licenses administered by the SWRCB, PG&E’s FERC License for Project No. 1403, YCWA’s FERC License for Project No. 2246, YCWA’s 1966 Power Purchase Contract with PG&E, a 1965 contract between YCWA and CDFW concerning instream flows, and a 1966 contract between YCWA and DWR under the Davis-Grunsky Act (NMFS 2007).
In 1962 and 1965, YCWA entered into agreements with CDFW to provide the following minimum instream flows for normal water years for preserving and enhancing the fish resources in the lower Yuba River downstream of Daguerre Point Dam:

- October through December – 400 cfs
- January through June – 245 cfs
- July through September – 70 cfs

Minimum flows required by the agreements were subject to reductions in critical dry years. However, in no event were flows to be reduced to less than 70 cfs. YCWA's FERC license also contains these requirements. In most years, YCWA voluntarily exceeded the 1962 and 1965 agreements’ minimum flow requirements. However, when these minimum flows were implemented they often produced water temperatures and habitat conditions that were well outside the optimal preferred ranges for salmonids (NMFS 2007).

On February 23, 1988, the SWRCB received a complaint filed by a coalition of fishery groups referred to as the United Groups regarding fishery protection and water rights issues on the lower Yuba River. In 1992 and 2000, the SWRCB held hearings to receive testimony and other evidence regarding fishery issues in the lower Yuba River and other issues raised in the United Groups complaint. The SWRCB held supplemental hearings in 2003.

On July 16, 2003, the SWRCB issued a decision (RD-1644) regarding the protection of fishery resources and other issues relating to diversion and use of water from the lower Yuba River. Among other requirements, RD-1644 specified new minimum flow requirements and flow fluctuation criteria for the lower Yuba River. Although these minimum flow requirements did not provide the level of flow protection recommended by CDFW or NMFS, according to RD-1644 these flows were developed to attempt to enhance habitat for adult attraction and passage, spawning, egg incubation, juvenile rearing, and emigration of Chinook salmon, steelhead, and American shad in the lower Yuba River (NMFS 2007).
Conflicts among fisheries resources, water supply reliability, flood concerns, and surface and groundwater management associated with the lower Yuba River resulted in litigation between environmental and water supply interests regarding RD-1644. The Yuba Accord was developed as an alternative to litigation over the flow requirements specified in RD-1644.

**LOWER YUBA RIVER ACCORD**

The Yuba Accord includes three separate but interrelated agreements that protect and enhance fisheries resources in the lower Yuba River, increase local supply reliability, and provide Reclamation and DWR with increased operational flexibility for protection of Delta fisheries resources through the Environmental Water Account (EWA) Program, and provision of supplemental dry-year water supplies to State and Federal water contractors (YCWA et al. 2007). These agreements are:

- Lower Yuba River Fisheries Agreement (Fisheries Agreement)
- Conjunctive Use Agreements (Conjunctive Use Agreements)
- Long-term Water Purchase Agreement (Water Purchase Agreement)

The development of the Yuba Accord was a collaborative process, which led to a comprehensive settlement of 20 years of litigation over lower Yuba River instream flow requirements and related issues. Stakeholders that participated in the development of the Yuba Accord include NMFS, CDFW, USFWS, YCWA, SYRCL, Trout Unlimited (TU), FOR, and the Bay Institute.

The Fisheries Agreement is the cornerstone of the Yuba Accord. The Fisheries Agreement contains new instream flow requirements for the lower Yuba River, developed to increase protection of the river’s fisheries resources. In addition to the best available science and data, the interests of the participating State, Federal, and local fisheries biologists, fisheries advocates, and policy representatives were considered during development of the Fisheries Agreement. The Fisheries Agreement provides for minimum instream flows during specified periods of the year that are higher than the corresponding flow requirements of RD-1644.
Besides the new minimum instream flows, the Fisheries Agreement also contains provisions for a monitoring and evaluation program to oversee the success of the flow schedules and a funding mechanism to pay for monitoring and study activities.

The Yuba Accord Technical Team tasked with flow schedule development pursued a variety of analytic techniques and tools, and performed numerous evaluations to develop minimum flow requirements, referred to as “flow schedules” for the lower Yuba River. Additionally, the development of a new Yuba Basin water availability index was required to allow a more precise determination of which flow schedule to use in the lower Yuba River under each of several hydrological conditions.

Several steps were taken to develop the Yuba Accord flow schedules:

1. Development of a stressor matrix for key fisheries species in the lower Yuba River
2. Focusing on key fish species, but also considering general aquatic habitat conditions and health in the lower Yuba River
3. Defining general fisheries goals (e.g., maintenance, recovery, enhancement, etc.)
4. Defining specific fisheries-related goals of the new flow regime in terms of flow, temperature, habitat, etc.
5. Developing a comprehensive understanding of the hydrology and range of variability in hydrology for the Yuba Basin
6. Developing a comprehensive understanding of the operational constraints (regulatory, contractual, and physical) of the YRDP and lower Yuba River, as well as an understanding of the flexibilities and inflexibilities of those constraints
7. Developing flow regimes based on specific fisheries-related goals and water availability (as defined by operational constraints and hydrologic conditions)

The Technical Team recognized that a new flow regime for the lower Yuba River would need to achieve several objectives, including:
Maximize the occurrence of “optimal” flows and minimize the occurrence of sub-optimal flows, within the bounds of hydrologic constraints

Maximize occurrence of appropriate flows for Chinook salmon and steelhead immigration spawning, rearing, and emigration

Provide month-to-month flow sequencing in consideration of Chinook salmon and steelhead life history periodicities

Provide appropriate water temperatures for Chinook salmon and steelhead immigration and holding, spawning, embryo incubation, rearing and emigration

Promote a dynamic, resilient, and diverse fish assemblage

Minimize potential stressors to fish species and lifestages

Develop flow regimes that consider all freshwater life stages of salmonids and allocate flows accordingly

To build a scientific basis for crafting a flow regime that would meet these objectives, the Technical Team needed a tool to prioritize impacts on and benefits to the lower Yuba River aquatic resources. To meet this need, the Technical Team undertook development of a matrix of the primary “stressors” that affect anadromous salmonids in the lower Yuba River.

While the Technical Team recognized the critical importance of having a dynamic and resilient aquatic community, the Technical Team also realized that developing a flow regime that considered the environmental and biotic requirements of each species in the entire aquatic community would not only be exceedingly complex and difficult, but probably also impossible, given the myriad constraints (time, operations, finite water availability, water rights, conflicting requirements of aquatic species, etc.) confronting the process. The Technical Team decided that, to meet its goals, efforts would be focused on addressing “keystone” lower Yuba River species. The Technical Team agreed that a flow regime that supported key fish species such as Central Valley steelhead and Central Valley Chinook salmon would generally benefit other native fish species, recreationally important fish species such as American shad and striped bass, aquatic...
macroinvertebrates, and other aquatic and riparian resources. The Technical Team also realized that, above all else, the developed flow regime would be evaluated primarily on its perceived value or benefit to State and Federally listed species, namely Central Valley steelhead and Central Valley spring-run Chinook salmon, and also to fall-run Chinook salmon. For this reason, the lower Yuba River stressor prioritization process principally considered steelhead, spring-run Chinook salmon, and fall-run Chinook salmon. Other fish species considered, but ultimately not included in the stressor prioritization process, were American shad, striped bass, and green sturgeon. At the time of development, green sturgeon were neither listed nor proposed for listing under the Federal ESA. The primary purpose of the stressor prioritization process was to provide specific input and rationale for seasonal flow regime development as well as to provide overall guidance for other management and potential restoration actions.

For the purpose of developing the lower Yuba River Anadromous Salmonid Stressor Matrix – the ultimate product of the stressor prioritization process – each species’ or race’s freshwater lifecycle was broken up into six commonly acknowledged lifestages. These lifestages are: (1) adult immigration and holding; (2) spawning and egg incubation; (3) post-emergent fry outmigration (referred to as young-of-year (YOY) downstream movement/outmigration for steelhead); (4) fry rearing; (5) juvenile rearing; and (6) smolt outmigration (referred to as yearling (+) outmigration for steelhead). Each of the lifestages was then assigned a temporal component reflecting the best available knowledge of the timing and duration of that lifestage in the lower Yuba River.

Potential stressors (also referred to as limiting factors) were then identified for each species’ or race’s lifestage. Because most potential stressors were limited to a particular geographic reach or extent in the lower Yuba River, a geographical component was assigned to each stressor. The following is a listing of all of the potential stressors considered for the purpose of Stressor Matrix development.
These potential stressors were not necessarily considered to be an exhaustive list of all stressors, but were the major perceived stressors, based on information current at that time. In addition, the list of stressors included some elements that were not necessarily considered to be stressors by all Technical Team members. The stressor prioritization process was intended to serve as a tool to provide context for and assistance in the development of the flow schedules.

Geographic and temporal considerations then were assigned to each stressor, further defining the extent of the potential stressor’s effect on each species and lifestage. The result was a stressor matrix, which provided the Technical Team with a quantitative context of the relative importance of stressors for each month. The Technical Team members utilized the Stressor Matrix results for each month to help guide flow schedule development.

The first step in developing the flow schedules was the development of an “optimal” flow schedule that was not constrained by water availability limitations. Available information such as the Stressor Matrix results (and the species and lifestage rankings, lifestage periodicities, and geographical considerations developed for the Stressor Matrix), flow-habitat relationships (i.e., WUA) for Chinook salmon and steelhead.
spawning, and an understanding of the lower Yuba River flow-water temperature relationship was utilized in this process.

The development of the “optimal” flow schedule resulted in a “high” (Schedule 1) and a “low” (Schedule 2) range of ideal flows. The development of the “high” and “low” range of ideal flows was representative of the variety of opinions among the Technical Team biologists. Through extensive discussion and collaboration, the Technical Team biologists and representatives came to a general agreement that the two flow schedules represented the range of the “optimal” flows.

The second step of the flow schedule development process was the development of a “worst case” flow schedule for years with extremely low water availability, targeting hydrologic year classes in the 5% of driest years. This flow schedule, which eventually became Schedule 6, was termed the “survival” flow schedule, because the Technical Team sought to develop a flow regime that would permit survival of the year’s cohort during very dry hydrological conditions.

Recognizing the year-to-year variations in lower Yuba River water availability, the Technical Team developed three additional flow schedules (Schedules 3, 4, and 5) between the “optimal” flows and the “survival” flows to be used during intermediate hydrological conditions. The step size between each successive flow schedule was adjusted to be large enough to cover the ranges of water availability without excessive jumps between flow schedules. The Technical Team considered utilizing more or fewer than a total of six flow schedules; however, it was ultimately determined that six flow schedules could adequately address nearly the entire spectrum of hydrological occurrences.

Ultimately, six flow schedules, plus conference year provisions, were developed to cover the entire range of Yuba River Basin water availabilities. The flow schedules were developed to maximize fisheries benefits during wetter years, and to maintain fisheries benefits to the greatest extent possible for drier years while taking into account other key considerations such as water supply demands, flood control operations, and hydrologic constraints of the system (NMFS 2007). Conference Years are predicted to occur during the 1% driest hydrological conditions. The Yuba Accord contains provisions regarding
the minimum flows, reductions in diversions for irrigation and consultations among representatives of interested parties and regulatory agencies that will occur during Conference Years.

The Yuba Accord flow schedules were developed between 2001 and 2004, and formalized in a set of proposed agreements in 2005. In April of 2005, a statement of support for the proposed Fisheries Agreement was signed by YCWA, CDFW, NMFS, USFWS, SYRCL, FOR, TU, and the Bay Institute. NMFS played a vital role in the development, and subsequent implementation, of the Yuba Accord.

In January 2006, the parties to the Proposed Yuba Accord signed the 2006 Pilot Program Fisheries Agreement, which contained minimum instream flow requirements for the lower Yuba River for the period of April 1, 2006 through February 28, 2007 (YCWA 2006). On April 5, 2006, the SWRCB issued Order WR-2006-0009, which granted YCWA’s petition to extend the effective date of the RD-1644 interim instream flow requirements from April 21, 2006 to March 1, 2007. On April 10, 2006, the SWRCB’s Division of Water Rights issued WR-2006-0010-DWR, which approved YCWA’s petition for the 2006 Pilot Program water transfer. Due to hydrologic conditions in the Delta (e.g., unbalanced conditions), YCWA was not able to transfer water to DWR for use in the EWA Program in 2006. However, the 2006 Pilot Program Fisheries Agreement flow schedules remained in effect through February 28, 2007 (YCWA 2006).

In August 2006, YCWA also filed two petitions to temporarily amend its water right permits so that YCWA could implement the 2007 Pilot Program. The first petition (the Extension Petition) requested a change in the effective date of the SWRCB RD-1644 long-term instream flow requirements from March 1, 2007 to April 1, 2008. The second petition (the Transfer Petition), filed pursuant to Water Code Section 1725, requested approval of the temporary changes in YCWA’s water right permits that were necessary for a one-year water transfer from YCWA to DWR. The SWRCB approved these petitions in February 2007.

The 2006 and 2007 Pilot Programs closely followed the proposed Yuba Accord flow regimes, accounting rules, management framework and other aspects of the Yuba Accord. Additionally, implementation of the 2006 and 2007 Pilot Programs allowed real-
world tests of several of the principal elements of the Yuba Accord, including the proposed lower Yuba River flow schedules, transfer accounting rules, and compliance provisions (YCWA et al. 2007).

In 2008, the SWRCB approved the water-rights petitions necessary to implement the Yuba Accord on a long-term basis. The six flow schedules for specific types of water years are based on hydrologic conditions represented by the North Yuba Index (NYI). The NYI is an indicator of the amount of water available in the North Yuba River at New Bullards Bar Reservoir that is used to achieve the flow schedules on the lower Yuba River through operations of the reservoir. The estimated frequencies of occurrence of year-type designations under the NYI are shown below.

<table>
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<tr>
<th>Flow Schedule</th>
<th>North Yuba Index (TAF)</th>
<th>Percent Occurrence (%)</th>
<th>Cumulative (%)</th>
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<td>1</td>
<td>≥ 1,400</td>
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<td>Conference</td>
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<td>100</td>
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In addition to the six types of water years for the flow schedules, Conference Years are predicted to occur at a frequency of 1% or less (during the driest years). Conference Years are defined as water years for which the NYI is less than 500 TAF.

As part of the Yuba Accord, YCWA operates the YRDP and manages lower Yuba River instream flows according to the revised instream flow requirements, and according to specific flow schedules, numbered 1 through 6 (measured at the Marysville Gage) and lettered A and B (measured at the Smartsville Gage), based on water availability (see Table 5-1 for Schedules 1 through 6 and Table 5-2 for Schedules A and B). The specific flow schedule that is in effect at any time is determined by the value of the NYI and the rules described in the Fisheries Agreement.
Table 5-1. Yuba Accord lower Yuba River minimum instream flows (cfs) for Schedules 1 through 6, measured at the Marysville Gage.

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a For the Yuba Accord Alternative (using the NYI): Schedule 1 years are years with the NYI ≥ 1,400 TAF, Schedule 2 are years with NYI 1,040 to 1,399 TAF, Schedule 3 are years with NYI 920 to 1,039 TAF, Schedule 4 are years with NYI 820 to 919 TAF, Schedule 5 are years with NYI 693 to 819 TAF, Schedule 6 are years with NYI 500 to 692 TAF, and Conference Years are years with NYI < 500 TAF.

b Indicated flows represent the average flow rate at the Marysville Gage for the specified time periods listed above. Actual flows may vary from the indicated flows according to established criteria.

c Indicated Schedule 6 flows do not include an additional 30 TAF available from groundwater substitution to be allocated according to the criteria established in the Fisheries Agreement.

Table 5-2. Yuba Accord lower Yuba River minimum instream flows (cfs) for Schedules A and B, measured at the Smartsville Gage

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a Schedule A flows are to be used concurrently with Schedules 1, 2, 3, and 4 at Marysville.

b Schedule B flows are to be used concurrently with Schedules 5 and 6 at Marysville.

c During the summer months, flow requirements at the downstream Marysville Gage always will control, and thus, Schedule A and Schedule B flows were not developed for the May through August period. Flows at the Smartsville Gage will equal or exceed flows at Marysville.

Implementation of the flow schedules contained in the Yuba Accord has addressed many of the flow-related stressors that existed previously, and represents relatively recent improvement to Environmental Baseline conditions. The NMFS (2009) Draft Recovery Plan states that “For currently occupied habitats below Englebright Dam, it is unlikely that habitats can be restored to pre-dam conditions, but many of the processes and conditions that are necessary to support a viable independent population of spring-run Chinook salmon can be improved with provision of appropriate instream flow regimes, water temperatures, and habitat availability. Continued implementation of the Yuba Accord is expected to address these factors and considerably improve conditions in the lower Yuba River.”
The Yuba Accord had not been approved or implemented on a long-term basis at the time that the 2007 NMFS BO was prepared. The 2007 NMFS BO generally treated effects resulting from flow regime changes on the lower Yuba River as part of the Environmental Baseline, but also discussed flow- and water temperature-related effects on critical habitat as part of the Proposed Action.

For this BA, previous regulatory requirements, including previous instream flow requirements and the Yuba Accord instream flows and associated water temperatures that have been implemented since 2006, which have led to the current status of the listed species in the lower Yuba River, are included in the Environmental Baseline.
6.0 Effects Assessment Methodology

The effects assessment in this BA addresses the presence of listed species in the Action Area and includes an analysis of the likely effects of the Proposed Action on the listed species and their habitat. One of the purposes of this BA is to provide information for the Corps to determine whether the Proposed Action is "likely to adversely affect" listed species and critical habitat (USFWS and NMFS 1998).

To inform NMFS’ jeopardy analysis and conclusion, population analyses are included in this BA to assist NMFS in their determination of whether the Proposed Action would reasonably be expected “...directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.” 50 C.F.R. §402.02; 16 U.S.C.S. §1536(a)(2). The population analysis applies the VSP concept, including considerations of abundance, productivity, spatial structure and diversity, for listed species in the appropriate ESU/DPS, as well as in the Action Area, including the lower Yuba River.

For the critical habitat effects analysis, an evaluation was conducted on the effects of the Proposed Action on the PCEs of critical habitat and, in particular, on the essential features of that critical habitat in the Action Area, by comparing the conditions of the habitat with and without the Proposed Action. In addition, for the lower Yuba River, an evaluation was conducted as to whether the Proposed Action would affect the VSP parameter of spatial structure. This BA includes information to assist the Corps as it makes its determination whether the Proposed Action is likely to adversely affect the PCEs of critical habitat. It also is anticipated that NMFS will use the Corps' analysis of potential effects to determine whether the Proposed Action would result in the destruction or adverse modification of critical habitat for each listed ESU/DPS.

6.1 Effects Assessment Framework

In conducting analyses of habitat-altering actions under Section 7 of the ESA, NMFS uses the consultation regulations and combines them with the following steps specified in
the document titled *The Habitat Approach, Implementation of Section 7 of the Endangered Species Act for Actions Affecting the Habitat of Pacific Anadromous Salmonids* (NMFS 1999): "(1) consider the status and biological requirements of the affected species; (2) evaluate the relevance of the environmental baseline in the action area to the species' current status; (3) determine the effects of the proposed or continuing action on the species; (4) consider cumulative effects; (5) determine whether the proposed action, in light of the above factors, is likely to appreciably reduce the likelihood of species survival in the wild or adversely modify its critical habitat."

According to NMFS (1999), the analytical framework described above is consistent with the ESA Consultation Handbook (USFWS and NMFS 1998) and builds upon the Handbook framework to better reflect the scientific and practical realities of salmon conservation and management on the West Coast. This BA is prepared within this analytical framework.

*An Assessment Framework for Conducting Jeopardy Analyses Under Section 7 of the Endangered Species Act* (NMFS 2004c) describes a nine-step approach that NMFS uses for evaluating the potential effects of a proposed action on listed species (*Figure 6-1*). This BA addresses the first seven steps of this approach. NMFS will complete steps 8 and 9 in their BO for the Proposed Action.

Using the completed description of the Proposed Action, the next step in the evaluation process is to “deconstruct” the Proposed Action (*Figure 6-2*) into its constituent parts to identify the environmental stressors (physical, chemical, or biotic stressors that are directly or indirectly caused by the Proposed Action and, for indirect effects, are “reasonably certain to occur”) and any environmental subsidies (i.e., environmental changes that improve conditions for taxa that prey on, compete with, or serve as pathogens for one or more of the listed species) caused by the Proposed Action (NMFS 2004c).

The next step of the assessment framework focuses on those aspects of the Proposed Action that were conceptually identified to have potential adverse or beneficial effects, and the extent of those potential preliminary effects were then applied to identify the
Figure 6-1. Conceptual model of the assessment framework (Modified from NMFS 2004).

6.1.1 Aggregate Effects Assessment Approach and “Net Effects” Analysis

This BA examines the Proposed Action in relation to each of the listed species’ current status and the effects of past, present, and reasonably certain future non-Federal projects on the species (i.e. cumulative effects). The ESA’s implementing regulations define NMFS’ responsibilities in consulting with another Federal agency. Among other things, NMFS must evaluate the current status of the listed species or critical habitat; evaluate the effects of the action and cumulative effects on the listed species or critical habitat; and formulate its biological opinion as to whether the action, taken together with
cumulative effects, is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat (50 C.F.R. §402.14(g)). Furthermore, the regulations state that the “effects of the action” refers to “…the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline.”

This approach addresses whether the effects of the Proposed Action (the Corps’ authorized discretionary O&M activities of the fish passage facilities at Daguerre Point...
Dam, administration of licenses to CDFW and Cordua Irrigation District, and specified conservation measures) viewed in context with the Environmental Baseline (including the continued presence of Daguerre Point Dam) and any cumulative effects, has the potential to adversely affect spring-run Chinook salmon, steelhead or green sturgeon or their critical habitats.

The significance of the effects of the Proposed Action will be driven in part by the current status of the species and the Environmental Baseline. As the NMFS (1999) policy document states: “[i]f the species’ status is poor and the baseline is degraded at the time of consultation, it is more likely that any additional adverse effects caused by the proposed or continuing action will be significant”.

The current status of the listed species and the stability of their populations, as presented in Chapter 4 of this BA, demonstrate that although the spring-run Chinook salmon population in the Yuba River may be stable, populations of steelhead and green sturgeon in the lower Yuba River are data deficient, and consequently cannot be concluded to be stable. Moreover, within the Central Valley Domain, the spring-run Chinook salmon ESU, the steelhead DPS and the Southern DPS of green sturgeon are not currently stable, and are subject to some risk of extinction. Therefore, additional evaluations are provided in this BA to inform NMFS’ jeopardy analyses and conclusions.

The additional evaluations in this BA consist of performing a “net effects” analysis to assist NMFS in determining whether the Proposed Action will cause “…some deterioration in the species' pre-action condition” (National Wildlife Federation v. NMFS, 524 F.3d 917 (9th Cir. 2008)). The net effects analysis in this BA considers guidance provided by National Wildlife Federation v. NMFS, 524 F.3d 917, 930 (9th Cir. 2008), which stated “…an agency's action only ‘jeopardize[s]’ a species if it causes some new jeopardy.” The Court went on to say NMFS must “…consider the effects of [the agency’s actions] ‘within the context of other existing human activities that impact the listed species’. Most importantly, in quoting Pacific Coast Federation of Fishermen’s Associations v. U.S. Bureau of Reclamation, 426 F.3d 1082, (9th Cir. 2005), the Court stated “…'[t]he proper baseline analysis is not the proportional share of responsibility the federal agency bears for the decline in the species, but what jeopardy
might result from the agency's proposed actions in the present and future human and natural contexts." (emphasis in original). This approach to the evaluation of effects is consistent with the preamble in NMFS’ proposed rule for interagency cooperation issued on June 29, 1983 (48 FR 29990). The preamble states:

“...In determining whether an action is likely to jeopardize the continued existence of a species or result in the destruction or adverse modification of critical habitat, the Director first will evaluate the status of the species or critical habitat at issue. This will involve consideration of the present environment in which the species or critical habitat exists, as well as the environment that will exist when the action is completed, in terms of the totality of factors affecting the species or critical habitat.

To identify potential stressors affecting listed species within the Action Area, the next step in the assessment approach involves: (1) the identification of specific stressors (physical, biological, and chemical) to which individual members of listed species are exposed; (2) where exposure may occur; (3) potential pathways of exposure, including the timing, magnitude, duration and frequency of exposure; and (4) characterization of how exposure may vary depending upon the characteristics of the environment, stressor intensity and individual behavior (NMFS 2004c).

After determining whether individual members of listed species would be exposed to one or more physical, biological or chemical stressors resulting from the Proposed Action, species’ responses to exposure are considered to determine how individuals would respond to the exposure, and whether the potential exposure would be sufficient to evoke particular responses (NMFS 2004c). As part of this assessment step, the analysis attempts to identify causal pathways that connect species’ exposure to responses, as well as latent periods between exposure and the onset of a species’ response (NMFS 2004c).

With respect to a habitat-based assessment, habitat modification represents the mechanism by which the Proposed Action has potential demographic effects on individuals or populations of listed species. Habitat modification also may serve as an indirect pathway by which listed species are exposed to potential effects of the Proposed Action (NMFS 2004c).
For each stressor identified under the Environmental Baseline or the Proposed Action, the magnitude of each stressor was ascertained by generally applying the stressor prioritization (“Very High”, “High”, “Medium”, and “Low”) used by NMFS (2009) in Appendix B (Threats Assessment) updated with information obtained since 2009 in the lower Yuba River.

For each stressor that emanates from or is exacerbated by the Proposed Action, the net effects analysis addresses the following: (1) the magnitude of effect of each stressor, to the extent possible; (2) the listed species’ ability to tolerate each stressor; and (3) the reason why each stressor will, or will not, contribute to the overall likelihood that the listed species or its critical habitat will be adversely affected by the Proposed Action. For this BA, it is recognized that incrementally assessing the magnitude of an individual stressor, or the incremental ability of the listed species to tolerate an individual stressor, is rendered problematic due to the interconnectivity of individual stressors and the inherent variation in biological response to suites of stressors. Nonetheless, to the extent possible, the net effects analysis addresses the magnitude of individual stressors associated with the Proposed Action, and evaluates whether such effects are likely to increase risks to the listed species.

6.1.1.1 Environmental Baseline Assessment

The Environmental Baseline identifies the antecedent conditions for individuals and populations before considering any new stressors associated with the Proposed Action (NMFS 2004c).

Applying steps six and seven of the assessment approach described in NMFS (2004), the Environmental Baseline assessment consists of evaluating potential risks to individuals and populations (see Task A in Figure 6-1).

Past, present, and future stressors associated with the physical presence of existing facilities are included in the Environmental Baseline for this BA, unless the Corps has authority and discretion to: (1) remove the facilities; or (2) alter the operations of the facilities in a manner that would reduce harm to listed species involved in the consultation. With the exception of stressors related to fish ladder performance
associated with authorized routine maintenance activities, the Corps does not have the
authority to lessen other stressors associated with Daguerre Point Dam (see Chapter 1).
Therefore, stressors associated with the ongoing existence of Daguerre Point Dam are
appropriately attributed to the Environmental Baseline (see Chapter 5). The
Environmental Baseline has led to the current status of the species. The main difference
between the Environmental Baseline and a species’ status is scale. While the
Environmental Baseline is limited to the Action Area, a species’ status encompasses the
base condition of the entire species (ESU/DPS), given the species’ exposure to human
activities and natural phenomena throughout their geographic distribution. NMFS
determines a species’ status to identify its risk of extinction (or probability of persistence)
at the time of consultation even if a proposed action did not occur. As a result, a species’
status provides the point of reference for jeopardy determinations in a consultation
(NMFS 2004c).

The limiting factors, threats and stressors associated with the Environmental Baseline that
has led to the current status of listed species, are described in detail in Chapter 4 of this
BA and are listed below.

**Spring-run Chinook Salmon**

**ESU**

- Habitat Blockage
- Water Development
- Water Conveyance and Flood Control
- Land Use Activities
- Water Quality
- Non-Native Invasive Species
- Hatchery Operations and Practices
- Disease and Predation
- Over Utilization (ocean commercial and sport harvest, inland sport harvest)
- Environmental Variation (natural environmental cycles, ocean productivity, global climate change, ocean acidification)
LOWER YUBA RIVER

- Passage Impediments/Barriers
- Harvest/Angling Impacts
- Poaching
- Physical Habitat Alteration
- Entrainment
- Predation
- Loss of Natural River Morphology and Function
- Loss of Floodplain Habitat
- Loss of Riparian Habitat and Instream Cover (riparian vegetation, instream woody material)
- Hatchery Effects (FRFH genetic considerations, straying into the lower Yuba River) and other genetic considerations

STEELHEAD

DPS

The aforementioned list of limiting factors and stressors pertinent to the spring-run Chinook salmon ESU also pertain to the steelhead DPS. Stressors that are unique to the steelhead DPS, or that substantially differ in the severity of a stressor for the previously described spring-run Chinook salmon ESU, include the following.

- Destruction, Modification, or Curtailment of Habitat or Range
- Overutilization for Commercial, Recreational, Scientific or Education Purposes (inland sport harvest)
- Inadequacy of Existing Regulatory Mechanisms (Federal efforts, non-Federal efforts)
- Other Natural and Man-Made Factors Affecting Its Continued Existence
- Non-Lifestage Specific Threats and Stressors (artificial propagation programs, small population size, genetic integrity and long-term climate change)
The list of limiting factors and stressors for the spring-run Chinook salmon population in the lower Yuba River that are pertinent to the steelhead population in the lower Yuba River are not repeated here. Stressors that are unique to steelhead in the lower Yuba River, and stressors that substantially differ in severity for steelhead (see Chapter 4) include the following.

- Harvest/Angling Impacts
- Poaching
- Hatchery Effects (genetic considerations, straying into the lower Yuba River)

**Green Sturgeon**

**DPS**

- Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range (reduction in spawning habitat, alteration of habitat - flows, water temperatures, delayed or blocked migration, impaired water quality, dredging and ship traffic, ocean energy projects)
- Commercial, Recreational, Scientific or Educational Overutilization
- Disease and Predation
- Inadequacy of Existing Regulatory Mechanisms
- Other Natural and Man-Made Factors Affecting Its Continued Existence (non-native invasive species)
- Entrainment

**Lower Yuba River**

As previously discussed, Daguerre Point Dam is a complete barrier to upstream passage for green sturgeon because they are unable to ascend the fish ladders on the dam, or otherwise to pass over or around the structure. NMFS (2007) stated that Daguerre Point Dam prevents green sturgeon from accessing potentially suitable spawning and rearing habitat located above the dam, and therefore potentially represents a stressor to green
sturgeon. However, the ongoing and future effects of Daguerre Point Dam’s blockage of green sturgeon are due to the presence of the dam and configuration of the fish ladders and are an existing condition, over which the Corps does not currently have the authority to make modifications to the structure to allow for green sturgeon passage. Therefore, the dam and the fish ladder configuration are part of the Environmental Baseline. In order to accommodate green sturgeon, a major modification to the existing structure would have to be authorized by Congress.

For this BA, the assessment of the Environmental Baseline within the Action Area will consider: (1) past, present and ongoing limiting factors, threats and stressors described in Chapter 4; (2) full implementation of the Yuba Accord, which has occurred since 2008; and (3) the results of available lower Yuba River fisheries monitoring data, which are included in the characterization of the current status of each species.

According to NMFS (1999), the Environmental Baseline represents the current basal set of conditions to which the effects of the Proposed Action are added, and does not include any future discretionary Federal activities in the Action Area that have not yet undergone ESA consultation. Each listed species’ current status is described in relation to the risks presented by the continuing effects of all previous actions and resource commitments that are not subject to further exercise of Federal discretion (NMFS 1999). For an ongoing Federal action (such as the Proposed Action being evaluated in this BA), the effects of the action resulting from past unalterable resource commitments are included in the Environmental Baseline, and those effects that would be caused by the continuance of the Proposed Action are then analyzed for determination of effects (NMFS 1999).

6.1.1.2 Proposed Action Effects Assessment

In this step of the effects assessment, NMFS (1999) suggests examining the anticipated direct and indirect effects of the Proposed Action on each listed species and its habitat within the context of the species’ current status and the Environmental Baseline. A two-part analysis is conducted as part of this step. The first analytical component focuses on the species itself, and describes the Proposed Action’s potential effects on individual fish, populations, or both – and places that effect within the context of the ESU/DPS as a whole (NMFS 1999). The second analytical component focuses on the Action Area and
defines the Proposed Action’s effects in terms of each species’ biological and habitat requirements in that area.

**DIRECT AND INDIRECT EFFECTS**

To evaluate potential direct and indirect effects of the Proposed Action, the following three factors are considered: (1) identify the probable risks to the individual organisms that are likely to be exposed to the Proposed Action’s effects on the environment; (2) identify whether the consequences of changing the risks to those individuals for the populations those individuals represent would be sufficient to increase extinction risk (or reduce the probability of persistence); and (3) identify whether changes in the extinction risk (or probability of persistence) of those populations would be sufficient to increase the extinction risk (or reduce the probability of persistence) of the species that those populations comprise, given the species’ status (NMFS 2004c).

For each component and subcomponent of the Proposed Action, the effects assessment first describes the stressors that are expected to result from each component/subcomponent and then describes each stressor in terms of its intensity, frequency, and duration. The analysis then assesses the likely responses of each listed species to the stressors, and the potential for specific stressors to affect critical habitat. Likely species responses are based upon the timing (when) and the location (where) potential stressors would occur, compared to the lifestage-specific spatial and temporal distributions of each listed species. Likely effects on the primary constituent elements of critical habitat for each listed species are assessed by describing changes in habitat suitability (e.g., flows and water temperatures), availability and accessibility for each specific lifestage. The assessment focuses on whether any of the possible responses are likely to result in the death or injury of individuals, reduced reproductive success or capacity, or the temporary or permanent blockage or destruction of biologically significant habitats (NMFS 2005).

These analytical steps comprise the assessment of potential “exposure” of each listed species and its critical habitat to the stressors resulting from the Proposed Action. According to NMFS (2005), this assessment of exposure is necessary to assess responses of the listed species and their effects on critical habitat resulting from stressors associated
with the Proposed Action, and will serve in large part as the bases of “not likely to adversely affect” or “likely to adversely affect” conclusions included in this BA.

6.1.1.3 Cumulative Effects Assessment

Cumulative effects are defined by Federal regulations as “…those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation” (50 CFR §402.02). Cumulative effects must be considered in the analysis of the effects of the Proposed Action (50 CFR §402.12(f)(4)).

The cumulative effects assessment in this BA addresses changes in lower Yuba River flows and water temperatures resulting from increased diversions associated with implementation of the Yuba-Wheatland In-Lieu Groundwater Recharge and Storage Project (Wheatland Project). Increased diversions associated with the Wheatland Project represent a future state or private action reasonably certain to occur. These effects are considered in the cumulative effects analysis because the Corps has no authority to regulate water diversions associated with the South Yuba/Brophy Diversion Canal and Facilities. For this BA, the cumulative effects assessment does not address changes in exposure of juvenile spring-run Chinook salmon and steelhead to impingement, entrapment and predation rates at the South Yuba/Brophy Diversion Canal and Facilities, because these effects will be evaluated in a future action requiring separate ESA consultation.

Updated 2011 demand projections indicate that water deliveries to the Wheatland Project in the future are projected to increase up to about 35,000 to 36,000 acre-feet, depending on water year type, above those demands currently in place under the Environmental Baseline (i.e., current condition demands). For effects assessment purposes in this BA, updated Wheatland Project demands are represented through modeling simulations for the future Cumulative Conditions (for additional detail, see Appendix F of this BA).

The Environmental Baseline (i.e., current conditions simulation) includes the irrigation demands of the seven YCWA Member Units that receive water from the Yuba River in amounts and flow rates that represent 2005 land use conditions, because the most recent
available land use survey data are from 2005. These Member Units are Hallwood Irrigation Company, Cordua Irrigation District, BVID, and Ramirez Water District (these Member Units divert water at or just upstream of Daguerre Point Dam to lands north of the Yuba River), and Brophy Water District, South Yuba Water District and Dry Creek Mutual Water Company (these Member Units divert water at Daguerre Point Dam to lands south of the Yuba River).

The Cumulative Condition scenario includes the irrigation demands for the Member Units listed previously plus the future irrigation demands of Wheatland Water District, which began receiving surface water through a new canal extension in 2010. The monthly amounts of irrigation demand for the Member Units were derived by taking DWR 2005 land use data for irrigated lands within these Member Units, and multiplying the various land use areas by their respective crop type applied water rates as determined by DWR for Yuba County. The applied water rates for two different years are used – 1999 to represent a wet year condition and 2001 to represent a dry year condition. Wet year conditions are assumed to occur in Wet and Above Normal years, and dry conditions are assumed for Below Normal, Dry and Critical years, where the year types are defined by the Yuba River Index (YRI) of SWRCB Decision 1644. Previously, the Lower Yuba River Accord EIR/EIS (YCWA et al. 2007) irrigation demands were derived based on 1995 land use data and field-adjusted, applied water rates published in DWR’s Bulletin 113-4. In the previous calculation, the differentiation of wet and dry conditions was made by reducing the Bulletin 113 applied water rates for the spring months of wet years to represent the wetter soil conditions that occur in those years.

YCWA is presently in the process of developing a daily operations model and a water temperature model as part of the FERC relicensing process for the YRDP (FERC Project No. 2246). However, at the time of preparation of this BA, daily models were not available for the Cumulative Condition.

To evaluate potential changes to listed species critical habitat under the Cumulative Condition for this BA, two scenarios were modeled to characterize monthly average flows and water temperature changes in the lower Yuba River. The modeling was conducted using two models – a water balance/operations model and a water temperature
model. The water balance/operations model simulates the hydrology of the lower Yuba River and YCWA’s operations of the YRDP on a monthly time step. The water temperature model predicts average monthly water temperatures at three locations in the lower Yuba River, and uses statistically derived relationships between meteorology, flow, reservoir water storage levels and resulting water temperatures. Both of these models were used in the preparation of the Lower Yuba River Accord EIR/EIS, and are documented in the modeling technical appendix to the EIR/EIS, a copy of which is included in Appendix F to this BA.

The significant attributes of the water balance/operations model are described in Appendix F. For ESA assessment purposes, three of the assumptions and modeling conditions used for the Lower Yuba River Accord EIR/EIS (YCWA et al. 2007) were modified in this BA. These modifications are: (1) the maximum release capacity of Colgate Powerhouse, which is the primary release point for New Bullards Bar Reservoir, has been corrected to be 3,430 cfs whereas previously it was modeled as 3,700 cfs; (2) the hydrologic period of record used for the simulations evaluated in this BA has been extended to encompass Water Year (WY) 1922 to WY 2008, in contrast to the period extending from WY 1922 through WY 2005 that was previously used in the Lower Yuba River Accord EIR/EIS; and (3) the irrigation diversion demands were changed as described below and in Appendix F.

For the cumulative effects analysis of flows and water temperatures in the lower Yuba River in this BA, the two scenarios of the “Environmental Baseline” and “Cumulative Condition” were modeled. Only one simulation element – the irrigation diversion demand at Daguerre Point Dam – was varied between the two modeled scenarios.

Flow modeling output is provided at two locations in the lower Yuba River: (1) the Smartsville Gage, which is located a short distance downstream of Englebright Dam and represents flows in the lower Yuba River above Daguerre Point Dam; and (2) the Marysville Gage, located 5.6 miles upstream from the mouth of the lower Yuba River and represents flows in the lower Yuba River below the diversions at Daguerre Point Dam.
The long-term average flows, by month, occurring over the 1922 through 2008 simulation period under the Environmental Baseline and the Cumulative Condition were calculated. This 87-year period of record was used for cumulative effects assessment because that was the model output available at the time of preparation of this BA. Average monthly simulated flows also were calculated by water year type, as defined by the YRI, for the Environmental Baseline and the Cumulative Condition. Presented in tabular format, the data tables for the long-term average flows by month, and the average flows by water year type demonstrate the changes that could be expected to occur under the Cumulative Condition.

In addition, monthly flow exceedance curves were developed for the 1922 through 2008 simulation period and illustrate the distribution of simulated flows under the Cumulative Condition and the Environmental Baseline. The flow exceedance curves were developed utilizing the Weibull method (Weibull 1939), which historically has been used by hydrologists in the United States for plotting flow-duration and flood-frequency curves. In general, flow exceedance curves represent the probability, as a percent of time that modeled flow values would be met or exceeded at an indicator location during a certain time period. Therefore, exceedance curves demonstrate the cumulative probabilistic distribution of flows for each month at a given river location under a given simulation.

Water temperature assessments were conducted using outputs from the water temperature model, comprised of monthly average water temperatures occurring over the 1922 – 2008 simulation period. Simulated average monthly water temperatures are provided for the following locations: (1) the Smartsville Gage; (2) Daguerre Point Dam; and (3) the Marysville Gage. Although a monthly water temperature model is not able to assess day-to-day water temperature variability or diurnal water temperature fluctuations, a more discrete time-step water temperature model is not presently available for the Cumulative Condition.

Monthly water temperature cumulative probability distributions represent the probability, as a percent of time, that modeled water temperature values would be met or exceeded at a given location.
SPRING-RUN CHINOOK SALMON AND STEELHEAD

Changes in river flows and water temperatures during certain periods of the year have the potential to affect specific lifestages of each listed species. Therefore, changes in monthly mean river flows and water temperatures are used as impact indicators for months when specific lifestages of each listed fish species occur in the lower Yuba River.

Lifestage periodicities for spring-run Chinook salmon and steelhead were developed through review of previously conducted studies, as well as recent and currently ongoing data collection activities of the Yuba Accord M&E Program. The resultant lifestage periodicities encompass the majority of activity for a particular lifestage, and are not intended to be inclusive of every individual in the population. The lifestage-specific periodicities for spring-run Chinook salmon and steelhead, which are applied to evaluate potential effects on critical habitat in this BA, were obtained from RMT (2013) and are presented in Table 6-1.

Table 6-1. Lifestage-specific periodicities for spring-run Chinook salmon and steelhead in the lower Yuba River.
For the spring-run Chinook salmon and steelhead flow-related critical habitat assessments, changes in flows under the Cumulative Condition relative to the Environmental Baseline are examined in three steps.

First, long-term monthly average flows, monthly average flows by water year type, and monthly flow exceedance distributions under the Cumulative Condition relative to the Environmental Baseline are compared to the monthly minimum flows contained in the Yuba Accord flow schedules developed by the Yuba Accord Technical Team. Situations are identified where the Cumulative Condition results in average monthly flows less than the corresponding flow schedule achieved under the Environmental Baseline. Particular emphasis is placed on potential flow differences that would lead to decreases below the flow rates specified in Flow Schedules 1 and 2 (see Chapter 5), which represent the range of optimal flow conditions.

Second, the analyses consider individual monthly changes in flow of 10% or greater over the 1922-2008 simulation period under the Cumulative Condition relative to the Environmental Baseline. A decrease in monthly flow of 10% or greater has been previously identified by various environmental documents as an appropriate criterion to evaluate flow changes. For example, in the Trinity River Mainstem Fishery Restoration Draft EIS/EIR (USFWS et al. 1999), the USFWS identified reductions in flow of 10% or greater as changes that could be sufficient to reduce habitat quantity or quality to an extent that could significantly affect fish. The Trinity River EIS/EIR further states, “...[t]his assumption [is] very conservative...[i]t is likely that reductions in streamflows much greater than 10 percent would be necessary to significantly (and quantifiably) reduce habitat quality and quantity to an extent detrimental to fishery resources.” Conversely, the Trinity River EIS/EIR considers increases in streamflow of 10% or greater, relative to the basis of comparison, to be “beneficial” to fish species.

In addition to the USFWS et al. (1999) criteria, the San Joaquin River Agreement EIS/EIR (Reclamation and SJRGA 1999) utilized USGS 1977 criteria thresholds, which were derived based on the ability to accurately measure stream flow discharges to ±10%. The criterion used to determine impacts associated with implementation of the San Joaquin Agreement was based on average percentage changes to stream flow relative to
the basis of comparison. The San Joaquin River Agreement EIS/EIR considered flow changes of less than ±10% to be insignificant (Reclamation and SJRGA 1999).

The Freeport Regional Water Project Draft EIS/EIR (JSA 2003) used a similar rationale as the USGS documentation for selecting criteria to evaluate changes in flow. The Freeport EIS/EIR states: “Relative to the base case, a meaningful change in habitat is assumed to occur when the change in flow equals or exceeds approximately 10 percent. The 10 percent criterion is based on the assumption that changes in flow less than 10 percent are generally not within the accuracy of flow measurements, and will not result in measurable changes to fish habitat area.”

The Lower Yuba River Accord Draft EIR/EIS (YCWA et al. 2007) also used a 10% change in flow as an indicator of potential impact.

These documents apparently have resulted in consensus in the use of 10% when evaluating the potential effects of flow changes on fish and aquatic habitat. Accordingly, the spring-run Chinook salmon and steelhead effects assessment in this BA relies on previously established information and, therefore, evaluates changes of 10% or greater in monthly mean flows under the Cumulative Condition relative to the Environmental Baseline.

Third, exceedance curves are particularly useful for examining flow changes occurring at lower flow levels. Because physical habitat simulation models oftentimes indicate that rearing habitat area tends to reach maximum abundance at low flows that inundate most of the channel area in a river (JSA 2003), estimates of rearing habitat area can decline as flows increase, primarily in response to increased average velocity. Because juvenile Chinook salmon and steelhead fry generally prefer low velocity areas, increasing flows can lead to reductions in estimated habitat area. However, this flow-habitat relationship may be misleading because it may not adequately reflect local habitat conditions (i.e., availability of low velocity) or the importance of flow-related habitat attributes (e.g., water temperature conditions or cover and prey availability). Given the vagaries of flow-habitat relationships associated with anadromous salmonid rearing, the effects assessment also includes specific evaluations of changes in low flow conditions. In accordance with the selected flow criteria (i.e., ≥ 10% change) described above, a change in the lowest
quartile distribution (i.e., 25th percentile) of 10% or greater is considered in relation to the magnitude of flows under the Environmental Baseline. This approach is consistent with the methodology included in previous environmental documentation, including the Freeport Regional Water Project Draft EIS/EIR (JSA 2003) and the Lower Yuba River Accord Draft EIR/EIS (YCWA et al. 2007).

In summary, the spring-run Chinook salmon and steelhead flow-related effects assessment evaluates whether changes in mean monthly flow at the Smartsville and Marysville gages under the Cumulative Condition relative to the Environmental Baseline are of sufficient magnitude and frequency to appreciably diminish the value of critical habitat. Evaluation indicators used in the assessment include: (1) changes in monthly mean flows that would result in monthly mean flows less than the corresponding flow schedule achieved under the Environmental Baseline; (2) changes in monthly mean flows equal to or greater than 10%; and (3) changes in flows equal to or greater than 10% during low flow conditions (i.e., when flows are in the lowest 25% of the cumulative flow distribution).

In addition to flow-related assessments, water temperature-related effects also are evaluated. For this BA, the monthly cumulative probability distributions are examined to identify the probability that specified water temperature index values would be exceeded for the individual months within the identified lifestages, at given locations, for spring-run Chinook salmon and steelhead. A comprehensive review and compilation of available literature was conducted to identify water temperature index values for water temperature-related critical habitat assessment for spring-run Chinook salmon and steelhead, by lifestage, in the lower Yuba River. The thermal requirements of Chinook salmon and steelhead have been extensively studied in California and elsewhere and, therefore, allow a detailed and specific determination of desired water temperature index values for each lifestage (YCWA et al. 2007). Identification of water temperature index values is largely based on information provided in the Lower Yuba River Accord Draft EIR/EIS (YCWA et al. 2007), Appendix B to the Upper Yuba River Studies Program Technical Report (DWR 2007), Attachment A to the Yuba Accord River Management Team Water Temperature Objectives Technical Memorandum (RMT 2010b), additional updated information provided in Bratovich et al. (2012) and in RMT (2013).
These documents present the results of literature reviews that were conducted to: (1) interpret the literature on the effects of water temperature on the various lifestages of Chinook salmon and steelhead; (2) consider the impacts of short-term and long-term exposure to constant or fluctuating temperatures; and (3) establish water temperature index (WTI) values to be used as guidelines for evaluation. Previous efforts presented both the upper optimum and upper tolerable WTI values to examine water temperature suitabilities by lifestage for target species. More recent efforts including the RMT Interim Monitoring and Evaluation Report (RMT 2013) and the YRDP FERC Relicensing BA have focused on comparing water temperature (model outputs as well as monitoring) to lifestage-specific upper tolerance WTIs for impact assessment purposes. Specifically, this present evaluation adopts the same approach for water temperature-related effects assessment for listed species in the lower Yuba River. Use of WTI values in the impacts assessments are not meant to be significance thresholds, but instead provide a mechanism by which to compare the suitability of the water temperature regimes associated with the Cumulative Condition. Spring-run Chinook salmon lifestage-specific upper tolerance WTI values are provided in Table 6-2, and in Table 6-3 for steelhead. The lifestages and periodicities presented in Table 6-2 and Table 6-3 differ from those presented in Table 6-1 due to specific lifestages that have the same or distinct upper tolerable WTI values, and/or the same or distinct geographic application.

Water temperature index values were determined by placing emphasis on the results of laboratory experiments and field studies that examined how water temperature affects spring-run Chinook salmon and steelhead, as well as by considering regulatory documents and other BOs from NMFS. Studies on fish from outside the Central Valley were used to establish index values when local studies were unavailable. To avoid unwarranted specificity, only whole numbers (°F) were selected as index values.

The water temperature-related critical habitat assessment for this BA is based upon comparing the probability of exceeding the lifestage-specific (month and location) selected water temperature index values under the Cumulative Condition with the Environmental Baseline.
Table 6-2. Spring-run Chinook salmon lifestage-specific upper tolerance water temperature index values.

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<tr>
<th>Lifestage</th>
<th>Upper Tolerance WTI</th>
<th>Jan</th>
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<th>May</th>
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<tbody>
<tr>
<td>Adult Migration</td>
<td>68°F</td>
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<tr>
<td>Adult Holding</td>
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<tr>
<td>Spawning</td>
<td>58°F</td>
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<tr>
<td>Embryo Incubation</td>
<td>58°F</td>
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<tr>
<td>Juvenile Rearing and Downstream Movement</td>
<td>65°F</td>
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<tr>
<td>Smolt (Yearling+) Emigration</td>
<td>68°F</td>
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Table 6-3. Steelhead lifestage-specific upper tolerance water temperature index values.

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<tr>
<th>Lifestage</th>
<th>Upper Tolerance WTI</th>
<th>Jan</th>
<th>Feb</th>
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<th>May</th>
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<td>Adult Holding</td>
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<tr>
<td>Spawning</td>
<td>57°F</td>
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<tr>
<td>Embryo Incubation</td>
<td>57°F</td>
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<tr>
<td>Juvenile Rearing and Downstream Movement</td>
<td>68°F</td>
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<tr>
<td>Smolt (Yearling+) Emigration</td>
<td>55°F</td>
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SPRING-RUN CHINOOK SALMON

- Adult immigration (April through September) – Smartsville, Daguerre Point Dam, and Marysville
- Adult holding (April through September) – Smartsville and Daguerre Point Dam
- Spawning (September through mid-October) – Smartsville
- Embryo incubation (September through December) – Smartsville
- Juvenile rearing (Year-round) – Smartsville and Daguerre Point Dam
STEELHEAD

- Juvenile downstream movement (Mid-November through June) – Daguerre Point Dam and Marysville
- Smolt (Yearling+) emigration (October through mid-May) – Daguerre Point Dam and Marysville

GREEN STURGEON

The Technical Team developed the Yuba Accord flow schedules based primarily on available information for spring-run Chinook salmon, steelhead, and fall-run Chinook salmon. Other fish species including green sturgeon were considered, but ultimately were not included in the stressor prioritization process. At the time of development of the Yuba Accord flow schedules, green sturgeon were neither listed nor proposed for listing. Hence, the green sturgeon flow-related critical habitat effects assessment cannot rely on reference to the Yuba Accord flow schedules, and is conducted in this BA as follows.

The critical habitat analysis for green sturgeon under the Cumulative Condition and the Environmental Baseline in the lower Yuba River addresses a unique specific PCE essential for the conservation of the Southern DPS of North American green sturgeon in freshwater riverine systems according to the document titled Designation of Critical
Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon - Final Biological Report (NMFS 2009e). According to NMFS (2009e), deep (≥ 5 m) holding pools for both upstream and downstream holding of adult or subadult green sturgeon, with adequate water quality and flow, are necessary to maintain the physiological needs of the holding adult or subadult fish. According to NMFS (2009e), deep pools of ≥ 5 meters depth with complex hydraulic features and upwelling are critical for adult green sturgeon spawning and for summer holding within the Sacramento River (Vogel 2008; Poytress et al. 2009). Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding and/or energy conservation (Erickson et al. 2002; Benson et al. 2007).

According to NMFS (2009e), earlier papers suggested that spawning most likely occurs in fast, deep water (> 3 m deep) over substrates ranging from clean sand to bedrock, with preferences for cobble substrates (Emmett et al. 1991; Moyle et al. 1995). Recent studies have provided additional information. Monitoring of green sturgeon and behavior data in the Rogue River suggests spawning occurs in sites at the base of riffles or rapids, where depths immediately increase from shallow to about 5 to 10 meters, water flow consists of moderate to deep turbulent or eddying water, and the bottom type is made up of cobble to boulder substrates (D. Erickson, ODFW, pers. comm. September 3, 2008 as cited in NMFS 2009e). For the Sacramento River, NMFS (2009a) reports that adult green sturgeon prefer deep holes (≥ 5 m depth) at the mouths of tributary streams, where they spawn and rest on the bottom.

As previously discussed, over the many years of sampling and monitoring in the lower Yuba River, only one sighting of an adult green sturgeon was confirmed before 2011. A memorandum dated June 7, 2011 by Cramer Fish Sciences (2011) stated that they observed what they believed were 4–5 green sturgeon near the center of the channel at the edge of the bubble curtain below Daguerre Point Dam. The sturgeon were observed either on a gravel bar approximately 1.5 meters deep, or in a pool approximately 4 meters deep immediately adjacent to the gravel bar.
Given the extremely infrequent sightings, the lack of green sturgeon life history information for the lower Yuba River, and potential changes in PCEs associated with the Cumulative Condition, the critical habitat analysis for green sturgeon in this BA addresses the PCE of water depth in pools for both pre- and post-spawning and subadult holding of adult or subadult green sturgeon. Because the lower Yuba River is smaller than the Sacramento River or other rivers citing a depth criterion of >5 meters (16.4 feet), use of that criterion may be overly restrictive and not account for local opportunistic habitat utilization by green sturgeon. Therefore, to provide a more rigorous and inclusive analysis, water depth is evaluated by identifying all pools located downstream of Daguerre Point Dam characterized by water depths of >10.0 feet over the general range of flow conditions where changes in monthly mean flows were observed in the lower Yuba River between the Cumulative Condition and the Environmental Baseline. These pools were identified by application of the RMT's SRH2D 2-dimensional (SRH-2D) model.

Deepwater habitats were identified downstream of Daguerre Point Dam in ArcGIS. Polygons were constructed of deepwater habitats greater than 10.0 feet in depth in the Yuba River downstream of Daguerre Point Dam at a baseflow of 530 cfs at the Marysville Gage, which represents the baseflow\(^1\) used to delineate morphological units in the geomorphologic investigations conducted for the Yuba River downstream of Englebright Dam. Deepwater habitat polygons, with a minimum inter-nodal spacing of 5 feet, were developed by YCWA through application of the DEM and the SRH-2D model.

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\(^1\) The final baseflow regime used in the report titled *Landforms of the Lower Yuba River* (Wyrick and Pasternack 2012) was the condition with a Smartsville Gage flow of 880 cfs, no discharge out of Deer Creek (whose outflow tends to be 0-5 cfs in the absence of rain or upstream reservoir maintenance), no discharge out of Dry Creek (whose outflow tends to be 0-5 cfs in the absence of rain or upstream reservoir maintenance), and an agricultural withdrawal of 350 cfs at Daguerre Point Dam, yielding a Marysville Gage flow of 530 cfs.
Identified deepwater pools downstream of Daguerre Point Dam were further analyzed using the following flows (cfs) at the Marysville Gage.²

- 300
- 350
- 400
- 450
- 530
- 600
- 622
- 700
- 800

- 880
- 930
- 1,000
- 1,300
- 1,500
- 1,700
- 2,000
- 2,500
- 3,000

- 4,000
- 5,000
- 7,500
- 10,000
- 15,000
- 21,100
- 30,000
- 42,200

The areal extent of the deepwater pools was calculated for each of the above-specified flows by calculating the difference between the DEM and the SRH-2D model results in ArcGIS, consistent with the methodology employed in Technical Memorandum 7-10, *Instream Flow Downstream of Englebright Dam* for the YRDP FERC Relicensing process.

² The relationship between the areal extent of deepwater pool habitat and flow was not based on flows exceeding 42,200 cfs at the Marysville Gage. At flows higher than 42,200 cfs, specifically at the flows of 84,400 and 110,400 cfs specified in YCWA’s Study 7.10, *Instream Flow Downstream of Englebright Dam*, the lower portion of the river spills far out onto the floodplain, and the necessary topographic data to map and model these flows are not currently available (G. Pasternack, pers. comm. 2012). For the analyses of the areal extent of deepwater pools in the lower portion of the river over the evaluation period (WY 1970 through WY 2010) for the “Base Case” (see Technical Memorandum 2-2, *Water Balance/Operations Model*), the areal extent of deepwater pool habitat at flows exceeding 42,200 cfs was assumed to equal the extent at that flow level.
Estimates of the areal extent of the deepwater pools were subsequently calculated for the modeled mean monthly flows under the Environmental Baseline simulation for each individual month from February through November (over the entire simulation period from WY 1922 through WY 2008) using linear interpolation between the flow values specified above and the associated areas of deepwater pool habitat. The period of February through November represents the months when adult green sturgeon may potentially be holding, including the pre-spawning holding, spawning, and post-spawning periods (Adams et al. 2002; Klimley et al. 2007).

Based on the estimated deepwater pool habitat areas calculated for each mean daily flow of the simulated hydrologic period of record for the Environmental Baseline, deepwater adult holding habitat duration curves were developed for each month of the evaluation period (i.e., February through November). The deepwater adult holding habitat duration curves were constructed in the same manner as a flow duration curve, but used estimates of deepwater adult holding habitat availability instead of flows as the ordered data. The product of the deepwater adult holding habitat duration analysis served as a record of mean monthly deepwater habitat availability in acres, presented as an exceedance curve, for each month of the year over the hydrologic period of record. The duration analysis also included generating deepwater habitat availability duration metrics.

In addition to areal extent of deepwater pool habitat availability, analyses were conducted to examine the change in depth of pools downstream of Daguerre Point Dam associated with change in flow at the Marysville Gage. The average and maximum change in water depth of the pools associated with change in discharge were normalized and expressed as inches per 100 cfs between each specified flow.

In addition to flow-related effects assessments, water temperature-related effects also are evaluated for green sturgeon. The evaluation of water temperature-related effects on critical habitat for green sturgeon in this BA utilizes water temperature index values identified by Yuba Accord RMT (2013). The following discussion regarding water temperature requirements for the various lifestages of green sturgeon is taken from Yuba Accord RMT (2010b).
The habitat requirements of green sturgeon are not well known. In the Klamath River, the water temperature tolerance of immigrating adult green sturgeon reportedly ranges from 44.4°F to 60.8°F. Reportedly, no green sturgeon were found in areas of the river outside this surface water temperature range (USFWS 1995a).

Green sturgeon reportedly tolerate spawning water temperatures ranging from 50°F to 70°F (CDFG 2001). Water temperatures tolerances for green sturgeon during spawning and egg incubation also have been reported to range between 46° to 57°F (NMFS 2009c), although eggs have been artificially incubated at temperatures as high as 60°F (Deng 2000 as cited in NMFS 2009c). Suitable water temperatures for egg incubation in green sturgeon reportedly ranges between 52°F and 63°F (optimally between 57-61°F) with lethal temperatures approaching 73°F (Van Eenennaam et al. 2005). Water temperatures above 68°F are reportedly lethal to North American green sturgeon embryos (Cech et al. 2000; Beamesderfer and Webb 2002).

Water temperatures not exceeding 62.6°F have been reported to permit normal North American green sturgeon larval development (Van Eenennaam et al. 2005 as cited in Heublein et al. 2009). Werner et al. (2007) suggests temperatures remain below 68°F for larval development. Temperatures of about 59°F are believed to be optimal for larval growth, whereas temperatures below about 52°F or above about 66°F may be detrimental for growth (Cech et al. 2000).

NMFS (2009c) reports optimal water temperatures for the development of green sturgeon egg, larval, and juvenile lifestages ranging between 52°F and 66°F. Growth of juvenile green sturgeon is reportedly optimal at 59°F and reduced at both 51.8°F and 66.2°F (Cech et al. 2000). According to NMFS (2009c) suitable water temperatures for juvenile green sturgeon should be below about 75°F. At temperatures above about 75°F, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and Cech 2004) and increased cellular stress (Allen et al. 2006).

Consistent with Yuba Accord RMT (2013), the water temperature-related assessment for green sturgeon critical habitat evaluates the differences in the probability of occurrence that water temperatures at Daguerre Point Dam and at the Marysville Gage in the lower
Yuba River are within reported suitable ranges for each of the lifestages (Table 6-4), under the Cumulative Condition relative to the Environmental Baseline.

**Table 6-4. Green sturgeon lifestage-specific water temperature index value ranges and associated periodicities.**

<table>
<thead>
<tr>
<th>Lifestage</th>
<th>Water Temperature Range</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
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<th>Sep</th>
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<th>Nov</th>
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</thead>
<tbody>
<tr>
<td>Adult Immigration and Holding</td>
<td>44°F – 61°F</td>
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<tr>
<td>Spawning and Embryo Incubation</td>
<td>46°F – 63°F</td>
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<tr>
<td>Post-Spawning Holding</td>
<td>44°F – 61°F</td>
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<tr>
<td>Juvenile Rearing and Outmigration</td>
<td>52°F – 66°F</td>
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**OTHER FUTURE NON-FEDERAL ACTIVITIES**

The cumulative effects assessment includes identification of other future non-Federal activities that are reasonably certain to occur in the Action Area, with particular reference to the lower Yuba River. Identified activities will be evaluated as to whether they have the potential to affect listed species or their critical habitat including any effects related to instream flows and water temperatures.
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7.0 Effects of the Proposed Action

Under the aggregate effects assessment approach, the Environmental Baseline and the status of the species are viewed together to determine the ability of each listed species to withstand additional stressors or the exacerbation of existing stressors. As the NMFS (1999) policy document states: “If the species’ status is poor and the baseline is degraded at the time of consultation, it is more likely that any additional adverse effects caused by the proposed or continuing action will be significant”.

7.1 Assessment of the Environmental Baseline

Past, present, and future effects associated with the physical presence of the existing facilities at Daguerre Point Dam are included in the Environmental Baseline. With the exception of potential effects related to fish ladder performance associated with authorized discretionary operations and maintenance activities at Daguerre Point Dam, the Corps does not have the authority or discretion to lessen other stressors associated with these facilities. Therefore, it is appropriate that the ongoing impacts from the stressors associated with the continued existence of Daguerre Point Dam are included in the Environmental Baseline. The limiting factors, threats and stressors associated with the Environmental Baseline, which have led to the current status of each of the listed species, are described in detail in Chapter 4 of this BA and are summarily discussed by ESU and DPS below, followed by Environmental Baseline stressors in the Action Area of the lower Yuba River, to provide context for the aggregate effects analysis.

7.1.1 Spring-run Chinook Salmon ESU

The key limiting factors, threats and stressors associated with the Environmental Baseline affecting the spring-run Chinook salmon ESU include the following.

- Habitat Blockage
- Water Development
The Central Valley spring-run Chinook salmon ESU continues to display broad fluctuations in abundance. According to NMFS (2011a), recent anomalous conditions in the coastal ocean, along with consecutive dry years affecting inland freshwater conditions, have contributed to statewide spring-run Chinook salmon escapement declines. As a species’ abundance decreases, and spatial structure of the ESU is reduced, a species has less flexibility to withstand changes in the environment.

The BO for the CVP/SWP OCAP consultation (NMFS 2009a) covered CVP and SWP facilities and potentially affected waterbodies. The lower Yuba River is not included in the CVP or SWP, and spring-run Chinook salmon would not be affected by CVP/SWP operations while in the lower Yuba River. However, the Yuba River spring-run Chinook salmon population would be subject to CVP/SWP operational and ESU-wide effects associated with the Environmental Baseline while in their migratory lifestages in the lower Feather River, lower Sacramento River, and the Delta, as well as in the Pacific Ocean. The NMFS (2009a) BO, therefore, is used in this BA for an assessment of the entire Central Valley spring-run Chinook salmon ESU.

NMFS’ evaluation of potential effects of the CVP/SWP OCAP (NMFS 2009a) included an assessment of the VSP parameters of abundance, productivity, spatial structure, and diversity. Regarding abundance, NMFS (2009a) stated that long-term CVP/SWP system-wide operations are expected to result in substantial mortality to juvenile spring-run Chinook salmon, and that CVP/SWP-related entrainment into the Central and South
Delta greatly increase the risk of mortality from direct (entrainment and impingement at the pumps) and indirect (predation) effects. NMFS (2009a) also stated that population growth rate of spring-run Chinook salmon would be expected to decline in the future.

According to NMFS (2009a), operations of the CVP and SWP reduce the population’s current spatial structure (by reducing habitat quantity and quality) and negatively affect the diversity of spring-run Chinook salmon in the mainstem Sacramento River. CVP/SWP operations are expected to continue these effects. The operations of the DCC, and historical operations of RBDD have affected the temporal distribution of adult spring-run on their spawning migration to mainstem Sacramento River spawning grounds, and potentially result in introgression with fall-run Chinook salmon and continues the pattern of genetic introgression and hybridization that has occurred since RBDD was built in the late 1960s (CDFG 1988; NMFS 2004b; TCCA 2008 as cited in NMFS 2009a). In addition, the FRFH program has affected the diversity of the Central Valley spring-run Chinook salmon and, together with the loss of the San Joaquin River Basin spring-run populations, the diversity of the Central Valley spring-run Chinook salmon ESU has been reduced (NMFS 2004).

Critical habitat for spring-run Chinook salmon is composed of PCEs that are essential for the conservation of the species, including but not limited to, spawning habitat, rearing habitat, migratory corridors, and estuarine areas. Most of the historic spawning and rearing habitat for the Central Valley spring-run Chinook salmon ESU is above impassable dams. According to NMFS (2009a), substantial habitat degradation and alteration also has affected the rearing, migratory, and estuarine areas used by spring-run Chinook salmon. Some general examples of how spring-run Chinook salmon critical habitat has been degraded include the loss of natural river function and floodplain connectivity through levee construction, and direct losses of floodplain and riparian habitat, effects to water quality associated with agricultural, urban, and industrial land use, and substantial changes to Delta estuarine habitat (NMFS 2009a).

Due to past and ongoing effects, the current condition of spring-run Chinook salmon critical habitat is considered to be highly degraded, and does not provide the conservation value necessary for the survival and recovery of the species (NMFS 2009a). In addition,
climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions (Lindley et al. 2007).

According to NMFS (2009a), all of the above factors, which reduce the spatial structure, diversity, and abundance, compromise the capacity for the spring-run Chinook salmon ESU to respond and adapt to environmental changes. NMFS’ VSP analysis at the population and diversity group scales showed reduced viability of extant spring-run Chinook salmon populations and diversity groups. Additionally, high quality critical habitat containing spawning sites with adequate water and substrate conditions, or rearing sites with adequate floodplain connectivity, cover, and water conditions (i.e., key PCEs of critical habitat that contribute to its conservation value) is considered to be limited.

Future projections over the duration of evaluated long-term CVP/SWP operations (i.e., through 2030), considering both increasing water demands and climate change, exacerbate risks to the Central Valley spring-run Chinook salmon ESU. NMFS (2009a) stated that the Central Valley spring-run Chinook salmon ESU is at moderate risk of extinction.

NMFS (2009a) concluded that long-term CVP/SWP operations are likely to jeopardize the continued existence of Central Valley spring-run Chinook salmon, and are likely to destroy or adversely modify critical habitat for Central Valley spring-run Chinook salmon.

NMFS (2009a) initially attempted to devise a RPA for spring-run Chinook salmon and its critical habitat by modifying CVP/SWP project operations (e.g., timing/magnitude of releases from dams, closure of operable gates and barriers, and reductions in negative flows). In some cases, however, altering CVP/SWP project operations was not sufficient to ensure that the CVP and SWP projects would be likely to avoid jeopardizing the species or adversely modifying critical habitat. Consequently, NMFS (2009a) developed focused actions designed to compensate for particular stressors, considering the full range of authorities that Reclamation and DWR may use to implement these actions. NMFS concentrated on actions that have the highest likelihood of alleviating the stressors with
the most significant effects on the species, rather than attempting to address every project stressor for each species or every PCE for critical habitat.

The NMFS (2009a) RPA is composed of numerous elements for each of the various CVP/SWP project divisions and associated stressors. NMFS recognized that the RPA must be an alternative that is likely to avoid jeopardizing listed species or adversely modifying their critical habitats, rather than a plan that will achieve recovery. Short-term actions are presented in NMFS (2009a) for each division of the CVP/SWP, and are summarized for each species to ensure that the likelihood of survival and recovery is not appreciably reduced in the short term (i.e., one to five years). In addition, because evaluated long-term CVP/SWP system-wide operations extend until 2030, the consultation also included long-term actions that NMFS identified as being necessary to address CVP/SWP project-related adverse effects on the likelihood of survival and recovery of the species over the next two decades. However, the Federal Court for the Eastern District of California held that the jeopardy conclusion of the 2009 NMFS BO was correct, but that the RPA actions were not adequately justified or supported by the record. The NMFS 2009 BO was remanded (Consol. Salmonid Cases, 791 F. Supp. 2d 802 (E.D. Cal. 2011)).

For the ESU-wide Environmental Baseline effects assessment of the spring-run Chinook salmon, NMFS (2009a) found that the entire suite of limiting factors, threats and stressors associated with the Environmental Baseline result in an unstable ESU at moderate risk of extinction.

### 7.1.2 Steelhead DPS

The aforementioned list of limiting factors and stressors pertinent to the spring-run Chinook salmon ESU also pertain to the steelhead DPS. Stressors that are unique to the steelhead DPS, or substantially differ in the severity from the stressor for the previously described spring-run Chinook salmon ESU, are discussed in Chapter 4 of this BA and include the following.

- Destruction, Modification, or Curtailment of Habitat or Range
Overutilization for Commercial, Recreational, Scientific or Education Purposes (inland sport harvest)

Disease and/or Predation

Inadequacy of Existing Regulatory Mechanisms (Federal efforts, non-Federal efforts)

Other Natural and Man-Made Factors Affecting the Continued Existence of the DPS

Non-Lifestage Specific Threats and Stressors for the DPS (artificial propagation programs, small population size, genetic integrity and long-term climate change)

As previously discussed for the Central Valley spring-run Chinook salmon ESU, the BO for the CVP/SWP OCAP consultation (NMFS 2009a) covered CVP and SWP facilities and potentially affected waterbodies, which did not include the lower Yuba River.

NMFS (2009a) stated that CVP/SWP system-wide operations are expected to result in direct mortality to steelhead, including: (1) increased predation of juveniles when the RBDD gates are down; (2) entrainment of juveniles into the Central and South Delta; (3) entrainment and impingement of juveniles at the CVP/SWP pumps in the South Delta (both direct and indirect loss); and (4) loss associated with the collection, handling, trucking and release program.

According to NMFS (2009a), steelhead habitat conditions in the mainstem Sacramento River and the Delta have been adversely affected by long-term CVP/SWP system-wide operations in several ways, including but not limited to: (1) delaying the upstream migration of adult steelhead through RBDD operations; (2) reducing the availability of quality rearing habitat through the seasonal creation of Lake Red Bluff; and (3) creating improved feeding opportunities at RBDD for predators such as pikeminnow and striped bass. In these ways, the CVP/SWP system-wide operations reduced the population’s spatial structure (by reducing habitat quantity and quality), which increases the risk of extinction of the mainstem Sacramento River steelhead population (NMFS 2009a). Beginning in September 2011 and implemented in response to the NMFS OCAP BO (2009a), the RBDD gates were permanently raised, which has likely improved fish
passage conditions at the RBDD. The Red Bluff Fish Passage Improvement Project, which included construction of a pumping plant to allow for diversion of water from the Sacramento River without closing the RBDD gates, was completed in 2012 (Tehama-Colusa Canal Authority 2012).

NMFS (2009a) stated that the diversity of mainstem Sacramento River steelhead also may be affected by CVP/SWP system-wide operations due to changed thermal regimes and food web structures in the Sacramento River such that a resident life history strategy may have fitness advantages over anadromous forms, although little is known about the relationship of resident and anadromous forms of *O. mykiss*. Without knowing the roles that resident *O. mykiss* play in population maintenance and persistence of anadromous *O. mykiss*, it is difficult to assess whether the current conditions on the Sacramento River, which may favor residency, are detrimental to the anadromous population in the Sacramento River or not (Lindley et al. 2007). In addition, widespread hatchery steelhead production within this DPS also raises concerns about the potential ecological interactions between introduced stocks and native stocks (Corps 2007).

According to NMFS (2009a), critical habitat for steelhead is composed of PCEs that are essential for the conservation of the species including, but not limited to, spawning habitat, rearing habitat, migratory corridors, and estuarine areas. Based on the host of stressors to spawning, rearing, migratory, and estuarine habitats in the Central Valley, it is apparent that the current condition of steelhead critical habitat is degraded, and does not provide the conservation values necessary for the survival and recovery of the species (NMFS 2009a).

NMFS (2009a) stated that CVP/SWP system-wide operations are expected to place critical habitat for mainstem Sacramento River steelhead at considerable risk. The status of steelhead critical habitat, within the mainstem Sacramento River is suggested by NMFS (2009a) to be substantially degraded due to factors such as warm water temperatures and low flows, loss of natural river function and floodplain connectivity through levee construction, direct loss of floodplain and riparian habitat, loss of tidal wetland habitat, a collapsed pelagic community in the Delta, and poor water quality associated with agricultural, urban, and industrial land use. Additionally, NMFS (2009a)
stated that climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, and overall drier conditions. Estuarine habitats also have been substantially degraded (e.g., Sommer et al. 2007) and climate change is expected to further alter these habitats through sea level rise and hydrological changes.

As described by NMFS (2009a), there are few data with which to assess the status of Central Valley steelhead populations. According to NMFS (2009a), data are lacking to suggest that the Central Valley steelhead DPS is at low risk of extinction, or that there are viable populations of steelhead anywhere in the DPS. Conversely, NMFS (2009a) states that there is evidence to suggest that the Central Valley steelhead DPS is at moderate or high risk of extinction. Most of the historical habitat once available to steelhead has been lost, and the observation that anadromous *O. mykiss* are becoming rare in areas where they were probably once abundant indicates that an important component of life history diversity is being suppressed or lost (NMFS 2009a). Lindley et al. (2007) stated that even if there were adequate data on the distribution and abundance of steelhead in the Central Valley, approaches for assessing steelhead population and DPS viability might be problematic because the effect of resident *O. mykiss* on the viability of steelhead populations and the DPS is unknown.

NMFS (2009a) concluded that long-term CVP/SWP operations are likely to jeopardize the continued existence of Central Valley steelhead and are likely to destroy or adversely modify critical habitat for Central Valley steelhead.

NMFS (2009a) developed RPA actions for each of the various CVP/SWP project divisions and associated waterbodies to avoid jeopardy and adverse modification of critical habitat. However, as previously discussed, the Federal Court for the Eastern District of California held that the jeopardy conclusion of the 2009 NMFS BO was correct, but that the RPA actions were not adequately justified or supported by the record. The NMFS 2009 BO was remanded (Consol. Salmonid Cases, 791 F. Supp. 2d 802 (E.D. Cal. 2011)).

For the DPS-wide Environmental Baseline effects assessment of steelhead, NMFS (2009a) found that the entire suite of limiting factors, threats and stressors associated with
the Environmental Baseline result in an unstable DPS at moderate or high risk of extinction.

### 7.1.3 Southern DPS of North American Green Sturgeon

The key limiting factors, threats and stressors associated with the Environmental Baseline affecting the Southern DPS of North American green sturgeon, discussed in Chapter 4 of this BA, include the following.

- Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range (reduction in spawning habitat, alteration of habitat – flows, water temperatures, delayed or blocked migration, impaired water quality, dredging and ship traffic, ocean energy projects)
- Commercial, Recreational, Scientific or Educational Overutilization
- Disease and Predation
- Inadequacy of Existing Regulatory Mechanisms
- Other Natural and Man-Made Factors Affecting the Species’ Continued Existence (non-native invasive species, entrainment)

As discussed in Chapter 4, about 217 green sturgeon have been acoustically-tagged in the Central Valley (CFTC 2012 as cited in YCWA 2013a). However, the current status of Southern DPS of North American green sturgeon abundance and productivity is unknown (NMFS 2009a). CVP/SWP system-wide operations, including closures of the ACID dam and the RBDD gates historically resulted in increased loss of individual fish and reduced abundance of adult fish in the green sturgeon population (NMFS 2009a). Closure of the gates at RBDD from May 15 through September 15 previously precluded all access to green sturgeon spawning grounds above the dam during that time period. However, as previously discussed, the RBDD gates were permanently raised during September 2011. With the RBDD gates raised, Vogel (2011) reports that green sturgeon have unimpeded access to upstream reaches as far as the ACID dam near Redding, CA.
Larval and juvenile green sturgeon entrainment or impingement from screened and unscreened agricultural, municipal, and industrial water diversions along the Sacramento River and within the Delta also are considered important threats (71 FR 17757).

The Southern DPS of North American green sturgeon is at substantial risk of future population declines (NMFS 2009a). The potential threats faced by green sturgeon include increased vulnerability due to the reduction of spawning habitat into one concentrated area on the Sacramento River, lack of good empirical population data, vulnerability of long-term cold water supply for egg incubation and larval survival, loss of juvenile green sturgeon due to entrainment at the project fish collection facilities in the South Delta and agricultural diversions within the Sacramento River and Delta systems, alterations of food resources due to changes in the Sacramento River and Delta habitats, and exposure to various sources of contaminants throughout the basin to juvenile, sub-adult, and adult lifestages (NMFS 2009a).

According to NMFS (2009a), past RBDD gate closures blocking access to upstream spawning areas decreased the productivity and spatial structure of the green sturgeon population. Fish forced to spawn below RBDD were believed to have a lower rate of spawning success compared to those fish that spawned above the RBDD. Furthermore, NMFS (2009a) stated that reductions in genetic diversity may occur due to the separation of upstream and downstream populations created anthropogenically by the closure of the RBDD. When the gates were down, RBDD precluded access to 53 miles of spawning habitat for 35-40 percent of the spawning population of green sturgeon. NMFS (2009a) mandated an RPA action for RBDD that required the gates to be raised year-round by 2012. As previously discussed, the Red Bluff Diversion Dam Fish Passage Improvement Project was completed in 2012. At the time that NMFS conducted the consultation for the CVP/SWP OCAP, green sturgeon critical habitat had been proposed but a final rule designating critical habitat had not yet been adopted. NMFS (2009a) therefore referred to “proposed” green sturgeon critical habitat in its evaluations.

According to NMFS (2009a), the proposed critical habitat at that time for the Southern DPS of North American green sturgeon is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the recovery of the
species, particularly in the upstream riverine habitat. In particular, passage and water
flow PCEs have been impacted by human actions, substantially altering the historical
river characteristics in which green sturgeon evolved. In addition, the alterations to the
Delta may have a particularly strong impact on the survival and recruitment of juvenile
green sturgeon due to the protracted rearing time in the delta and estuary. Loss of
individuals during this phase of the life history of green sturgeon represents losses to
multiple year classes rearing in the Delta, which can ultimately impact the potential
population structure for decades to come (NMFS 2009a).

NMFS (2009a) stated that CVP/SWP system-wide operations are expected to reduce the
conservation value of green sturgeon critical habitat. The principal factor for the decline
of green sturgeon reportedly comes from the reduction of green sturgeon spawning
habitat to a limited area of the Sacramento River (70 FR 17391). The potential for
catastrophic events to affect such a limited spawning area increases the risk of the green
sturgeon’s extirpation. The value of the upstream migration corridor is currently
degraded mainly by the installation of the ACID dam (NMFS 2009a). Elevated water
temperatures in the spawning and rearing habitat likely also pose threats to this species
(70 FR 17391). The effects of future CVP/SWP system-wide operations under climate
change scenarios would likely further degrade the water quality PCE.

As described by NMFS (2009a), there are few data with which to assess the status of
green sturgeon in the Central Valley domain. NMFS (2009a) stated that the green
sturgeon DPS is data deficient. Nonetheless, NMFS (2009a) concluded that the Southern
DPS of North American green sturgeon remains vulnerable to becoming endangered in
the future. Key factors upon which this conclusion was based include: (1) the DPS is
comprised of only one spawning population, which has been blocked from a considerable
portion of its potential spawning range by dams; (2) the DPS has a risk associated with
catastrophes and environmental perturbations (i.e., water temperatures from Shasta Dam)
affecting current spawning areas; and (3) mortality rates have significant effects on the
adult and sub-adult life history phases of this long-lived species (NMFS 2009a).

NMFS (2009a) concluded that continued operations of the CVP/SWP would be expected
to have population level consequences for the single extant population in the mainstem
Sacramento River, and greatly increase the extinction risk of the species (NMFS 2009a). Additionally, NMFS (2009a) concluded that the conservation value of the critical habitat, as designated for the conservation of green sturgeon, would be reduced.

NMFS (2009a) developed a RPA for green sturgeon in order to avoid jeopardy and adverse modification of critical habitat. The green sturgeon RPA specifies many significant actions that will reduce the adverse effects of the continued operation of the CVP/SWP and bring about the proper functioning of PCEs of its proposed critical habitat (NMFS 2009a).

The entire suite of limiting factors, threats, and stressors associated with the Environmental Baseline are likely to jeopardize the continued existence of the Southern DPS of North American green sturgeon (NMFS 2009a).

**7.1.4 Lower Yuba River**

The vast majority of the available information for the lower Yuba River addresses spring-run Chinook salmon where specifically identified, Chinook salmon in general where runs are not specifically identified, and *O. mykiss* (anadromous and resident forms). There is a paucity of information available regarding green sturgeon in the lower Yuba River.

Anadromous salmonid populations in the Yuba River watershed have endured nearly 150 years of intense human degradation of their riverine habitat, starting with hydraulic gold mining in the mid-nineteenth century, and continuing through the construction of dams and the ongoing development of water for hydropower and consumptive uses (NMFS 2007). According to UC Davis Professor Dr. Gregory Pasternack, “the LYR is moving along on a path of natural, self-driven ecological recovery that is directly attributable to the existence of Englebright Dam. Englebright Dam protects the river from the vast wastes of a degraded watershed blocked upstream” (see Appendix B, Attachment 3).

For this BA, the assessment of the Environmental Baseline within the Action Area for listed fish species considers: (1) past, present and ongoing limiting factors, threats and stressors described in Chapter 4; (2) full implementation of the Yuba Accord, which has occurred as a pilot program basis since 2006; and (3) the results of available lower Yuba
River fisheries monitoring data, current status of the listed species and the viability of these species as discussed in detail in Chapter 4.

It is problematic to incrementally assess the magnitude of an individual stressor because of the interconnectivity of individual stressors, and because the entire suite of limiting factors, threats and stressors associated with the Environmental Baseline has resulted in the current status and viability of the listed species within the Action Area. Nonetheless, based upon available information (see Chapter 4 of this BA) the following sections discuss, to the extent possible, each of the stressors associated with the Environmental Baseline regarding the relative magnitude of its contribution to the current status and viability of each listed species in the lower Yuba River.

### 7.1.4.1 Spring-run Chinook Salmon

The key limiting factors, threats and stressors associated with the Environmental Baseline affecting the spring-run Chinook salmon in the lower Yuba River include the following.

- Passage Impediments/Barriers
- Harvest/Angling Impacts
- Poaching
- Loss of Floodplain Habitat
- Entrainment
- Predation
- Loss of Natural River Morphology and Function
- Physical Habitat Alteration (including Waterway 13)
- Loss of Riparian Habitat and Instream Cover (riparian vegetation, instream woody material)
- Hatchery Effects (FRFH genetic considerations, straying into the lower Yuba River) and other genetic considerations

#### Passage Impediments/Barriers

As described in Chapter 4 (Status of the Species), Englebright Dam presents an impassable barrier to the upstream migration of anadromous salmonids, and marks the upstream extent of currently accessible spring-run Chinook salmon habitat in the lower...
Yuba River, whereas Daguerre Point Dam presents an impediment to upstream migration in the Action Area.

**Barriers Upstream of the Action Area (Englebright Dam)**

Although located upstream of the Action Area, NMFS (2007, 2009) reports that the greatest impact to listed anadromous salmonids in the Yuba River watershed is the complete blockage of access for these species to their historical spawning and rearing habitat above Englebright Dam. Because this historic habitat is no longer accessible, spring-run Chinook salmon and steelhead are relegated to the 24 miles of the lower Yuba River from Englebright Dam to the confluence with the lower Feather River. Since construction of Englebright Dam in 1941, these species are required to complete all of their riverine lifestages in the 24 miles of the lower Yuba River, which previously served primarily as a migratory corridor to upstream spawning and rearing habitats.

The long-standing effects of Englebright Dam on the status of spring-run Chinook salmon and steelhead have affected the viability of these populations in the Yuba River. The lack of access to historic habitats upstream of Englebright Dam has reduced all four VSP parameters (abundance, productivity, spatial structure and genetic diversity) for spring-run Chinook salmon (and steelhead). Although the effects of the presence of Englebright Dam persist and continue to affect the status of the species in the Action Area, recent actions have ameliorated some of the stressors on these populations, which now are restricted to the lower Yuba River.

The NMFS (2009) Draft Recovery Plan states that, for currently occupied habitats below Englebright Dam, it is unlikely that habitats can be restored to pre-dam conditions, but many of the processes and conditions that are necessary to support viable independent populations of spring-run Chinook salmon and steelhead can be improved with provision of appropriate instream flow regimes, water temperatures, and habitat availability. Flow schedules specified in the Fisheries Agreement of the Yuba Accord were first implemented on a pilot program basis in 2006 and 2007, and then were implemented on a long-term basis in 2008, after the SWRCB made the necessary changes to YCWA’s water right permits. Continued implementation of the Yuba Accord addresses flow-related major stressors, including flow-dependent habitat availability, flow-related habitat...
complexity and diversity, and water temperatures, and considerably improves conditions in the lower Yuba River (NMFS 2009).

Related to external influences in the upper Yuba River watershed that have the potential to affect the status of listed species present in the Action Area, NMFS (2007) identified the following non-flow related stressors associated with Englebright Dam: (1) blocking access of listed salmonids to the habitat above the dam; (2) forcing overlapping use of the same spawning areas by spring and fall-run Chinook salmon below the dam; (3) forcing fish to spawn in a limited area without the benefit of smaller tributaries, which can provide some level of refuge in the event of catastrophic events; and (4) preventing the recruitment of spawning gravel and LWM from upstream of the dam into the lower river.

Information developed since 2007 provides clarification regarding the fourth component in the foregoing list of stressors, as well as the influence of fluvial geomorphological processes affecting PCEs in the Action Area of the lower Yuba River.

The fluvial geomorphology of the Yuba River is so unique that it is crucial to evaluate it on its own terms and not to apply simple generalizations and concepts from other rivers with dams (Pasternack 2010). First, unlike most other rivers below dams, lack of spawning gravel is not limiting in the lower Yuba River, with the localized exception of the Englebright Dam Reach of the river, which extends from immediately downstream of Englebright Dam to the vicinity of the confluence with Deer Creek. In this reach, no rounded river gravels/cobbles, suitable for spawning, were present until a small amount (about 500 tons) of gravel was injected artificially by the Corps in the Narrows II pool area of the Englebright Dam Reach during November 2007 and the subsequent injections by the Corps of: (1) 5,000 tons of suitable spawning substrate downstream of the Narrows I powerhouse during the fall of 2010 extending to January 2011; (2) 5,000 tons of suitable spawning substrate downstream of the Narrows I powerhouse during July and August of 2012; and (3) 5,000 tons in the Englebright Dam Reach during July and August of 2013.

In the Timbuctoo Bend area of the lower Yuba River, Pasternack (2008) reported that there is adequate physical habitat to support spawning of Chinook salmon and steelhead. Farther downstream, spawning habitat does not appear to be limited by an inadequate
supply of gravel within the Parks Bar and Hammon Bar reaches of the lower Yuba River, due to ample storage of mining sediments in the banks, bars, and training walls (cbec and McBain & Trush 2010). For the remainder of the lower Yuba River, Beak Consultants, Inc (1989) stated that the spawning gravel resources in the river are considered to be excellent based on the abundance of suitable gravels, and that the tremendous volumes of gravel remaining in the river as a result of hydraulic mining make it unlikely that spawning gravel will be in short supply in the foreseeable future.

Pasternack (2010) concluded that because of the pre-existing, unnatural condition of the river corridor influenced by mining debris, Englebright Dam… “is actually contributing to the restoration of the river toward its historical geomorphic condition, in the truest meaning of the term - going back to the pre-existing state prior to hydraulic gold mining.” He further concluded that most of the lower Yuba River is still geomorphically dynamic and the river has a diversity of in-channel physical habitats, and that because Englebright Dam prevents residual mining wastes from moving downstream into the Action Area, channel complexity and habitat diversity in the lower Yuba River have been re-emerging, and that process continues.

Regarding the recruitment of woody material, some woody material may not reach the lower Yuba River due to collecting on the shoreline and sinking in Englebright Reservoir, or due to New Bullard’s Bar Dam blocking natural downstream migration. However, Englebright Dam does not functionally block woody material from reaching the lower Yuba River because any accumulated woody material either spills over the dam during uncontrolled flood events or otherwise is pushed over the dam by the Corps.

In conclusion, the lack of spawning gravel (or recruitment thereof) is not a significant stressor to spring-run Chinook salmon in the lower Yuba River, with the exception of the Englebright Dam Reach. Moreover, the abundance of LWM in the lower Yuba River is not substantively attributable to the presence of Englebright Dam. Ongoing effects associated with Englebright Dam include the loss of historical spawning and rearing habitat above Englebright Dam, resultant loss of reproductive isolation and subsequent hybridization with fall-run Chinook salmon, restriction of spatial structure and associated vulnerability to catastrophic events. Although the genesis of these stressors emanate
upstream of the Action Area at Englebright Dam, the manifestation of these stressors affect the current status of the species in the Action Area in the lower Yuba River.

**Impediments Within the Action Area (Daguerre Point Dam)**

**Adult Upstream Migration**

Daguerre Point Dam has been reported to be an impediment to upstream migration of adult salmon and steelhead under certain conditions. When high flow conditions occur during winter and spring, adult spring-run Chinook salmon (and steelhead) have been reported to experience difficulty in finding the entrances to the ladders because of the relatively low amount of attraction flows exiting the fish ladders, compared to the magnitude of the sheet-flow spilling over the top of Daguerre Point Dam. The angles of the fish ladder entrance orifices and their proximities to the plunge pool also increase the difficulty for fish to find the entrances to the ladders. Periodic obstruction of the ladders by sediment and woody debris may temporarily block passage or reduce attraction flows at the ladder entrances.

Other configuration and design features of the fish ladders and passage facilities that reportedly could either delay or impede access to spawning and rearing areas above the dam include: (1) the fish ladder control gate entrance, acting as a submerged orifice, is more passable at low flows (actual flow data are unavailable) during the summer and fall than at high flows during winter and spring; (2) unfavorable within-bay hydraulic characteristics, particularly associated with debris collection; (3) “masking” of the entrances to the ladders when overflow over the spillway occurs; (4) insufficient attraction flows during non-overflow operational conditions; (5) unfavorable fish ladder geometric configurations; (6) proximity of the ladder exits to the spillway, potentially resulting in adult fish exiting the ladder being immediately swept by flow back over the dam; and (7) sediment accumulation and unfavorable habitat conditions at the upstream exits of the fish ladders, resulting in reduced unimpeded passage from the ladders to the main channel, and the potential for fish to “fall-back” into the ladders. In addition, it has been suggested that poaching within the fish ladders and downstream of the dam occurs when fish become concentrated in the area due to delayed passage (NMFS 2005a), although grates have been installed over most of the ladder bays during 2011.
NMFS (2007) suggested that the biological consequences of blockage or passage delays include changes in spawning distribution, increased adult pre-spawning mortality, and decreased egg viability, which may result in the reduction of the abundance and productivity of spring-run Chinook salmon and steelhead. Each of these potential biological consequences is discussed below in consideration of information that has become available since 2007 (also see the discussion regarding fish ladders and fish passage in Chapter 5).

Recent information (2009, 2010 and 2011 acoustic tracking) demonstrates that phenotypic spring-run Chinook salmon (Chinook salmon that enter the lower Yuba River during spring months) display variable upstream migration and holding patterns, and that some fish may remain in the lower Yuba River in areas downstream (and proximate) to Daguerre Point Dam for extended periods of time during the spring and summer. It is uncertain whether, or to what extent, the duration of residency in the large pool located downstream of Daguerre Point Dam is associated with upstream passage impediment and delay, or volitional habitat utilization prior to spawning in upstream areas.

The RMT (2013) examined passage and flow data to evaluate whether upstream passage could be associated with either an ascending or descending hydrograph, or that the fish ladders may impede or prohibit passage at high or low flow levels. Examination of the daily number of adult Chinook salmon passing upstream of Daguerre Point Dam obtained by the VAKI Riverwatcher system from 2004 through 2011, and mean daily flows at the Marysville Gage did not reveal any consistent trend or relationship between adult Chinook salmon passage upstream of Daguerre Point Dam and flow rate. Chinook salmon passage was observed over a variety of flow conditions, including ascending or descending flows, as well as during extended periods of stable flows.

The RMT (2013) further evaluated whether adult Chinook salmon upstream passage through the ladders at Daguerre Point Dam is associated with specific flow levels. They reported that Chinook salmon upstream passage through the ladders at Daguerre Point Dam not only occurs over a wide range of flows but that, at least to some degree, passage occurs during the upstream migration period irrespective of flow rates (over the range of flows examined). In other words, passage occurs at higher flows during “wetter” years.
characterized by high flows from spring into summer, and at lower flows during “drier” years characterized by low flows from spring into summer. Flow thresholds prohibiting passage of Chinook salmon through the ladders at Daguerre Point Dam were not apparent in the data.

The RMT’s 3-year acoustic telemetry study of adult Chinook salmon tagged during the phenotypic adult spring-run Chinook salmon upstream migration period has provided new information to better understand adult spring-run Chinook salmon temporal and spatial distributions in the Yuba River. The results from the acoustic telemetry study found past characterizations of temporal and spatial distributions to be largely unsupported, as adult spring-run Chinook salmon were observed to exhibit a much more diverse pattern of movement, and holding locations in the lower Yuba River were more expansive than has been previously reported (RMT 2013). Observations from the telemetry study identified that a large longitudinal extent of the lower Yuba River was occupied by the tagged spring-run Chinook salmon during immigration and holding periods. Also, temporal migrations to areas upstream of Daguerre Point Dam occurred over an extended period of time. A longitudinal analysis of acoustic tag detection data indicated that distributions were non-random, and that the tagged spring-run Chinook salmon were selecting locations for holding.

Flows under the Yuba Accord have provided adult spring-running Chinook salmon migratory access to areas located throughout the lower Yuba River, as well as a broad expanse of longitudinally distributed areas selected for holding. In general, acoustically-tagged spring-run Chinook salmon exhibited an extended holding period, followed by a rapid movement into upstream areas (i.e., the upper Timbuctoo Reach, Narrows Reach, and Englebright Dam Reach) during September (RMT 2013).

Regarding potential changes in spawning distribution, it is not possible to assess if, or the manner in which, extended duration of holding below Daguerre Point Dam could potentially change spawning distribution, because no base data are available for conditions without the presence of Daguerre Point Dam.

During the RMT’s pilot redd survey conducted from the fall of 2008 through spring of 2009, the vast majority (i.e., 96%) of fresh Chinook salmon redds constructed by the first
week of October 2008, potentially representing spring-run Chinook salmon, were observed upstream of Daguerre Point Dam. Similar distributions were observed during the other two years of redd surveys, when weekly redd surveys were conducted. About 97% and 96% of the fresh Chinook salmon redds constructed by the first week of October were observed upstream of Daguerre Point Dam during 2009 and 2010, respectively.

The similar percentage distribution of Chinook salmon redds, potentially representing spring-run Chinook salmon, located upstream of Daguerre Point Dam occurred despite considerable differences in flow (monthly average cfs) that occurred from late spring into fall prior to each of the redd survey periods, as indicated below.

<table>
<thead>
<tr>
<th></th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
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<tbody>
<tr>
<td><strong>Marysville Gage</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2008</td>
<td>597</td>
<td>866</td>
<td>882</td>
<td>622</td>
</tr>
<tr>
<td>2009</td>
<td>1,846</td>
<td>1,737</td>
<td>1,715</td>
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<tr>
<td>2010</td>
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<td>2,698</td>
<td>1,991</td>
<td>768</td>
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<tr>
<td><strong>Smartsville Gage</strong></td>
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<td></td>
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<tr>
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<tr>
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<tr>
<td>2010</td>
<td>4,516</td>
<td>3,104</td>
<td>2,273</td>
<td>896</td>
</tr>
</tbody>
</table>

Regarding increased adult prespawning mortality, one way that adult prespawning mortality could occur is the potential for fish to jump out of the fish ladders. Because this phenomenon has rarely been observed or reported historically, and potential effects have been further eliminated/reduced following the installation of locking metal grates over 25 of the 33 unscreened bays of the fish ladders during the summer of 2011, it has likely represented a low impact to Yuba River spring-run Chinook salmon, but nonetheless has been identified as a stressor that could harm adult fish. Another way that adult prespawning mortality could occur is associated with anecdotal reported observations of Chinook salmon (run unspecified) leaping into the downstream face of Daguerre Point Dam, although no information is available regarding the potential extent or frequency of this reported phenomenon. It is possible that prespawning adult mortality could occur.
from repeated attempts to pass over the dam and injuries resulting from contact with the 
rough concrete surface of the dam face. However, it is unlikely that this represents a 
significant source of mortality to spring-run Chinook salmon.

Adult prespawning acute or latent mortality also could occur due to exposure to elevated 
water temperatures, which could also affect egg viability. The RMT (2013) included 
evaluation of water temperatures during the spring-run Chinook salmon adult upstream 
immigration and holding lifestage, which addressed considerations regarding both water 
temperature effects to pre-spawning adults and egg viability. They found that available 
water temperature monitoring data at all three gages (i.e., Smartsville, Daguerre Point 
Dam, Marysville) were always below the upper tolerance WTI values for adult 
immigration and holding. Thus, it is unlikely that this represents a significant source of 
mortality to spring-run Chinook salmon.

**Juvenile Downstream Migration**

Concern has been expressed that if emigrating salmon and steelhead juveniles encounter 
high water temperatures in the reach below Daguerre Point Dam, they cannot return to 
the lower-temperature habitat upstream because their passage is blocked by the dam 
(DWR and Corps 2003). However, this concern was raised prior to implementation of 
the Yuba Accord minimum flow schedules and associated water temperatures (initiated 
as a Pilot Program in 2006 and continuing to present). The RMT (2013) also included 
evaluation of water temperatures in the lower Yuba River during the year-round juvenile 
rearing period for spring-run Chinook salmon (and steelhead), and found that water 
temperatures at all three gages (i.e., Smartsville, Daguerre Point Dam, Marysville) were 
always below the upper tolerance WTI values for the juvenile rearing and outmigration 
lifestage. Thus, it is unlikely that this represents a significant source of mortality to 
spring-run Chinook salmon.

Daguerre Point Dam may influence predation rates on emigrant juvenile anadromous 
salmonids. Although it is recognized that there is a paucity of information regarding 
predation rates on juvenile salmonids in the lower Yuba River, predation likely represents 
a stressor of relatively high magnitude to the juvenile rearing lifestage of Yuba River 
spring-run Chinook salmon. The presence of Daguerre Point Dam may influence
predation rates above Daguerre Point Dam compared to below Daguerre Point Dam. The higher abundance of juvenile anadromous salmonids above Daguerre Point Dam may be due to larger numbers of spawners, greater amounts of more complex, high-quality cover, and lower densities of predators such as striped bass and American shad, which reportedly are generally restricted to areas below the dam due to their limited ability to pass through the fish ladders, relative to anadromous salmonids (YCWA et al. 2007). Daguerre Point Dam also may influence localized predation rates by increased predation of juveniles in the plunge pool located immediately downstream of the dam.

**Summary**

Given the entire suite of considerations associated with the design configuration and features of Daguerre Point Dam and its associated fish ladders that reportedly could either delay or impede adult upstream migration, as well as issues identified regarding juvenile downstream passage, the effects associated with the presence of Daguerre Point Dam likely represent a medium to high stressor to Yuba River spring-run Chinook salmon under the Environmental Baseline.

**Harvest/Angling Impacts**

Angling regulations on the lower Yuba River are intended to protect sensitive species, in particular spring-run Chinook salmon (and wild steelhead). The lower Yuba River from its confluence with the lower Feather River up to Englebright Dam is closed year-round to salmon fishing, and no take or possession of salmon is allowed. Fishing for hatchery trout or hatchery steelhead is allowed on the lower Yuba River from its confluence with the lower Feather River up to the Highway 20 Bridge year-round. Incidental impacts have the potential to occur to spring-run Chinook salmon through physical disturbance of salmonid redds, and incidental hooking and catch-and-release stress or mortality. However, the lower Yuba River, between the Highway 20 Bridge and Englebright Dam, is closed to fishing from September through November to protect spring-run Chinook salmon spawning activity and egg incubation.
Harvest/angling likely represents a negligible impact to Yuba River adult spring-run Chinook salmon. Hence, harvest/angling is characterized as a stressor of low magnitude to spring-run Chinook salmon.

**POACHING**

Poaching of adult Chinook salmon at the fish ladders and at the base of Daguerre Point Dam has been previously suggested to represent a stressor to spring-run Chinook salmon. NMFS' Draft Recovery Plan (NMFS 2009) identified poaching as a stressor of “low” importance to spring-run Chinook salmon in the lower Yuba River. The only actual account of documented poaching was provided in a declaration by Nelson (2009) in which he stated that during his tenure at CDFW (which extended until 2006) he personally observed people fishing illegally in the ladders, and further observed gear around the ladders used for poaching. It is not clear regarding the time period to which he was referring, although it may have been referring to the period prior to 2000. The VAKI Riverwatcher infrared and videographic sampling system began operations in 2003. CDFW monitored VAKI Riverwatcher operations at Daguerre Point Dam seasonally from 2003 through 2005, and CDFW and/or PSMFC have monitored the system on an approximate every other day basis, year-round, since 2006. Over this 10-year period, neither CDFW nor PSMFC staff has reported poaching in the ladders, or immediately downstream of Daguerre Point Dam.

More recently, in a July 2011 Court Order, the Federal Court of the Eastern District of California concluded that “installation of locked metal grates over the Daguerre fish ladders is necessary to prevent irreparable harm to the survival and recovery of the species during the interim period”. In response to the Court’s Order, the Corps installed locking metal grates over the Daguerre Point Dam fish ladder bays\(^1\) in August/September 2011 to prevent fish from jumping out of the ladders and to prevent poaching in the fish ladders.

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\(^1\) Excluding the eight bays on the lowermost section of the south fish ladder at Daguerre Point Dam so that CDFW can maintain continued access to the flow modification equipment that is located in the fish ladder and designed to improve fish passage conditions.
The extent to which spring-run Chinook salmon are targeted for poaching in the lower Yuba River is unknown, and it is unclear whether the previous reports of poaching were directed toward spring-run or fall-run Chinook salmon. With the installation of the metal grates over the Daguerre Point Dam fish ladders, poaching likely represents a low (or negligible) stressor to Yuba River adult spring-run Chinook salmon.

**Physical Habitat Alteration**

According to NMFS (2009), the stressor associated with physical habitat alteration specifically addressed the issue of return flows and attraction of anadromous salmonids into the Yuba Goldfields through Waterway 13. As previously discussed in Chapter 5, efforts have been undertaken to prevent anadromous salmonids from entering the Goldfields via Waterway 13 during the mid-1980s, 1997, and 2003. In May 2005, heavy rains and subsequent flooding breached the structure at the east (upstream facing) end. Subsequently, the earthen “plug” was replaced with a "leaky-dike" barrier intended to serve as an exclusion device for upstream migrating adult salmonids (AFRP 2010). During July of 2011, it was confirmed that the "leaky-dike" barrier had been washed out, presumably due to high flood flows that occurred during May of 2011. Because of the episodic occurrence of attraction flows emanating from Waterway 13, it likely represents a relatively low stressor to the adult lifestage of Yuba River spring-run Chinook salmon.

In addition to Waterway 13 issues, physical habitat alteration stressors include Lake Wildwood operations, which are controlled by the Lake Wildwood Association, and the potential for stranding of adult Chinook salmon in Deer Creek, near its confluence with the lower Yuba River, due to changes in Lake Wildwood operations. Given the infrequent observation of this phenomenon and the relative magnitude compared to the lower Yuba River, Lake Wildwood operations likely represent a relatively low stressor to the adult lifestage of Yuba River spring-run Chinook salmon.

**Entrainment**

Water diversions at and in the vicinity of Daguerre Point Dam in the lower Yuba River generally occur during two seasons. The agricultural irrigation season generally extends from approximately April 1 through mid-October. Additional diversions occur during the
waterfowl/straw management season which generally extends from mid-October through January. Overall, diversions are relatively low from January through March, and diversions are highest from May through August.

As described in Chapter 5, a new state-of-the-art fish screen that meets NMFS and CDFW screening criteria was installed at the BVID Pumpline Diversion Facility in 1999 (SWRCB 2001; NMFS 2002; CALFED and YCWA 2005). The SWRCB (2001) determined that the new fish screen at the BVID diversion facility provided adequate protection for juvenile salmonids, and that BVID should continue to operate and maintain the fish screen in compliance with NMFS and CDFW criteria. The BVID diversion is not licensed by the Corps and it has no direct physical link to Corps property.

Under the Environmental Baseline, ongoing effects of diversions at the Hallwood-Cordua and South Yuba/Brophy diversion facilities represent potential threats to juvenile salmonids (NMFS 2009). The relatively recent fish screen constructed at the Hallwood-Cordua diversion is considered a notable improvement over the previous design, and likely has eliminated any significant entrainment at the Hallwood-Cordua diversion.

The issues of impingement and entrainment at the South Yuba/Brophy Diversion Canal and Facilities have been the subject of numerous evaluations over the past many years. NMFS (2007) noted that several studies have suggested that the structure does not exclude juvenile salmonids from being entrained into this diversion. However, Bergman et al. (2013) concluded that present operations at the diversion facility provide adequate bypass flows to create positive sweeping velocities along the rock gabion, and measured approach velocities satisfied NMFS approach velocity standards except at a bend at the upstream end of the rock gabion, where an eddy draws water up-river. The end of the gabion where an eddy draws water up-river was identified because this anomalous area of higher approach velocities did not meet the NMFS (2011d) criteria of providing “nearly uniform” flow distribution along the face of a screen and, thus, may increase susceptibility of juvenile salmonids to impingement or entrainment.

Spring-run Chinook salmon spawn upstream of Daguerre Point Dam, but only a portion of the annual year-class of outmigrant juvenile spring-run Chinook salmon pass Daguerre Point Dam during the diversion season, particularly during the relatively high diversion
period extending from May through August. Based on analysis of RST data, most (over 85 percent) of outmigrant juvenile Chinook salmon are captured during the relatively low diversion period extending from late fall through March and therefore would be reasonably assumed to be subjected to commensurate relatively low amounts of entrainment. Also, many of these fish exceed fry size, which is the size most susceptible to entrainment. Consequently, entrainment likely represents a stressor of low to medium magnitude to the juvenile lifestage of Yuba River spring-run Chinook salmon.

**Predation**

The extent of predation on juvenile Chinook salmon in the lower Yuba River is not well documented (NMFS 2009). Although predation is a natural component of salmonid ecology, it has been suggested that the rate of predation of salmonids in the lower Yuba River has potentially increased through the introduction of non-native predatory species such as striped bass, largemouth bass and American shad, and through the alteration of natural flow regimes and the development of structures that attract predators (NMFS 2009).

Daguerre Point Dam creates a large plunge pool at its base, which may provide ambush habitat for predatory fish in an area where emigrating juvenile salmonids may be disoriented after plunging over the face of the dam into the deep pool below (NMFS 2002). It has been suggested that the rate of predation of juvenile salmonids passing over dams in general, and Daguerre Point Dam in particular, may be unnaturally high (NMFS 2007). It also has been suggested that unnaturally high predation rates may also occur in the diversion channel associated with the South Yuba/Brophy diversion (NMFS 2007). Demko and Cramer (2000a) reviewed all studies previously performed at the South Yuba/Brophy diversion, and found that none of the research by USFWS, CDFW, or fisheries consultants had indicated that juvenile Chinook became disoriented upon entering the diversion channel, or that abnormally high predation on juvenile Chinook salmon occurred. Nonetheless, SWRCB (2001) stated that there was no way to prevent water from entering the diversion channel when water was not being diverted into the South Canal for irrigation, and that therefore losses due to predation occur even when no water is being diverted for beneficial use.
Other structure-related predation issues in the Environmental Baseline include the potential for increased rates of predation of juvenile salmonids: (1) in the entryway of the Hallwood-Cordua diversion canal upstream of the fish screen; and (2) at the point of return of fish from the bypass pipe of the Hallwood-Cordua diversion canal into the lower Yuba River. The relatively recent fish screen constructed at the Hallwood-Cordua diversion is considered a notable improvement over the previous design, but the configuration of the bypass return pipe and predation losses of emigrating fry and juvenile Chinook salmon, including spring-run Chinook salmon, remain a concern.

As previously discussed, most juvenile Chinook salmon and steelhead rearing has been reported to occur above Daguerre Point Dam. The higher abundance of juvenile salmonids above Daguerre Point Dam may be due to larger numbers of spawners, greater amounts of more complex, high-quality cover, and lower densities of predators such as striped bass and American shad, which reportedly are generally restricted to areas below the dam (YCWA et al. 2007).

For the purpose of stressor identification in this BA, predation includes the predation associated with increases in predator habitat and predation opportunities for piscivorous species created by major structures and diversions, and predation resulting from limited amounts of prey escape cover in the lower Yuba River. Consequently, predation of juvenile salmonids by introduced and native piscivorous fishes occurs throughout the lower Yuba River potentially at relatively high rates. Therefore, predation likely represents a high stressor to the juvenile lifestage of Yuba River spring-run Chinook salmon.

**LOSS OF NATURAL RIVER MORPHOLOGY AND FUNCTION**

The loss of natural river morphology and function is the result of river channelization and confinement, which leads to a decrease in riverine habitat complexity and, thus, to a decrease in the quantity and quality of adult and juvenile anadromous salmonid habitat. This is a particularly operative stressor affecting juvenile anadromous salmonid rearing habitat availability.

From a floodplain meander perspective, braided channels, side channels, and channel sinuosity are created through complex hydraulic-geomorphic interactions. Attenuated
peak flows and controlled flow regimes emanating from the upper Yuba River watershed, and the influence of gravel berms along portions of the lower Yuba River have affected the natural meandering of the lower Yuba River in the Action Area. As stated by UC Davis Professor Greg Pasternack (see Appendix B, Attachment 3) “… the morphology of the LYR is self-determined, dynamic, and increasing habitat complexity over time due to the restorative role of Englebright Dam relative to the vast reservoir and continuing influx of hydraulic mining waste upstream of that barrier. It is true that the LYR’s morphology is altering, but all the evidence indicates that the alterations are beneficial, not harmful, and are driven by understandable and beneficial natural processes”. Nonetheless, loss of natural river morphology and function presently continues to represent a relatively high stressor to Yuba River spring-run Chinook salmon under the Environmental Baseline.

**LOSS OF FLOODPLAIN HABITAT**

Off-channel habitats such as floodplains, riparian, and wetland habitats have been suggested to be of major importance for the growth and survival of juvenile salmon (Moyle 2002). These habitats also promote extended rearing and expression of the stream-type rearing characteristic of spring-run Chinook salmon. Within the Yuba Goldfields area (RM 8–14), confinement of the river by massive deposits of cobble and gravel derived from hydraulic and dredge mining activities resulted in a relatively simple river corridor dominated by a single main channel and large cobble-dominated bars, with little riparian and floodplain habitat (DWR and PG&E 2010).

For this BA, a distinction is made between floodplain habitat and the previously discussed stressors of physical habitat alteration and loss of natural morphology and function, both of which focused on habitat and complexity in the lower Yuba River. Considerations of those stressors included adult and juvenile lifestages. Floodplain habitat, as considered in this section of the BA, is more narrowly focused on the inundation of floodplain habitat and associated effects on juvenile rearing. In consideration that this stressor primarily addresses one lifestage, that inundation of floodplain habitat occurs relatively frequently compared to other Central Valley streams (see Chapter 4), that inundation of floodplain habitat would not necessarily occur each
year even under unaltered hydrologic conditions, and that the lower Yuba River floodplain is comprised of unconsolidated alluvium without an abundance of characteristics associated with increased juvenile salmonid growth, loss of floodplain habitat availability likely represents a medium stressor to Yuba River juvenile spring-run Chinook salmon.

**LOSS OF RIPARIAN HABITAT AND INSTREAM COVER (RIPARIAN VEGETATION, INSTREAM WOODY MATERIAL)**

Mature riparian vegetation is relatively sparse and intermittent along the lower Yuba River, leaving much of the bank areas unshaded. It has previously been reported that relatively low amounts of LWM occur in the lower Yuba River because of the general paucity of riparian vegetation throughout much of the lower Yuba River, and because some of the upstream dams in the upper Yuba River watershed reduce the downstream transport of LWM (cbec and McBain & Trush 2010).

In 2012, YCWA conducted a riparian habitat and woody material studies in the Yuba River from Englebright Dam to the confluence with the Feather River. In the lower Yuba River, although woody material was found to be relatively ubiquitous (see Appendix B, Attachment 3), it was generally found in bands of willow (*Salix sp.*) shrubs near the wetted edge, dispersed across open cobble bars, and stranded above normal high-flow indicators. Most (77-96%) pieces of wood found in each reach surveyed were smaller than 25 feet in length and smaller than 24 inches in diameter, which is the definition of LWM (RMT 2013). The largest size classes of LWM (i.e., longer than 50 feet and greater than 24 inches in diameter) were rare or uncommon (i.e., fewer than 20 pieces total) with no discernible distribution. Pieces of this larger size class were counted as “key pieces”, as were any pieces exceeding 25 inches in diameter and 25 feet in length and showing any morphological influence (e.g., trapping sediment or altering flow patterns). A total of 15 key pieces of LWM were found in all study sites, including six in the Marysville study site. Few of the key pieces were found in the active channel or exhibiting channel forming processes. As previously discussed, the abundance of LWM in the lower Yuba River is not substantively attributable to the presence of Englebright
Dam upstream of the Action Area because accumulated woody material spills over the
dam during uncontrolled flood events and otherwise is pushed over by the Corps.

LWM creates both micro- and macro-habitat heterogeneity by forming pools, back eddies
and side channels and by creating channel sinuosity and hydraulic complexity. This
habitat complexity provides juvenile salmonids numerous refugia from predators and
water velocity, and provides efficient locations from which to feed. Snorkeling
observations in the lower Yuba River have indicated that juvenile Chinook salmon had a
strong preference for near-shore habitats with instream woody material (JSA 1992).

In consideration of the importance that riparian vegetation and LWM play in the habitat
complexity and diversity which potentially limits the productivity of juvenile salmonids,
the abundance and distribution of these physical habitat characteristics in the lower Yuba
River, and the fact that the present availability of riparian habitat and instream cover (in
the form of LWM) is a stressor that is manifested every year, it represents a stressor of
relatively high magnitude to Yuba River juvenile spring-run Chinook salmon.

HATCHERY EFFECTS (FRFH GENETIC CONSIDERATIONS, STRAYING INTO THE LOWER YUBA RIVER) AND
OTHER GENETIC CONSIDERATIONS

FRFH hatchery spring-run Chinook salmon straying into the lower Yuba River and
interbreeding with naturally-spawning Yuba River spring-run Chinook salmon has been
suggested to represent a threat to the genetic integrity of the naturally-spawning spring-
run Chinook salmon population in the lower Yuba River. This suggested threat raises the
question of the present genetic integrity of the fish expressing phenotypic characteristics
of spring-run Chinook salmon in the lower Yuba River.

Between 1900 and 1941, debris dams constructed on the lower Yuba River by the
California Debris Commission completely or partially blocked the migration of Chinook
salmon and steelhead to historic spawning and rearing habitats. Upstream of the Action
Area, Englebright Dam (constructed in 1941) continues to completely block spawning
runs of Chinook salmon and steelhead, and is the upstream limit of anadromous salmonid
migration. CDFG (1991) reported that a small spring-run Chinook salmon population
historically occurred in the lower Yuba River, but the run virtually disappeared by 1959.
Since the completion of New Bullards Bar Reservoir in 1970 by YCWA, higher, colder flows in the lower Yuba River have improved conditions for over-summering and spawning of spring-run Chinook salmon in the lower Yuba River downstream of Englebright Dam (YCWA et al. 2007). As of 1991, a remnant spring-run Chinook salmon population reportedly persisted in the lower Yuba River downstream of Englebright Dam, maintained by fish produced in the lower Yuba River, fish straying from the Feather River, or fish previously and infrequently stocked from the FRFH (CDFG 1991).

If spring-run Chinook salmon were extirpated from the lower Yuba River in 1959 and, as reported by CDFG (1991), a population of spring-run Chinook salmon became reestablished in the 1970s due to improved habitat conditions and fish straying from the Feather River or stocked and straying from the FRFH, then it is likely that spring-run Chinook salmon on the lower Yuba River do not represent a “pure” ancestral genome. In fact, in the report titled *Salmonid Hatchery Inventory and Effects Evaluation* (NMFS 2004), through an analysis of Yuba River Chinook salmon tissues, NMFS genetically linked the spring-run and fall-run Chinook salmon populations, which exhibit a merged run timing similar to that found in the Feather River. More recently, NMFS Southwest Fisheries Science Center conducted a preliminary genetic analysis of tissues collected from adult Chinook salmon downstream of Daguerre Point Dam in the lower Yuba River during May 2009 (i.e., phenotypic spring-run Chinook salmon). Of the 43 samples, 28 were positively identified as Feather River spring-run Chinook salmon. The remaining 15 samples were all identified as Central Valley fall-run Chinook salmon, primarily from the Feather River. These preliminary results are presented with the strong cautionary note that the genetic analyses have somewhat limited ability to distinguish Central Valley fall-run Chinook salmon from Feather River spring-run Chinook salmon due to past introgression, and due to incomplete databases for some Central Valley populations.

Available information indicates that the phenotypic spring-run Chinook salmon in the lower Yuba River actually represents hybridization between spring- and fall-run Chinook salmon in the lower Yuba River, and hybridization with Feather River stocks including the FRFH spring-run Chinook salmon stock, which itself represents a hybridization between Feather River fall- and spring-run Chinook salmon populations (RMT 2013).
The FRFH “spring-run” stock is dominated by fall-run ancestry (Garza et al. 2008). However, the FRFH "spring” run retains remnants of the phenotype and ancestry of the Feather River spring-run Chinook salmon that existed prior to the Oroville Dam and the FRFH, but has been heavily introgressed by fall-run Chinook salmon through some combination of hatchery practices and hybridization induced by lack of access to spring-run Chinook salmon habitat above Oroville Dam. This suggests that it may be possible to preserve some additional component of the ancestral Central Valley spring-run Chinook salmon genomic variation through careful management of this stock, although it will not be possible to reconstitute a “pure” spring-run stock from these fish (Garza et al. 2008).

The FRFH spring-run Chinook salmon population is part of the Central Valley spring-run Chinook salmon ESU (NMFS 2005d) and, therefore, is protected by the applicable provisions of the ESA. At the time of issuance of the final rule regarding the listing status of the Central Valley ESU of spring-run Chinook salmon, NMFS (2005d) recognized that naturally spawning spring-run Chinook in the Feather River are genetically similar to the FRFH spring-run Chinook stock, and that the hatchery stock shows evidence of introgression with Central Valley fall-run Chinook salmon. However, NMFS also stated that FRFH stock should be included in the ESU because the FRFH spring-run Chinook salmon stock may play an important role in the recovery of spring-run Chinook salmon in the Feather River Basin, as efforts progress to restore natural spring-run populations in the Feather and Yuba Rivers (NMFS 2005d).

In summary, available information indicates the following.

- Two fishways, one for low water and the other for high water, were constructed at Daguerre Point Dam prior to the floods of 1927-1928. The ladders were destroyed by floods in 1927 and 1928.
- Fish passage was not provided until a new ladder was constructed on the south end of the dam in 1938.
- Between 1928 through 1934, there was a 10-year drought, which raised water temperatures below Daguerre Point Dam much higher than those tolerated by Chinook salmon and may have caused the extirpation of spring-run Chinook salmon from the lower Yuba River.
A small spring-run Chinook salmon population historically occurred in the lower Yuba River, but the run virtually disappeared by 1959.

By 1991, a small spring-run Chinook salmon population became reestablished in the lower Yuba River due to improved habitat conditions and due to recolonization by fish straying from the Feather River, fish previously and infrequently stocked from the FRFH, or possible production from a remnant population in the lower Yuba River.

The phenotypic spring-run Chinook salmon in the lower Yuba River actually represents hybridization between spring- and fall-run Chinook salmon in the lower Yuba River, and hybridization with Feather River stocks including the FRFH spring-run Chinook salmon stock.

The FRFH spring-run Chinook salmon stock itself represents a hybridization between Feather River fall- and spring-run Chinook salmon populations.

Straying from FRFH origin “spring-run” Chinook salmon into the lower Yuba River has and continues to occur, and this rate of straying is associated with “attraction flows” – the relative proportion of lower Yuba River flows to lower Feather River flows (see Chapter 4 of this BA).

The FRFH spring-run Chinook salmon is included in the ESU, and is therefore afforded protection under the ESA, in part because of the important role this stock may play in the recovery of spring-run Chinook salmon in the Feather River Basin, including the Yuba River (NMFS 2005d).

Although the FRFH spring-run Chinook salmon population is part of the Central Valley spring-run Chinook salmon ESU, concern has been expressed that straying of FRFH fish into the lower Yuba River may represent an adverse impact to the genetic integrity of lower Yuba River stocks. This concern is due to the potential influence of previous hatchery management practices on the genetic integrity of FRFH spring-run Chinook salmon.

Straying of FRFH “spring-run” Chinook salmon into the lower Yuba River has oftentimes been suggested to represent an adverse impact on lower Yuba River “spring-
run” Chinook salmon stocks. It is reasonable to assume that such straying would represent an impact if the lower Yuba River stocks represented a genetically distinct, independent population. However, given the foregoing available information, spring-run Chinook salmon on the lower Yuba River do not represent a “pure” ancestral genome.

In conclusion, past hatchery practices and straying of FRFH fish into the lower Yuba River have resulted in a stressor of a relatively high magnitude on the potential for the lower Yuba River to support a genetically distinct, independent population of spring-run Chinook salmon. The continued and ongoing influx of FRFH-origin fish under the Environmental Baseline would represent a relatively high stressor if the management goal is to reestablish a genetically distinct, independent population of spring-run Chinook salmon in the lower Yuba River. However, data obtained through the course of implementing the M&E Program demonstrate that phenotypically “spring-running” Chinook salmon in the lower Yuba River do not represent an independent population – rather, they represent an introgressive hybridization of the larger Feather-Yuba river regional population (RMT 2013). Continued influx of FRFH-origin fish into the lower Yuba River contributes to the present and ongoing maintenance of phenotypic spring-run Chinook salmon populations in the lower Yuba River.

SUMMARY OF ENVIRONMENTAL BASELINE STRESSORS ON SPRING-RUN CHINOOK SALMON

The Yuba Accord RMT prepared an interim report of the Monitoring and Evaluation Program in April 2013, which assessed the VSP parameters using all information available up to that time. Given the information presently available, following is a summary of Environmental Baseline stressors on spring-run Chinook salmon.

Intermittently from the early 1900s until 1941, and consistently since 1941 with the construction of Englebright Dam by the California Debris Commission, access to historic habitats upstream of Englebright Dam has been blocked and has therefore reduced all four VSP parameters (abundance, productivity, spatial structure and genetic diversity) for spring-run Chinook salmon in the Yuba River watershed. Although the stressors associated with the presence of Englebright Dam persist and continue to affect the status of the species in the Action Area, recent actions have ameliorated flow-related stressors on the spring-run Chinook salmon population now restricted to the lower Yuba River.
This BA has presented available information regarding the present status of the VSP parameters of abundance, productivity, spatial structure and diversity of spring-run Chinook salmon in the lower Yuba River. Additionally, available information regarding the PCEs and characteristics of critical habitat in the Action Area (i.e., the lower Yuba River extending from the upstream extent of where in-river gravel placement has occurred (an area that is located within the first 300 feet below Englebright Dam) downstream to the mouth of the lower Yuba River) has been described and discussed, including the relative magnitude of the stressors affecting the Yuba River spring-run Chinook salmon population associated with the Environmental Baseline. The entire suite of information and analyses indicates that the phenotypic spring-run Chinook salmon annual abundance in the lower Yuba River over the evaluated time period (2004-2011) is stable, and is not exhibiting a significant declining trend (RMT 2013). Under the Environmental Baseline, these abundance and trend considerations would correspond to low extinction risk according to NMFS criteria (Lindley et al. 2007). However, the RMT (2013) questions the applicability of any of these criteria addressing extinction risk, because they presumably apply to independent populations and, as previously discussed, lower Yuba River anadromous salmonids represent introgressive hybridization of larger Feather-Yuba river populations, with substantial contributions of hatchery-origin fish to the annual runs.

7.1.4.2 Steelhead

Many of the most important stressors specific to steelhead in the Action Area of the lower Yuba River correspond to the stressors described for spring-run Chinook salmon. These stressors include passage impediments and barriers, harvest and angling impacts, poaching, physical habitat alteration, loss of riparian habitat and instream cover (e.g., riparian vegetation, LWM), loss of natural river morphology and function, loss of floodplain habitat, entrainment, predation, and hatchery effects. The foregoing discussion in this BA addressing stressors for the phenotypic spring-run Chinook salmon population in the lower Yuba River that are pertinent to the steelhead population in the lower Yuba River is not repeated here. Stressors that are unique to steelhead in the lower Yuba River, and stressors that substantially differ in severity for steelhead, include
harvest/angling impacts, poaching, and hatchery effects were specifically described in Chapter 4 of this BA. The remainder of this section summarily discusses each of the stressors associated with the Environmental Baseline, regarding the relative magnitude of the stressor and its contribution to the current status of steelhead in the lower Yuba River.

**Passage Impediments/Barriers**

**Barriers Upstream of the Action Area (Englebright Dam)**

Lack of spawning gravel (or recruitment thereof) is not a significant stressor to steelhead, and the reported restricted abundance of LWM in the lower Yuba River is not substantively attributable to the presence of Englebright Dam. Some of the other upstream dams in the upper Yuba River watershed reduce the downstream transport of LWM, and Englebright Dam does not functionally block woody material from reaching the lower Yuba River because accumulated woody material spills over the dam during uncontrolled flood events and otherwise is pushed over by the Corps. Nonetheless, the loss of historical spawning and rearing habitat above Englebright Dam, restriction of spatial structure and associated vulnerability to catastrophic events, represent very high stressors to Yuba River steelhead. Although the genesis of these stressors emanate upstream of the Action Area at Englebright Dam, the manifestation of these stressors affect the current status of the species in the Action Area in the lower Yuba River.

**Impediments in the Action Area (Daguerre Point Dam)**

Given the entire suite of considerations associated with the design configuration and features of Daguerre Point Dam and its associated fish ladders that reportedly could either delay or impede adult upstream migration, as well as issues identified regarding juvenile downstream passage, the presence of Daguerre Point Dam likely represents a medium to relatively high stressor to Yuba River steelhead under the Environmental Baseline.

**Harvest/Angling Impacts**

Angling regulations on the lower Yuba River are intended to protect sensitive species, including wild steelhead. Possession of wild steelhead (characterized by an intact
adipose fin) is prohibited. Harvest/angling likely represents a low stressor to Yuba River adult and sub-adult steelhead.

**POACHING**

By contrast to the previous discussion regarding the potential for poaching to be a stressor to spring-run Chinook salmon, no occurrences have been reported regarding the potential poaching of steelhead at the fish ladders, or at the base of Daguerre Point Dam. The NMFS Draft Recovery Plan (NMFS 2009) identified poaching as a stressor of “low” importance to steelhead in the lower Yuba River. In response to the Court’s order, the Corps installed locking metal grates over the Daguerre Point Dam fish ladder bays in August/September 2011, in part, to prevent poaching in the fish ladders. Consequently, poaching likely represents a low (or negligible) stressor to Yuba River adult steelhead.

**PHYSICAL HABITAT ALTERATION**

No references have been reported specifically regarding the attraction of adult steelhead into the Yuba Goldfields through Waterway 13. Nonetheless, because of the episodic occurrence of attraction flows emanating from Waterway 13, it likely represents a relatively low stressor to the adult lifestage of Yuba River steelhead. Lake Wildwood operations changes are primarily associated with annual maintenance activities during the fall (e.g., October) and changed inflows to Deer Creek. The potential for stranding of adult steelhead in Deer Creek, near its confluence with the lower Yuba River, due to changes in Lake Wildwood operations likely represents a negligible to low stressor to the adult lifestage of Yuba River steelhead due to disjunct temporal periodicity.

**ENTRAINMENT**

Because the BVID diversion is not licensed by the Corps, water rights are not regulated by the Corps, and it has no direct physical link to Corps property, the BVID diversion facility and associated effects of diversion on the listed species and their habitat in the lower Yuba River are in the Environmental Baseline. As described above, a new state-of-the-art fish screen was installed at the BVID diversion facility in 1999, and BVID continues to operate and maintain the fish screen in compliance with NMFS and CDFW
criteria. Consequently, the BVID diversion facility represents a low or negligible stressor to juvenile steelhead outmigration.

The relatively recent fish screen constructed at the Hallwood-Cordua diversion is considered a notable improvement over the previous design, and likely has eliminated any significant entrainment at the Hallwood-Cordua diversion.

As previously discussed, an anomalous area of higher approach velocities at the South Yuba/Brophy Diversion Canal and Facilities where an eddy draws water up-river was found to not meet the NMFS (2011d) criteria of providing “nearly uniform” flow distribution along the face of a screen (Bergman et al. 2013) and, thus, may increase susceptibility of juvenile salmonids to impingement or entrainment. However, only a portion of the annual year-class of outmigrant juvenile steelhead passes Daguerre Point Dam during the diversion season, particularly during the relatively high diversion period extending from May through August. Based on analysis of RST data, the percentage of steelhead fry from May through August, relative to the total annual number of outmigrant steelhead juveniles, potentially susceptible to entrainment is 26% (although actual entrainment is much lower than potential susceptibility to entrainment). Consequently, entrainment likely represents a relatively low stressor to Yuba River juvenile steelhead.

**Predation**

It is recognized that there is a paucity of information regarding predation rates on juvenile salmonids in general, and juvenile steelhead in particular, in the lower Yuba River. However, steelhead primarily spawn upstream of Daguerre Point Dam, and most juvenile steelhead must at some time pass over the spillway at Daguerre Point Dam, through the fish ladders, or past the diversion structures located in the vicinity of Daguerre Point Dam and are subject to predation at this location. As previously discussed in Chapter 5, field studies were conducted during 2012 to investigate potential sources of juvenile salmonid mortality, including predation due to a concentration of predators in the diversion canal, associated with the South Yuba/Brophy Diversion Canal and Facilities located immediately upstream of Daguerre Point Dam. Contrary to that which has been previously reported, the data suggest that the diversion channel does not support a unique concentration of predators (Bergman et al. 2013). Adult pikeminnow densities were not
significantly different between the diversion channel and the mainstem lower Yuba River adjacent to the diversion. However, predation of juvenile salmonids by introduced and native piscivorous fishes occurs throughout the lower Yuba River at potentially relatively high rates. Therefore, predation likely represents a high stressor to the juvenile lifestage of Yuba River steelhead.

**Loss of Natural River Morphology and Function**

The loss of natural river morphology and function and resultant decrease in riverine habitat complexity affects steelhead very similarly as was previously described for spring-run Chinook salmon in the lower Yuba River. Consequently, it likely represents a relatively high stressor to Yuba River steelhead under the Environmental Baseline.

**Loss of Floodplain Habitat**

Floodplain habitat considerations previously presented for spring-run Chinook salmon also pertain to steelhead in the lower Yuba River. Consequently, loss of floodplain habitat availability likely represents a medium stressor to Yuba River juvenile steelhead under the Environmental Baseline.

**Loss of Riparian Habitat and Instream Cover (Riparian Vegetation, Instream Woody Material)**

The previous assessment of the importance that riparian vegetation and LWM play in the habitat complexity and diversity that potentially limits the productivity of juvenile spring-run Chinook salmon, is applicable to steelhead. Therefore, the present availability of riparian habitat and instream cover (in the form of LWM) is a stressor of relatively high magnitude to Yuba River juvenile steelhead under the Environmental Baseline.

**Hatchery Impacts (FRFH Genetic Considerations Straying into the Lower Yuba River) and Other Genetic Considerations**

As previously discussed, the experimental fish hatchery on a tributary (i.e., Fiddle Creek) of the North Fork Yuba River was reported to hatch and rear trout, including steelhead, from 1929 to 1950 (CDNR 1931; Leitritz 1969). From 1970 to 1979, CDFW annually stocked 27,270–217,378 fingerlings, yearlings, and sub-catchable steelhead from

The observation of adipose fin clips on adult steelhead passing upstream through the VAKI Riverwatcher system at Daguerre Point Dam demonstrates that hatchery straying into the lower Yuba River has occurred, and continues to occur. Although no information is presently available regarding the origin of adipose-clipped steelhead observed at the VAKI Riverwatcher system at Daguerre Point Dam, it is reasonable to surmise that these fish most likely originate from the FRFH.

As previously discussed in Chapter 4 of this BA, only two years of data (2010/2011 and 2011/2012) are available identifying adipose fin-clipped *O. mykiss* passing through the VAKI Riverwatcher system at Daguerre Point Dam, during which extensive inoperable periods did not occur during the adult steelhead upstream migration period. Analysis of the VAKI Riverwatcher data indicates that the percent contribution of hatchery-origin adult upstream migrating fish (represented by the percentage of adipose fin-clipped adult steelhead relative to the total number of adult upstream migrating steelhead, because 100% of FRFH-origin steelhead have been marked since 1996) was approximately 43% for the 2010/2011 biological year, and about 63% for the 2011/2012 biological year (RMT 2013).

Past hatchery practices, including the Yuba River experimental fish hatchery until 1950, FRFH hatchery practices from 1967 to present, and straying of FRFH fish into the lower Yuba River have likely resulted in a stressor of relatively high magnitude on the potential for the lower Yuba River to support a genetically distinct, independent population of steelhead. As previously discussed for spring-run Chinook salmon, the continued and ongoing straying of hatchery-origin fish would represent a relatively high stressor if the management goal is to reestablish a genetically distinct, independent population of steelhead in the lower Yuba River. However, data obtained through the course of implementing the M&E Program demonstrate that continued influx of FRFH-origin fish into the lower Yuba River contributes to the present and ongoing maintenance of steelhead populations in the lower Yuba River (RMT 2013).
SUMMARY OF ENVIRONMENTAL BASELINE STRESSORS ON STEELHEAD

This BA has presented available information regarding the present status of the VSP parameters, the PCEs and characteristics of critical habitat in the lower Yuba River, and the stressors affecting the Yuba River steelhead population associated with the Environmental Baseline. The data limitations previously discussed, particularly in Chapter 4 of this BA, preclude multi-year abundance and trend analyses and therefore application of the extinction risk criteria. Consequently, the steelhead population in the lower Yuba River is categorized as data deficient, and therefore cannot be concluded to be stable or at a specific risk of extinction.

7.1.4.3 Green Sturgeon

As previously discussed, Daguerre Point Dam was not constructed for green sturgeon passage, and it is a complete barrier to the upstream migration of green sturgeon because they are unable to ascend the fish ladders on the dam, or otherwise pass over or around the structure. The existing fish ladders at Daguerre Point Dam were constructed to provide passage for Chinook salmon and steelhead.

Moreover, in 1938, a biological study was financed by the U.S. Army Corps of Engineers, under the supervision of the U.S. Bureau of Fisheries, to determine the effects of mining debris dams and hydraulic mining on fish life in the Yuba and American rivers. The survey was conducted by F.H. Sumner, Assistant Aquatic Biologist with the U.S. Army Corps of Engineers and Osgood R. Smith, Assistant Aquatic Biologist with the U.S. Bureau of Fisheries, in accordance with methods used by the U.S. Bureau of Fisheries. The 1939 survey report included a list of native and introduced fishes known or presumed to occur in the Yuba and American River basins at that time - which did not list the green sturgeon (Sumner and Smith 1939).

The scarcity of information on green sturgeon in the lower Yuba River makes it difficult to determine how these fish are utilizing the habitat in the river, or for what purpose green sturgeon are entering the river (NMFS 2007). However, because the ongoing stressors associated with Daguerre Point Dam’s blockage of green sturgeon are due to the presence of the dam and configuration of the fish ladders, the Corps does not have the
ability to lessen the potential passage/blockage stressors, and therefore they are part of the Environmental Baseline.

Despite the fact that historical accounts of fish species known or presumed to occur in the lower Yuba River do not include reference to green sturgeon (Sumner and Smith 1939), NMFS (2007) suggested that the abundance, productivity, spatial structure and diversity of the green sturgeon population in the lower Yuba River could be improved if green sturgeon had access to areas upstream of Daguerre Point Dam. Mora et al. (2009) suggest that Daguerre Point Dam blocks approximately 4 ± 2 km (~2.5 miles ± 1.2 miles) of potential green sturgeon habitat in the lower Yuba River. Regardless, designated critical habitat for green sturgeon does not extend upstream of Daguerre Point Dam.

Over the many years of sampling and monitoring in the lower Yuba River, only one sighting of an adult green sturgeon was confirmed before 2011, although studies specifically designed to search for green sturgeon in the lower Yuba River have not been implemented until the past few years. Sampling conducted during May 2011 with underwater videography indicated the presence of four or five adult green sturgeon just downstream of Daguerre Point Dam (Cramer Fish Sciences 2011). During 2012, underwater videography also was used in an attempt to document the presence of green sturgeon downstream of Daguerre Point Dam, although no green sturgeon were observed.

Under the Environmental Baseline, a total of 26 general pool locations exhibiting deepwater pool habitat potentially available to green sturgeon (i.e., greater than 10.0 feet in depth) was identified within the Yuba River downstream of Daguerre Point Dam (YCWA 2013a). Table 7-1 shows: (1) the total wetted area of the pool habitats for each flow; and (2) the incremental increase in the wetted pool area compared to the previous flow value.

The period of February through November represents the months when adult green sturgeon may potentially be holding, including the pre-spawning holding, spawning, and post-spawning periods (Adams et al. 2002; Klimley et al. 2007). Examination of Table 7-1 demonstrates that a Marysville flow of 500 cfs would provide about 295,218 square
Table 7-1. Areal extent of deepwater pool habitat availability in the Yuba River downstream of Daguerre Point Dam (YCWA 2013a).

<table>
<thead>
<tr>
<th>Marysville Flow (cfs)</th>
<th>Wetted Pool Area (sq. ft.)</th>
<th>Incremental Increase in Pool Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>249,453</td>
<td>--</td>
</tr>
<tr>
<td>350</td>
<td>261,441</td>
<td>4.8%</td>
</tr>
<tr>
<td>400</td>
<td>274,005</td>
<td>4.8%</td>
</tr>
<tr>
<td>450</td>
<td>284,508</td>
<td>3.8%</td>
</tr>
<tr>
<td>530</td>
<td>301,644</td>
<td>6.0%</td>
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<tr>
<td>600</td>
<td>315,044</td>
<td>4.8%</td>
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<tr>
<td>622</td>
<td>320,400</td>
<td>1.4%</td>
</tr>
<tr>
<td>700</td>
<td>335,484</td>
<td>4.7%</td>
</tr>
<tr>
<td>800</td>
<td>354,501</td>
<td>5.7%</td>
</tr>
<tr>
<td>880</td>
<td>370,296</td>
<td>4.5%</td>
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<tr>
<td>930</td>
<td>380,070</td>
<td>2.6%</td>
</tr>
<tr>
<td>1,000</td>
<td>395,181</td>
<td>4.0%</td>
</tr>
<tr>
<td>1,300</td>
<td>456,930</td>
<td>15.6%</td>
</tr>
<tr>
<td>1,500</td>
<td>499,626</td>
<td>9.3%</td>
</tr>
<tr>
<td>1,700</td>
<td>548,487</td>
<td>9.8%</td>
</tr>
<tr>
<td>2,000</td>
<td>634,266</td>
<td>15.6%</td>
</tr>
<tr>
<td>2,500</td>
<td>804,861</td>
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<td>24.3%</td>
</tr>
<tr>
<td>4,000</td>
<td>1,400,292</td>
<td>40.0%</td>
</tr>
<tr>
<td>5,000</td>
<td>1,579,815</td>
<td>12.8%</td>
</tr>
<tr>
<td>7,500</td>
<td>1,859,247</td>
<td>17.7%</td>
</tr>
<tr>
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<td>1,920,357</td>
<td>3.3%</td>
</tr>
<tr>
<td>15,000</td>
<td>1,936,989</td>
<td>0.9%</td>
</tr>
<tr>
<td>21,100</td>
<td>1,938,600</td>
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</tr>
<tr>
<td>30,000</td>
<td>1,938,465</td>
<td>0.0%</td>
</tr>
<tr>
<td>42,200</td>
<td>1,938,600</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

feet of deepwater pool habitat downstream of Daguerre Point Dam. Modeled mean monthly flows under the Environmental Baseline simulation for each individual month from February through November (over the entire simulation period from WY 1922 through WY 2008) demonstrates that mean monthly flows at the Marysville Gage exceed 500 cfs nearly all of the time from February through June, and equal or exceed 500 cfs about 85-90% of the time from July through November (see the Cumulative Condition analysis, below). Consequently, a substantial amount of deepwater pool habitat is generally available for the relatively low numbers of green sturgeon that may be present downstream of Daguerre Point Dam under the Environmental Baseline. According to
NMFS (2009a), the current population status of the Southern DPS of North American green sturgeon is unknown. For the Central Valley Domain, currently there are limited data on population sizes, population trends, or productivity of green sturgeon (NMFS 2009e). No information regarding these topics is available for the lower Yuba River, due to the rarity of even sighting green sturgeon in the river.

Hence, it is not practicable to attempt to apply the VSP concepts developed for salmonids to green sturgeon in the lower Yuba River. Moreover, the lack of information pertaining to abundance, productivity, habitat utilization, life history and behavioral patterns in the lower Yuba River, due to infrequent sightings over the past several decades, does not provide the opportunity for reliable alternative methods of viability assessment of green sturgeon in the lower Yuba River. Data limitations preclude application of the extinction risk criteria to green sturgeon in the lower Yuba River. Consequently, green sturgeon in the lower Yuba River cannot be concluded to be stable or at a specific risk of extinction.

The foregoing discussion indicates that the potential stressor of flow-related habitat availability is low or negligible for green sturgeon in the Action Area below Daguerre Point Dam in the lower Yuba River.

The other potential flow-related stressor to green sturgeon in the Action Area below Daguerre Point Dam in the lower Yuba River is water temperature suitability. Water temperature monitoring over the past six years demonstrated that water temperatures remain below the upper WTI values for all lifestages of green sturgeon at Daguerre Point Dam, and for most lifestages at the Marysville Gage. The upper end of the WTI value range for post-spawning adult holding (i.e., 61°F) was exceeded at the Marysville Gage during a portion of this lifestage evaluation period (see Chapter 4).

Water temperature modeling demonstrated similar results as water temperature monitoring. Modeled mean monthly water temperatures under the Environmental Baseline (i.e., current conditions simulation) for each individual month from February through November (over the entire simulation period from WY 1922 through WY 2008) demonstrates that mean monthly water temperatures at Daguerre Point Dam always remain below the upper WTI value range for all lifestages of green sturgeon. Modeled water temperatures at the Marysville Gage also remained below the upper WTI value.
range for all lifestages of green sturgeon with the exception of post-spawning holding. The upper end of the WTI value range for post-spawning adult holding (i.e., 61°F) was exceeded at the Marysville Gage during variable portions of time from June through September (see the Cumulative Condition analysis, below).

7.2 Effects of the Proposed Action

The Proposed Action is comprised of the Corps’ authorized discretionary O&M activities of the existing fish passage facilities at Daguerre Point Dam, including the administration of two outgrants associated with O&M of the facilities, and specified conservation measures. The two outgrants administered by the Corps that are associated with Daguerre Point Dam include: (1) a license issued to CDFW for VAKI Riverwatcher operations; and (2) a license issued to Cordua Irrigation District for flashboard installation, removal and maintenance.

Of the stressors associated with the Environmental Baseline affecting the spring-run Chinook salmon in the lower Yuba River, the Proposed Action (including protective conservation measures) does not have the capability of affecting poaching, entrainment, loss of natural river morphology and function, harvest/angling impacts, physical habitat alteration (including Waterway 13), loss of floodplain habitat, and hatchery and other genetic considerations. The remaining stressors are evaluated below.

7.2.1 Operation and Maintenance Activities of Fish Passage Facilities at Daguerre Point Dam

In this BA, a distinction is made between effects on listed species attributable to the current design of the Daguerre Point Dam facilities that have been operational since 1965 – which are part of the Environmental Baseline, and effects associated with the Corps’ authorized discretionary O&M activities associated with the fish ladders as part of the Proposed Action. The Corps has the authority and discretion to lessen adverse effects associated with O&M of the fish ladders and sediment removal upstream of Daguerre Point Dam, removal of sediment and woody debris from the fish ladders themselves, and minor adjustments to the hydraulic performance of the ladders, as described in Section
2.1.1. The Corps’ authorized discretionary O&M activities associated with the fish ladders include making minor modification as necessary to maintain and improve the existing fish ladder performance. Additionally, conservation measures incorporated into the Proposed Action and associated with discretionary O&M activities of existing fish passage facilities are considered to be authorized, discretionary actions by the Corps. Therefore, effects to listed species associated specifically with these activities are characterized as effects of the Proposed Action. All other stressors associated with design and on-going existence of the ladders and other Daguerre Point Dam facilities are part of the Environmental Baseline.

7.2.1.1 Fish Ladder Operations

The Corps’ fish ladder operations consist of adjusting the fishway gates, within-ladder flashboards, and the fish ladder gated orifices. Fishway gates allow water to enter the fish ladders, and the fish ladder gated orifices regulate the point where upstream migrating fish can most easily enter the ladders (Corps 1966). The Proposed Action also includes continued collaboration with CDFW regarding adjustment of the within-ladder flashboards that were installed in the lower bays of the south fish ladder during June 2010. Adjustment of these within-ladder flashboards influence hydraulics and have been shown to improve adult anadromous salmonid attraction flows to the south ladder (Grothe 2011). As part of these activities, the Corps also will continue to coordinate with CDFW and NMFS regarding operations at the existing ladders and fishway structure to provide passage opportunities for anadromous salmonids.

**Related Stressors and Effects**

Operations-related passage impediments associated with upstream migration of adult spring-run Chinook salmon and steelhead include: (1) intermittent passage ability due to closure of the fish ladder control gates at high flow levels; (2) unfavorable within-ladder hydraulics resulting in passage impediment or delay; and (3) insufficient attraction flows exiting the fish ladders.

The stressors related to this component of the Proposed Action include the potential for blockage or passage delays in the upstream migration of adult spring-run Chinook salmon...
and steelhead. The Proposed Action will: (1) improve passage ability due to continuing to keep the fish ladder control gates open at high flow levels; (2) improve within-ladder hydraulics and attraction flows by adjustment of within-ladder flashboards and fish ladder gated orifices. Operations-related components of the Proposed Action are not expected to substantively affect stressors associated with juvenile downstream migration. The operations-related components of the Proposed Action will not substantively affect these stressors. Consequently, with implementation of the operations-related components of the Proposed Action, these stressors remain characterized as "medium to high".

7.2.1.2 Fish Passage Facility Maintenance

Corps and CDFW joint maintenance activities include cleaning the bays of the fish ladders, cleaning the grates covering the fish ladder bays, and other minor maintenance activities. Presently, PSMFC staff, in collaboration with CDFW, operating the VAKI Riverwatcher devices, make observations of the fish ladders on an approximately daily basis, and the Corps coordinates with them regarding observations of debris or blockages, and/or adult salmonid upstream passage observations. Since August 2010, the Corps also has conducted sub-surface inspections of the ladders, after NMFS advised the Corps of the possibility of sub-surface blockage. The Proposed Action includes continuation of the routine maintenance of removal of debris from the fish ladders.

Additionally, the Corps and NMFS have been holding monthly meetings to coordinate regarding maintenance activities and other issues pertaining to the lower Yuba River since the spring of 2010. These meetings would continue as part of the Proposed Action.

Related Stressors and Effects

The stressors related to fish passage facility maintenance activities also include the potential for blockage or passage delays in the upstream migration of adult spring-run Chinook salmon and steelhead. Potential impediments to upstream migration of adult salmon and steelhead may include: (1) sediment accumulation at the upstream exits of the fish ladders, potentially resulting in blockage of egress from the ladders and/or upstream migration routes, and "fall-back" of adults into the ladders; and (2) obstruction of the
ladders by sediment and woody debris that can block passage or substantially reduce attractor flows to the fish ladder entrances.

In recognition of the ongoing maintenance-related potential impediments to upstream migration of adult salmon and steelhead, the Corps has identified protective conservation measures and incorporated them into the Proposed Action. These maintenance-related protective conservation measures are: (1) implementation of the Daguerre Point Dam Fish Passage Sediment Management Plan; and (2) implementation of a Debris Monitoring and Maintenance Plan at Daguerre Point Dam. Consequently, evaluation of the manner in which the Proposed Action influences stressors associated with maintenance-related activities at the fish passage facilities at Daguerre Point Dam includes consideration of these measures, and is presented below.

7.2.2 Staff Gage Maintenance

The Proposed Action includes continuation of maintaining, reading, and filing all records obtained from the staff gage located on the right abutment of Daguerre Point Dam. No stressors to the listed species or their critical habitats have been identified associated with this component of the Proposed Action.

7.2.3 Administration of a License Issued to CDFW for VAKI Riverwatcher Operations at Daguerre Point Dam

The Proposed Action includes continued administration of the license to CDFW (DACW05-3-03-550) to install and operate electronic fish counting devices, referred to as a VAKI Riverwatcher infrared and photogrammetric system, in the fish ladders at Daguerre Point Dam, which remains in effect until 2018. The only potential stressor identified to be associated with the VAKI Riverwatcher system is the potential collection of debris and resultant impediments to passage. However, the Debris Monitoring and Maintenance Plan at Daguerre Point Dam specifies that CDFW is responsible for inspecting and clearing the portion of the ladders containing the VAKI device, and that
the Corps is responsible for all other parts of the ladders. Implementation of this plan is included in the evaluation of that protective conservation measure, below.

7.2.4 Administration of a License Issued to Cordua Irrigation District for Flashboard Installation, Removal and Maintenance at Daguerre Point Dam

In 2011, the Corps, NMFS and CDFW collaborated in the development of the Daguerre Point Dam Flashboard Management Plan. The Flashboard Management Plan was incorporated into the September 27, 2011 license amendment issued by the Corps to Cordua Irrigation District. The Proposed Action includes continued administration of the license issued to Cordua Irrigation District which incorporates the Flashboard Management Plan, until the license expires in 2016. Implementation of this plan is included in the evaluation of that protective conservation measure, below.

7.2.5 Protective Conservation Measures

The Corps has committed to incorporate several conservation measures into its activities for this Proposed Action. These measures are intended to improve conditions for listed salmonids in the lower Yuba River.

7.2.5.1 Implementation of the Daguerre Point Dam Fish Passage Sediment Management Plan

The Proposed Action includes continued implementation of the Daguerre Point Dam Fish Passage Sediment Management Plan. The Corps, through collaboration with NMFS, CDFW, and USFWS, developed an updated Daguerre Point Dam Fish Passage Sediment Management Plan in February 2009 (Corps 2009). The purpose of the plan is to describe the methods used to manage the sediment that accumulates upstream of Daguerre Point Dam in order to improve flows to the ladders at Daguerre Point Dam, to provide suitable adult salmonid migratory habitat conditions upstream of the Daguerre Point Dam fish ladders, and to provide attraction to the ladders downstream of Daguerre Point Dam.
**RELATED STRESSORS AND EFFECTS**

Sediment accumulation results in unfavorable habitat conditions at the upstream exits of the fish ladders, which impedes the upstream migration of adult spring-run Chinook salmon and steelhead. Resultant stressors include reduced unimpeded passage from the ladders to the main channel, the potential for adult fish exiting the ladder being immediately swept by flow back over the dam, and the potential for fish to “fall-back” into the ladders.

Implementation of the Daguerre Point Dam Fish Passage Sediment Management Plan will provide passage ability of spring-run Chinook salmon and steelhead due to the maintenance of migratory pathways upstream of the dam. Because the plan was developed in February 2009 and has been implemented since that time, implementation of this protective conservation measure will maintain the status quo relative to the Environmental Baseline. However, stressors associated with sediment accumulation upstream of the face of Daguerre Point Dam have occurred over the many years that have led to the current status of the species. Hence, this component of the Proposed Action may be considered to improve conditions, and lessen stressors associated with sediment accumulation at Daguerre Point Dam. Consequently, stressors specifically associated with sediment accumulation at Daguerre Point Dam are characterized as remaining "low" under the Proposed Action.

This component of the Proposed Action will reduce stressors associated with the PCE of "freshwater migratory corridor" of critical habitat for spring-run Chinook salmon and steelhead. With improvements to passage at Daguerre Point Dam resulting from implementation of this protective conservation measure, it is reasonable to expect improved accessibility for adult spring-run Chinook salmon and steelhead to critical habitat located upstream of Daguerre Point Dam when compared with the totality of the temporal effect of the Environmental Baseline.

### 7.2.5.2 Management of a Long-term Flashboard Program at Daguerre Point Dam

The Proposed Action includes implementation of the Flashboard Management Plan (see Section 2.1.4) through the administration of a license issued to Cordua Irrigation District.
If the Corps does not renew the license to Cordua Irrigation District or another entity when it expires in 2016, then the Corps will assume responsibility for implementing the operations and maintenance activities addressing the placement, timing and configuration of the flashboards at Daguerre Point Dam that are described in the Flashboard Management Plan, on a long-term basis.

**RELATED STRESSORS AND EFFECTS**

Sheet flow over the top of Daguerre Point Dam can "mask" the ability of upstream migrating adult salmonids to find the entrance to the fish ladders. Resultant stressors include potential delay or disruption of upstream migration. The purpose of the plan is to benefit spring-run Chinook salmon and steelhead by directing sheet flow that spills over the top of Daguerre Point Dam into the fish ladders, thereby improving the ability of adult fish to locate the fish ladders and migrate upstream to spawning and rearing habitats.

Additional potential stressors associated with sheet flow over the top of Daguerre Point Dam include physical injury to juveniles spilling over the top of the dam onto the concrete apron at the downstream base of the dam, and increased susceptibility to predation in the plunge pool below Daguerre Point Dam due to disorientation.

Ancillary benefits include directing downstream migrating juvenile spring-run Chinook salmon and steelhead into the fish ladders, and thereby avoiding physical injury from spilling over the dam, and avoiding potentially increased predation due to disorientation in the plunge pool below the dam.

The Flashboard Management Plan was incorporated into the September 27, 2011 license amendment issued by the Corps to Cordua Irrigation District. Thus, continued implementation of this protective conservation measure will maintain the status quo relative to the Environmental Baseline. However, relative to stressors associated with sheet flow over Daguerre Point Dam that occurred prior to 2011 that have led to the current status of the species, this component of the Proposed Action may be considered to improve conditions, and lessen stressors (masking adult attraction flows, physical injury and predation of juveniles) associated with sheet flow over Daguerre Point Dam.
This component of the Proposed Action will reduce stressors associated with the PCE of "freshwater migratory corridor" of critical habitat for each listed species. With improvements to passage at Daguerre Point Dam resulting from implementation of this protective conservation measure, it is reasonable to expect improved accessibility for adult spring-run Chinook salmon and steelhead to critical habitat located upstream of Daguerre Point Dam when compared with the totality of the temporal effect of the Environmental Baseline.

In addition, because the Proposed Action includes the commitment that, if necessary, the Corps will assume responsibility for implementing the Flashboard Management Plan on a long-term basis, this component provides an assurance that related stressors also will be reduced on a long-term basis. Consequently, stressors specifically associated with sheet flow over Daguerre Point Dam are characterized as "medium" under the Proposed Action.

7.2.5.3 Implementation of a Debris Monitoring and Maintenance Plan at Daguerre Point Dam

The Proposed Action includes implementation of the Debris Monitoring and Maintenance Plan for clearing accumulated debris and blockages in the fish ladders at Daguerre Point Dam. The plan specifies the frequency and conduct of routine inspection and clearing of debris from the two fish ladders at Daguerre Point Dam, and debris maintenance associated with specific flow events.

Related Stressors and Effects

Accumulation of debris and sediment within the bays of the ladders at Daguerre Point Dam can result in unfavorable within-bay hydraulic characteristics and resultant passage delay or blockage of upstream migrating adult salmonids. Debris and sediment accumulation within the ladder bays also can affect flow through the ladders and resultant attraction flow for upstream migrating adult spring-run Chinook salmon and steelhead.

The purpose of the Debris Monitoring and Maintenance Plan is to benefit spring-run Chinook salmon and steelhead by improving the ability of adult fish to locate the fish ladders and successfully pass through the ladders to upstream spawning and rearing...
habitats. To the extent that reduced debris accumulation in the fish ladders would potentially increase flow through the ladders and reduce sheet flow over Daguerre Point Dam, ancillary benefits include reducing the severity of the stressors on downstream migrating juvenile spring-run Chinook salmon and steelhead, susceptibility to physical injury from spilling over the dam, and potentially increased predation due to disorientation in the plunge pool below the dam.

This component of the Proposed Action will reduce stressors associated with the PCE of "freshwater migratory corridor" of critical habitat for each listed species. With improvements to passage at Daguerre Point Dam resulting from implementation of this protective conservation measure, it is reasonable to expect improved accessibility for adult spring-run Chinook salmon and steelhead to critical habitat located upstream of Daguerre Point Dam when compared with the totality of the temporal effect of the Environmental Baseline.

Continued implementation of the Debris Monitoring and Maintenance Plan would be expected to reduce the severity of the stressors associated with debris and sediment accumulation within the bays of the fish ladders at Daguerre Point Dam on a long-term basis. Consequently, stressors specifically associated with debris and sediment in the fish passage facilities at Daguerre Point Dam are characterized as "low" under the Proposed Action.

### 7.2.6 Voluntary Conservation Measures

In addition to protective measures integrated into the Proposed Action, the Corps proposes to implement additional conservation measures to avoid or minimize potential effects and to improve conditions for listed salmonids in the lower Yuba River through implementation of voluntary conservation measures. These voluntary conservation measures are subject to the availability of funding.
7.2.6.1 Gravel Injection in the Englebright Dam Reach of the Lower Yuba River

The Proposed Action includes continued implementation of a spawning gravel injection program in the Englebright Dam Reach of the lower Yuba River. Four separate gravel injection efforts have been undertaken from 2007-2013, with approximately 15,500 tons of gravel/cobble placed into the Englebright Dam Reach. The Corps is using the Gravel/Cobble Augmentation Implementation Plan (GAIP) (Pasternack 2010) to provide guidance for a long-term gravel injection program. The purpose of the program is to provide Chinook salmon, and spring-run Chinook salmon in particular, spawning habitat in the bedrock canyon downstream of Englebright Dam.

Related Stressors and Effects

The stressor related to this conservation measure is lack of suitable spawning gravels in the Englebright Dam Reach. Implementation of this voluntary conservation measure is expected to expand available spawning habitat, primarily for spring-run Chinook salmon. No anticipated increased adverse effects associated with lack of suitable spawning gravel would be expected to occur. By contrast, the intensity, frequency, and duration of stressors associated with the lack of spawning habitat in the Englebright Dam Reach would be reduced relative to the Environmental Baseline. Expansion of suitable spawning habitat in the Englebright Dam Reach may encourage additional behavioral segregation between spawning spring-run and fall-run Chinook salmon, because spring-run Chinook salmon tend to spawn in the uppermost reaches of the Yuba River whereas fall-run Chinook salmon spawning is more spread throughout downstream locations.

This voluntary conservation measure will beneficially affect the PCEs of critical habitat of "freshwater spawning sites" for spring-run Chinook salmon, as well as for steelhead. With the addition of suitable spawning gravels in the Englebright Dam Reach, habitat suitability and availability will be improved for the spawning lifestages of spring-run Chinook salmon and steelhead, and a likely response will be increased reproductive success or capacity.

Consequently, the stressor of the lack of suitable spawning gravels in the Englebright Dam Reach would be lessened relative to the Environmental Baseline. However,
spawning habitat is abundant and readily available throughout the lower Yuba River, and available spawning habitat is not considered to be limiting to the spring-run Chinook salmon population in the lower Yuba River. Hence, this voluntary conservation measure is intended to contribute to an increased likelihood of recovery of spring-run Chinook salmon, with ancillary benefits to steelhead spawning habitat availability. With continued implementation of the gravel injection program in the Englebright Dam Reach, subject to available funding, stressors specifically associated with the lack of suitable spawning gravels in the Englebright Dam Reach are characterized as "low">

7.2.6.2 Large Woody Material Management Program

The Corps has prepared a LWMMP, which includes the implementation of a pilot study in order to enhance juvenile rearing conditions for spring-run Chinook salmon and steelhead (Corps 2012d). The Corps proposed to initiate a pilot study to determine an effective method of replenishing the supply of LWM back into the lower Yuba River. The pilot study will use LWM from existing stockpiles at New Bullards Bar Reservoir for placement at selected sites along the lower Yuba River, and will include monitoring of placed materials, which will be used to assess the effectiveness of LWM placement in the lower Yuba River to develop a long-term program (Corps 2012d). Based upon the outcome of the pilot study, the Corps will refine the draft plan, consistent with recreation safety needs and findings from the pilot study, and implement a long-term LWMMP for the lower Yuba River, subject to available funding.

**Related Stressors and Effects**

The stressors related to this voluntary conservation measure are associated with the reported relative paucity of habitat complexity and diversity associated with structural elements in the lower Yuba River. LWM plays a significant role in determining the suitability of aquatic habitats for juvenile salmonids, including providing concealment from predators, shelter from fast current, feeding stations and nutrient inputs, as well as for other organisms upon which salmonids depend for food.

Under the Environmental Baseline, reduced abundance of LWM was identified as a "high" stressor to the juvenile rearing lifestage of Yuba River spring-run Chinook salmon
and steelhead. Implementation of this voluntary conservation measure would reduce the intensity, frequency, and duration of stressors associated with the reduced abundance of LWM providing habitat complexity and diversity (and therefore predator escape cover, velocity, shelter, and feeding stations) for rearing juvenile salmonids, relative to the Environmental Baseline.

This voluntary conservation measure will beneficially affect the PCE of "freshwater rearing sites" of critical habitat for spring-run Chinook salmon, as well as for steelhead. With the addition of LWM, habitat suitability and availability will be improved for the juvenile rearing lifestages of spring-run Chinook salmon and steelhead. Likely responses include the potential for reduced predation on juvenile spring-run Chinook salmon and steelhead in the lower Yuba River.

Consequently, stressors associated with relatively low abundance of LWM would be lessened relative to the Environmental Baseline. With continued implementation of the LWMMP, stressors specifically associated with the abundance of LWM in the Action Area of the lower Yuba River are characterized as "medium to high" due to lack of certainty of benefit associated with results of the pilot study, uncertainty of specific elements as yet undefined in the long-term plan, and uncertainty associated with funding availability.

### 7.3 Interrelated Actions

Interrelated actions are defined by the Federal regulations as “...those that are part of a larger action and depend on the larger action for their justification” (50 CFR 402.02). The effects of “interrelated actions” (i.e., actions that would not occur “but for” a larger action) (Federal Register 19957; USFWS and NMFS 1998), along with the direct and indirect effects of the Proposed Action, are compared to the Environmental Baseline in determining whether the Proposed Action will jeopardize the continued existence of a listed species (50 CFR 402.02, 402.12(f)(4)).
7.3.1 Potential Effects Associated with Interrelated Actions

There are no interrelated actions associated with the Proposed Action.

7.4 Interdependent Actions

Interdependent actions are defined by the Federal regulations as “...those that have no independent utility apart from the action under consideration” (50 CFR 402.02). The effects of “interdependent actions” (i.e., other actions would not occur “but for” this action (USFWS and NMFS 1998)), along with the direct and indirect effects of the Proposed Action, are compared to the Environmental Baseline to determine whether the Proposed Action will jeopardize the continued existence of a listed species (50 CFR 402.02, 402.12(f)(4)).

7.4.1 Potential Effects Associated with Interdependent Actions

There are no interdependent actions associated with the Proposed Action.

7.5 Cumulative Effects

Cumulative effects are defined by Federal regulations as “...those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation” (50 CFR 402.02). Cumulative effects must be considered in the analysis of the effects of the Proposed Action (50 CFR 402.12(f)(4)).

7.5.1 Wheatland Project

7.5.1.1 Cumulative Effects Flow Analysis

Overall, the Cumulative Condition would generally result in higher flows above Daguerre Point Dam (as measured at the Smartsville Gage) and lower flows below Daguerre Point Dam (as measured at the Marysville Gage), primarily during the summer months of July,
August and September. Comparisons of model simulations of monthly mean flows at each of these gages under the Cumulative Condition, relative to the current conditions, are provided below.

**FLOW AT THE SMARTSVILLE GAGE**

Examination of model output presented in Appendix F of this BA demonstrates that over the 87-year simulation period, long-term average monthly flows at the Smartsville Gage would increase slightly from May through October (ranging from a 0.6% flow increase in May to a 2.4% flow increase in July), would decrease slightly from December through April (ranging from a 0.7% flow reduction in March to a 1.7% flow reduction in December), and would not change during November under the Cumulative Condition, relative to the current conditions. None of the minor reductions in long-term average monthly flows from December through April under the Cumulative Condition, relative to the current conditions, would result in long-term average monthly flows below the monthly minimum instream flows of Flow Schedule A, and therefore would remain above the corresponding optimum flow level.

For Wet and Above Normal water years, flow at the Smartsville Gage changed slightly during most months of the year, with no reductions in average monthly flow exceeding 10% under the Cumulative Condition relative to the current conditions. The largest average monthly flow increase (2.2%) occurred in July and the largest flow reduction (4.3%) occurred during February of Above Normal water years under the Cumulative Condition relative to the current conditions. Average monthly flow values under the Cumulative Condition and the current conditions remained well above the monthly minimum instream flows of Flow Schedule A, and therefore remained above the corresponding optimum flow level.

For Below Normal water years, average monthly flows at the Smartsville Gage changed slightly during most months of the year, with no reductions in average monthly flow exceeding 10%. The largest average monthly flow increase (2.3%) occurred in July and the largest flow reduction (4.1%) occurred during March under the Cumulative Condition relative to the current conditions. Average monthly flow values under the Cumulative Condition and the current conditions remained well above the monthly minimum
instream flows of Flow Schedule A, and therefore remained above the corresponding optimum flow level.

For Dry and Critical water years, no change or relatively minor reductions in average monthly flow occur during winter (January, February and March), but flow increases occur during all other months of the year with the largest increases in average monthly flow occurring from May through September. During Dry water years, average monthly flow changes ranged from an 8.6% flow increase during July to a 3.7% flow reduction during January of Dry water years. Changes in flows did not result in average monthly flow values below the monthly minimum instream flows of Flow Schedule A, and therefore remained above the corresponding optimum flow level. During Critical water years, average monthly flows generally increased, and flow changes ranged from an 8.4% flow increase during August to a 0.6% flow reduction during January. Except for September, flow changes did not result in average monthly flow values below the monthly minimum instream flows of Flow Schedule A and therefore remained above the corresponding optimum flow level. Although average monthly flows under the Cumulative Condition increased by 5.4% during September, the average monthly flows under both the Cumulative Condition (689 cfs) and the current conditions (653 cfs) were below the corresponding monthly minimum instream flow (700 cfs) identified for September in Flow Schedule A.

Examination of monthly mean flow exceedance distributions over the 87-year simulation period at the Smartsville Gage indicate minor differences in flow reductions between the Cumulative Condition and the current conditions. Relatively minor flow decreases would occur during winter months. The greatest reduction in monthly mean flows would occur during January, although reductions of 10% or more would be expected with less than a 6% probability of occurrence under the Cumulative Condition relative to the current conditions. However, this reduction and other minor reductions primarily would occur at high flow levels (above the corresponding optimum flow level of 700 cfs). Conversely, flow increases of 10% or more would be expected to occur during July and August with a 1% and 9% probability of occurrence, respectively, under the Cumulative Condition relative to the current conditions.
Low flow conditions are defined as flows in the lowest 25 percent of the cumulative flow distribution, which for this period of simulation represents the 22 lowest ranked flow values each month. During low flow conditions, a flow reduction of 10% or more would be expected to occur only once out of the 22 years during November. Flow increases of 10% or more at Smartsville would occur once out of the 22 years during July, and 8 out of the 22 years during August under the Cumulative Condition, relative to the current conditions.

**Flow at the Marysville Gage**

Examination of model output presented in Appendix F of this BA demonstrates that over the 87-year simulation period, the long-term average monthly flows at the Marysville Gage would be reduced slightly from October through June (ranging from a 0.4% flow reduction in April to a 3.2% flow reduction in June) under the Cumulative Condition relative to the current conditions. Long-term average monthly flows at the Marysville Gage would be reduced by 7.1%, 9.2% and 8.7% during July, August and September, respectively under the Cumulative Condition relative to the current conditions. However, none of the reductions in long-term average monthly flows under the Cumulative Condition relative to the current conditions would result in long-term average monthly flow below the monthly minimum instream flows of Flow Schedule 1 and therefore remained above the upper optimum flow levels.

For Wet and Above Normal water years, average monthly flows at the Marysville Gage changed slightly during most months of the year, with no reductions in average monthly flow exceeding 10% with the exceptions of September (10.5%) during Wet water years, and August (13.0%) and September (10.3%) during Above Normal water years under the Cumulative Condition relative to the current conditions. However, these reductions during August and September under the Cumulative Condition relative to the current conditions did not result in average monthly flow values below the monthly minimum instream flows of Flow Schedule 1 and therefore remained above the upper optimum flow levels.

For Below Normal water years, average monthly flows at the Marysville Gage changed slightly during most months of the year, with no reductions in average monthly flow
exceeding 10% with the exception of July (12.2%). However, this reduction during July under the Cumulative Condition relative to the current conditions did not result in average monthly flow values below the monthly minimum instream flows of Flow Schedule 2 and therefore remained above the lower optimum flow level.

Even less change in average monthly flow at the Marysville Gage would be expected to occur during Dry and Critical water years under the Cumulative Condition relative to the current conditions. Flow changes would range from a 1.1% flow increase during December of Dry water years to a 4.1% flow reduction during January of Dry water years. During Critical water years, flow changes would range from a 0.7% flow increase during April to a 3.4% flow reduction during November.

Examination of monthly mean flow exceedance distributions over the 87-year simulation period at the Marysville Gage indicates minor differences between the Cumulative Condition and the current conditions from October through June. During these months, flow decreases of 10% or more would be expected with less than a 6% probability of occurrence. Larger differences in flow would be expected to occur during July, August and September, with flow decreases of 10% or more with about a 32%, 28% and 53% probability of occurrence, respectively, under the Cumulative Condition relative to the current conditions. However, these differences primarily would occur at high flow levels (above the upper optimum flow level of 700 cfs during July, 600 cfs during August and 500 cfs during September). Resultant flows under the Cumulative Condition generally remain above the lower optimum flow levels during July, August and September.

Low flow conditions are defined as flows in the lowest 25 percent of the cumulative flow distribution, which for this period of simulation represents the 22 lowest ranked flow values each month. During low flow conditions, a flow reduction of 10% or more would be expected to occur only twice out of the 22 years during November, and once out of the 22 years during each month from May through September.

The aforementioned examination of model simulation of monthly mean flows indicates that flow reductions at the Marysville Gage primarily would occur during the months of July, August and September under the Cumulative Condition, relative to the current conditions. However, when reductions in flow occurred during July, August and
September, resultant flows under the Cumulative Condition nearly always remained at or above the lower optimum flow levels.

**FLOW-RELATED EFFECTS ON SPRING-RUN CHINOOK SALMON**

From the spatial and temporal distribution information presented in Chapter 4 of this BA, the lifestage-specific periodicities used for this evaluation of monthly mean flows for spring-run Chinook salmon are as follows.

- **Adult immigration and holding (April through September)**
- **Spawning (September through mid-October)**
- **Embryo incubation (September through December)**
- **Juvenile rearing (Year-round)**
- **Juvenile downstream movement (Mid-November through June)**
- **Smolt (yearling+) emigration (October through mid-May)**

**ADULT IMMIGRATION AND HOLDING**

Spring-run Chinook salmon immigrate up through the lower Yuba River from early spring into July, August, or as late as September, and primarily hold upstream or just downstream of Daguerre Point Dam until initiation of spawning during September. Overall, monthly mean flows at the Smartsville Gage are increased during April though August and are similar during September of the adult immigration and holding time period under the Cumulative Condition relative to the current conditions. It is expected that these changes in flow would result in very minor differences in holding pool depth and areal extent upstream of Daguerre Point Dam. The magnitude of flow reductions during July, August and September below Daguerre Point Dam (as indicated by the Marysville Gage) under the Cumulative Condition relative to the current conditions also would result in very minor differences in holding pool depth or areal extent.

These relatively minor reductions in flow would not be expected to significantly affect passage at Daguerre Point Dam. RMT (2013) found that passage at Daguerre Point Dam occurs over a wide range of flows, and generally occurs irrespective of flow rates over the range of flows examined. No flow thresholds prohibiting passage of Chinook salmon
through the ladders at Daguerre Point Dam were apparent in the 8 years of VAKI Riverwatcher data (RMT 2013).

These relatively minor reductions in flow also would not be expected to significantly affect attraction flows. As described in Chapter 4 of this BA, a positive and significant relationship was identified between the percentage of adipose fin-clipped Chinook salmon passing Daguerre Point Dam during the spring-run Chinook salmon upstream migration period, and the ratio of lower Yuba River flow relative to lower Feather River flow and the ratio of lower Yuba River water temperature relative to lower Feather River water temperature, four weeks prior to the time of passage at Daguerre Point Dam. However, the relatively minor reductions in flow under the Cumulative Condition relative to the current conditions also would not be expected to significantly affect attraction of adipose fin-clipped Chinook salmon for two reasons.

First, the time series of Chinook salmon moving daily upstream of Daguerre Point Dam illustrated in Chapter 4 exhibit a plurality of modes with large inter-annual variation in timing and magnitude. The phenotypic adult spring-run Chinook salmon upstream migration period generally began during May or June of each year, although the end date of the annual migration period varied among years. For the eight years of available VAKI Riverwatcher data, the phenotypic spring-run Chinook salmon upstream migration period end date ranged from early July to early September. However, most phenotypic spring-run Chinook salmon passed upstream of Daguerre Point Dam by the end of July or August during all eight years. Because the attraction flow and water temperature relationship with the percentage of adipose fin-clipped Chinook salmon passing Daguerre Point Dam occurs four weeks prior to passage at the dam, the potentially affected “attraction” period primarily occurs during May and June for most years, and into July of some years.

Second, and perhaps more importantly, the relatively minor changes in flow at the Marysville Gage under the Cumulative Condition, relative to the current conditions, would result in flow reductions and therefore would not be expected to additionally contribute to the attraction of adipose fin-clipped (hatchery) spring-run Chinook salmon into the lower Yuba River from the lower Feather River.
SPAWNING AND EMBRYO INCUBATION

During the spring-run Chinook salmon spawning and embryo incubation period (September through December), relatively minor changes in flow occur at the Smartsville Gage, generally remain above those flow levels specified in Flow Schedule A and thus remain above the corresponding upper optimum flow level. Consequently, monthly mean flow changes under the Cumulative Condition relative to the current conditions would not be expected to substantively affect the spring-run Chinook salmon spawning and embryo incubation lifestage.

JUVENILE REARING

Most juvenile spring-run Chinook salmon rearing occurs above Daguerre Point Dam. In general, juvenile Chinook salmon have been observed throughout the lower Yuba River, but with higher abundances above Daguerre Point Dam (SWRI et al. 2000). This may be due to larger numbers of spawners, greater amounts of more complex, high quality cover, and lower densities of predators such as striped bass and American shad, which reportedly are restricted to areas below the dam (YCWA et al. 2007; NMFS 2009). Therefore, although flow changes under the Cumulative Condition relative to the current conditions at the Smartsville Gage have the potential to affect most juvenile spring-run Chinook salmon rearing in the lower Yuba River, the relatively minor changes in flow would not be expected to substantively affect juvenile rearing physical habitat.

Flow changes under the Cumulative Condition relative to the current conditions at the Marysville Gage would not affect most juvenile spring-run Chinook salmon rearing in the lower Yuba River. Moreover, changes in juvenile spring-run Chinook salmon rearing habitat under the Cumulative Condition relative to the current conditions would have the highest potential to affect habitat suitability by changes in water temperature (described below).

JUVENILE DOWNSTREAM MOVEMENT

As previously discussed, juvenile spring-run Chinook salmon downstream movement (and outmigration) occurs from mid-November through June. During these months, flow decreases of 10% or more would be expected with less than a 6% probability of
occurrence at both the Smartsville and Marysville gages. The minor reductions in long-
term average monthly flows at the Marysville Gage under the Cumulative Condition
relative to the current conditions would not result in long-term average monthly flow
below the monthly minimum instream flows of Flow Schedule 1 and therefore would
remain above the upper optimum flow levels. Relatively minor changes in flow at the
Smartsville and Marysville gages under the Cumulative Condition relative to the current
conditions would not be expected to substantively affect the spring-run Chinook salmon
juvenile downstream movement (and outmigration) lifestage.

SMOLT (YEARLING+) EMIGRATION

The RMT (2013) recently identified the spring-run Chinook salmon smolt (yearling+)
outmigration period as extending from October through mid-May. Relatively minor
reductions in long-term average monthly flows, low probabilities of flow reductions of
10% or more, and retention of flows above the optimum specified flow levels at the
Marysville Gage during the smolt (yearling+) emigration period under the Cumulative
Condition relative to the current conditions would not be expected to substantively affect
the spring-run Chinook salmon smolt (yearling+) emigration lifestage.

SUMMARY OF FLOW-RELATED EFFECTS ON SPRING-RUN CHINOOK SALMON

Relatively minor flow changes would occur under the Cumulative Condition relative to
the current conditions. In general, under the Cumulative Condition seasonal (summer)
flow increases would occur upstream of Daguerre Point Dam, and seasonal (summer)
flow decreases would occur downstream of Daguerre Point Dam. The foregoing
evaluation of changes in flow under the Cumulative Condition relative to the current
conditions indicates no substantive effects for any of the spring-run Chinook salmon
lifestages in the Action Area of the lower Yuba River.

FLOW-RELATED EFFECTS ON STEELHEAD

From the spatial and temporal distribution information presented in Chapter 4 of this BA,
the lifestage-specific periodicities used for this evaluation of monthly mean flows for
steelhead are as follows.
Adult immigration and holding (August through March)

Spawning (January through April)

Embryo incubation (January through May)

Juvenile rearing (Year-round)

Juvenile downstream movement (April through September)

Smolt (yearling+) emigration (October through mid-April)

ADULT IMMIGRATION AND HOLDING

The immigration of adult steelhead in the lower Yuba River occurs from August through March, with peak immigration from October through February. Overall, increases in flow during August and September and the relatively minor reductions in flow during the winter (January, February and March) at the Smartsville Gage under the Cumulative Condition relative to the current conditions: (1) would not be expected to affect the physical ability of adult steelhead to migrate through the upper portion of the Yuba River; and (2) would be expected to result in very minor differences in holding pool depth or areal extent.

Changes in flow at the Marysville Gage during July, August and September would not occur during the peak immigration period and would only be potentially relevant to a relatively small amount of the annual adult steelhead run. Also, the relatively minor changes in flow below Daguerre Point Dam would not be expected to affect the physical ability of adult steelhead to migrate through the lower portion of the Yuba River.

SPAWNING AND EMBRYO INCUBATION

During the steelhead spawning and embryo incubation period (January through May), relatively minor changes in flow at the Smartsville Gage would generally remain above those flow levels specified in Flow Schedule A and therefore remain above the corresponding optimum flow level. Consequently, monthly mean flow changes under the Cumulative Condition relative to the current conditions would not be expected to substantively affect the steelhead spawning and embryo incubation lifestage.
**JUVENILE REARING**

Most juvenile steelhead rearing occurs above Daguerre Point Dam. Juvenile trout (age 0 and 1+) abundances were substantially higher upstream of Daguerre Point Dam, with decreasing abundance downstream of Daguerre Point Dam (NMFS 2009). In fact, Kozlowski (2004) reported that approximately 82 percent of juvenile *O. mykiss* were observed upstream of Daguerre Point Dam. Therefore, although flow changes under the Cumulative Condition relative to the current conditions at the Smartsville Gage have the potential to affect most juvenile steelhead rearing in the lower Yuba River, the relatively minor changes in flow would not be expected to substantively affect juvenile rearing physical habitat.

Flow changes under the Cumulative Condition relative to the current conditions at the Marysville Gage would not affect most juvenile steelhead rearing in the lower Yuba River. Moreover, changes in juvenile steelhead rearing habitat under the Cumulative Condition relative to the current conditions would have the highest potential to affect habitat suitability by changes in water temperature (described below).

**JUVENILE DOWNSTREAM MOVEMENT**

The juvenile downstream movement (and outmigration) period extends from April through September and, therefore, flow changes at the Marysville Gage under the Cumulative Condition relative to the current conditions have the potential to affect a restricted portion of this lifestage. Moreover, RST sampling at Hallwood Boulevard over several years has not indicated a relationship between flow magnitude and the rate of juvenile steelhead outmigration *per se*. As previously discussed, some YOY *O. mykiss* are captured in RSTs during late-spring and summer, indicating movement downstream. However, the RMT’s (2013) analysis of the cumulative temporal distribution of *O. mykiss* observed catch at the Hallwood Boulevard RST site revealed that most emigration generally occurred from March through July, with approximately 95 percent of the observed catch generally occurring by early August. Moreover: (1) at least some of this downstream movement may be associated with the pattern of flows in the river; (2) increases in juvenile *O. mykiss* downstream movement appear to be associated with rapid, large ramp-ups of flows; and (3) increased downstream movement is not observed during
gradual ramping up of flows. Therefore, it is unlikely that downstream movement of juvenile *O. mykiss* would be substantively affected by the relatively minor reductions in flows at the Marysville Gage primarily occurring during July, August, and to some extent, during September under the Cumulative Condition relative to the current conditions.

**SMOLT (YEARLING+) EMIGRATION**

Relatively minor changes in flow at the Marysville Gage occur during the October through April steelhead smolt (yearling+) emigration period. Relatively minor reductions in long-term average monthly flows, low probabilities of reductions of average monthly flows of 10% or more, and retention of flows above the optimum specified flow levels at the Marysville Gage during the smolt (yearling+) emigration period under the Cumulative Condition relative to the current conditions would not be expected to substantively affect the steelhead smolt (yearling+) emigration lifestage. Changes in steelhead smolt (yearling+) emigration habitat under the Cumulative Condition relative to the current conditions would have the highest potential to affect habitat suitability by changes in water temperature (described below).

**SUMMARY OF FLOW-RELATED EFFECTS ON STEELHEAD**

Relatively minor flow changes would occur under the Cumulative Condition relative to the current conditions. In general, under the Cumulative Condition seasonal flow increases would occur upstream of Daguerre Point Dam, and seasonal flow decreases would occur downstream of Daguerre Point Dam. The foregoing evaluation of changes in flow under the Cumulative Condition relative to the current conditions indicates no substantive effects to any of the steelhead lifestages in the lower Yuba River.

**FLOW-RELATED EFFECTS ON GREEN STURGEON**

The critical habitat analysis for green sturgeon under the Cumulative Condition addresses the unique specific PCE of deepwater pool habitat - essential for the conservation of the green sturgeon in freshwater riverine systems according to NMFS (2009e). Two analyses were conducted for identified pools downstream of Daguerre Point Dam in the lower Yuba River: (1) change in depth; and (2) change in the areal extent of deepwater pool
These analyses are conducted for the February through November period, which represents the potential green sturgeon adult holding, spawning and post-spawning holding periods.

Using the RMT's SRH-2D model, a total of 26 pool locations were identified between Daguerre Point Dam and the mouth of the lower Yuba River, with water depths greater than 10.0 feet deep at the nominal flow of 530 cfs at the Marysville Gage. The mean depth of deepwater pool areas ranges from approximately 12.2 feet at flows from 300 to 800 cfs, to 25.4 feet at 42,200 cfs at the Marysville Gage (see Appendix G). The rate of change in pool depth varies depending upon the range of flows at the Marysville Gage. The mean depth of deepwater pool areas increases by only about 0.3 inches per 100 cfs on average, when flows increase from 300 cfs to 42,200 cfs.

Examination of model output presented in Appendix G of this BA demonstrates that over the 87-year simulation period, long-term average monthly depth of deepwater pool areas below Daguerre Point Dam would be equivalent or decrease only 0.1% during any month of the February through November period under the Cumulative Condition relative to the current conditions.

For Wet and Above Normal water years, average monthly depth of deepwater pool areas changed slightly over the February through November period. The greatest average monthly depth reduction during any month of the evaluation period was -0.2% under the Cumulative Condition relative to the current conditions.

For Below Normal water years, average monthly depth of deepwater pool areas changed even less over the evaluation period, with no reductions in average monthly depth exceeding -0.1% under the Cumulative Condition relative to the current conditions.

For Dry and Critical water years, average monthly depth of deepwater pool areas did not change during any month of the entire March through November period.

Application of the RMT's SRH-2D hydraulic model resulted in estimates of the total wetted area (ft²) of pools > 10 feet deep (i.e., deepwater pool habitat) from Daguerre Point Dam to the confluence with the lower Feather River at various flow rates ranging from 300 to 42,200 cfs at the Marysville Gage. The areal percentage of the wetted
channel comprised of deepwater pools ranges from 2.6% at 300 cfs, to 10.3% at 5,000 cfs, to 44.8% at 42,200 cfs (see Appendix G).

Appendix G of this BA displays monthly exceedance curves of the areal extent of deepwater pool habitat associated with the simulated mean monthly flows at the Marysville Gage over the entire modeled hydrologic period of record (i.e., 1922 through 2008) for the Cumulative Condition and current conditions. These exceedance curves are presented monthly for the February through November period, which represents the potential green sturgeon adult holding, spawning and post-spawning holding periods.

Examination of model output presented in Appendix G demonstrates that over the 87-year simulation period, the long-term average monthly deepwater pool habitat exceedance distributions would vary only slightly during February through May, October and November, and would generally be similar during June and September. The largest differences in the monthly deepwater habitat exceedance distributions occur during July and August. However, monthly deepwater habitat exceedance distributions under the Cumulative Condition differ by less than 10% over 93-100% of the monthly distributions over the entire February through November evaluation period, relative to the current conditions. Moreover, the largest reductions in deepwater pool habitat occur during July and August when deepwater pool habitat availability remains above 300,000 square feet downstream of Daguerre Point Dam. Over the quartile of the monthly deepwater pool habitat exceedance distributions representing the lowest amounts of habitat availability, deepwater pool habitat is essentially equivalent most of the time during all months, and does not differ by 10% or more during any year of any month of the evaluation period.

**SUMMARY OF FLOW-RELATED EFFECTS ON GREEN STURGEON**

In summary, the relatively minor flow reductions under the Cumulative Condition relative to the current conditions would be expected to result in corresponding minor reductions in deepwater pool depth and habitat availability below Daguerre Point Dam during the February through November evaluation period. During low flow conditions, deepwater pool habitat availability under the Cumulative Condition would be essentially equivalent during all months of the evaluation period, relative to the current conditions. Minor flow-related changes to depth or areal extent of deepwater pool habitat under the
Cumulative Condition relative to the current conditions indicate no substantive effects to the unique specific PCE of deepwater pool habitat associated with green sturgeon critical habitat in the lower Yuba River.

### 7.5.1.2 Cumulative Effects Water Temperature Analysis

**WATER TEMPERATURE AT THE SMARTSVILLE GAGE**

Over the 87-year simulation period, long-term average monthly water temperatures, as well as average monthly water temperatures by water year type at the Smartsville Gage would not change or would change only very slightly under the Cumulative Condition relative to the current conditions. Changes in average monthly water temperatures over all water year types would range only from an estimated 0.1°F decrease to a 0.2°F increase under the Cumulative Condition relative to the current conditions.

Examination of monthly mean water temperature exceedance distributions over the 87-year simulation period at the Smartsville Gage indicate no or minor differences between the Cumulative Condition and the current conditions during each month of the year.

**WATER TEMPERATURE AT DAGUERRE POINT DAM**

Over the 87-year simulation period, the long-term average monthly water temperatures, as well as average monthly water temperatures during Wet, Above Normal and Below Normal water year types at Daguerre Point Dam would not change or would change only very slightly under the Cumulative Condition relative to the current conditions. Changes in average monthly water temperatures over these water year types would range only from a 0.1°F decrease to a 0.2°F increase under the Cumulative Condition relative to the current conditions.

For Dry and Critical water year types, average monthly water temperatures at Daguerre Point Dam change slightly during most months of the year, with no change or changes of 0.1°F occurring from October through April. However, relative to the current conditions, the Cumulative Condition results in decreases in water temperature from May through September, with the largest decreases in temperature occurring during July (0.4°F and 0.3°F during Dry and Critical years, respectively) and August (0.4°F during both Dry and Critical years).
Examination of monthly mean water temperature exceedance distributions over the 87-year simulation period at Daguerre Point Dam indicate no or minor differences between the Cumulative Condition and the current conditions from October through June. Differences in the monthly mean water temperature exceedance distributions generally occur during July and August, with the Cumulative Condition exhibiting somewhat lower water temperatures over approximately the warmest one-half of the distributions, and to a lesser extent during September.

**WATER TEMPERATURE AT THE MARYSVILLE GAGE**

Examination of model output presented in Appendix F of this BA demonstrates that over the 87-year simulation period, the long-term average monthly water temperatures at the Marysville Gage would increase slightly during August and September (0.4°F) and either would not change or would change only very slightly from October through July under the Cumulative Condition relative to the current conditions.

For Wet water year types, average monthly water temperatures at the Marysville Gage are changed slightly during most months of the year, with no change or changes of 0.1°F occurring from October through June. Relative to the current conditions, the Cumulative Condition results in water temperature increases during July (0.2°F), August (0.4°F) and September (0.5°F).

For Above Normal water year types, average monthly water temperatures at the Marysville Gage change slightly during most months of the year, with no change or changes of 0.1°F during seven months of the year, excluding November, February and July through September. Water temperature increases occur in November, February and July (0.2°F), August (0.6°F) and September (0.5°F) under the Cumulative Condition, relative to the current conditions.

For Below Normal water year types, average monthly water temperatures at the Marysville Gage change slightly during most months of the year, with no change or changes of 0.1°F occurring from October through April. The Cumulative Condition results in water temperature increases of 0.2°F (May through July), 0.5°F (August) and 0.4°F (September) at the Marysville Gage, relative to the current conditions.
For Dry and Critical water year types, average monthly water temperatures at the Marysville Gage change slightly during most months of the year, with changes in average monthly water temperatures during these water year types ranging from a 0.4°F decrease (July of Dry water years) to a 0.1°F increase (May, August and September in Dry water years and October, November and May in Critical water years) under the Cumulative Condition, relative to the current conditions.

Examination of monthly mean water temperature exceedance distributions over the 87-year simulation period at the Marysville Gage indicate no or minor differences between the Cumulative Condition and the current conditions from October through June. Differences in the monthly mean water temperature exceedance distributions generally would occur during July, August and September, with the Cumulative Condition exhibiting somewhat lower water temperatures over approximately the warmest one-half of the distribution during July, and generally similar water temperatures over approximately the warmest one-half of the distribution during August and September, with slightly higher temperatures over the other half of the distributions.

**WATER TEMPERATURE-RELATED EFFECTS ON SPRING-RUN CHINOOK SALMON**

From the spatial and temporal distribution information presented in Chapter 4 of this BA, the spring-run Chinook salmon lifestage-specific periodicities used for this evaluation of monthly mean water temperatures under the Cumulative Condition relative to the current conditions are as follows.

- Adult immigration and holding (April through September)
- Spawning (September through mid-October)
- Embryo incubation (September through February)
- Juvenile rearing and downstream movement (Year-round)

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2 Water temperature suitabilities for the juvenile rearing and downstream movement lifestages are evaluated together because they have the same upper tolerance WTI.
Smolt (yearling+) emigration (October through mid-May)

**ADULT IMMIGRATION AND HOLDING**

As previously discussed, adult spring-run Chinook salmon immigrate up through the lower Yuba River from early spring into July, August, and as late as September, and hold upstream and just downstream of Daguerre Point Dam until initiation of spawning during September. Examination of monthly mean water temperatures over the 87-year simulation period at the Smartsville Gage indicates that monthly mean water temperatures during the April though September adult immigration and holding time period would not approach the WTI value of 65°F at the Smartsville Gage under either the Cumulative Condition or the current conditions.

At Daguerre Point Dam, monthly mean water temperatures during April through June would not exceed the WTI value of 65°F under either the Cumulative Condition or the current conditions. From July through September water temperatures remain below the 65°F WTI value about 99% of the time under both the Cumulative Condition and the current conditions.

Relatively minor differences would occur between monthly mean water temperatures at the Marysville Gage under the Cumulative Condition and the current conditions during all months with the exception of June and July. The Cumulative Condition results in about a 9% lower probability of exceeding the 65°F index value during June, and about a 1% higher probability of exceeding the 65°F index value during July. The WTI value of 68°F would not be exceeded during October through June under either the Cumulative Condition or current conditions. The 68°F WTI value would be exceeded with the same probability (< 5%) during July, August and September at the Marysville Gage under the Cumulative Condition and the current conditions.

**SPAWNING AND EMBRYO INCUBATION**

During the September through December spring-run Chinook salmon spawning and embryo incubation period, mean monthly water temperatures at the Smartsville Gage would remain below the WTI value of 58°F under the Cumulative Condition and the current conditions.
**JUVENILE REARING AND DOWNSTREAM MOVEMENT**

Although the WTI value of 65°F was established for both the juvenile spring-run Chinook salmon rearing and downstream movement lifestages, the index value is applied at Smartsville and Daguerre Point Dam for rearing (year-round), and at Daguerre Point Dam and Marysville for juvenile downstream movement (Mid-November through June). Consequently, the probability of exceeding the 65°F index value is evaluated year-round for all three locations for these combined lifestages.

Examination of monthly mean water temperatures over the 87-year simulation period at the Smartsville Gage indicates that monthly mean water temperatures during the year-round juvenile rearing and downstream movement combined lifestages remain below the WTI value of 65°F at the Smartsville Gage under both the Cumulative Condition and the current conditions.

At Daguerre Point Dam, monthly mean water temperatures from October through June would not exceed the WTI value of 65°F under either the Cumulative Condition or the current conditions. From July through September, water temperatures remain below the 65°F WTI value about 99% of the time under both the Cumulative Condition and the current conditions.

At the Marysville Gage, during the (mid-)November through June downstream movement lifestage of juvenile spring-run Chinook salmon, monthly mean water temperatures remain below the WTI value of 65°F under both the Cumulative Condition and the current conditions. During June, water temperatures exceed the 65°F WTI value with an equal probability (< 5%) under both the Cumulative Condition and the current conditions.

**SMOLT (YEARLING+) EMIGRATION**

The RMT (2013) identified the spring-run Chinook salmon smolt (yearling+) outmigration period as extending from October through mid-May in the lower Yuba River. Examination of monthly mean water temperatures over the 87-year simulation period at Daguerre Point Dam and at Marysville indicates that monthly mean water
temperatures would remain below the WTI value of 68°F from October through May under both the Cumulative Condition and the current conditions.

**Summary of Water Temperature-Related Effects on Spring-run Chinook Salmon**

Minor water temperature changes would occur under the Cumulative Condition relative to the current conditions. The foregoing evaluation of changes in water temperatures under the Cumulative Condition relative to the current conditions indicates no substantive effects for any of the spring-run Chinook salmon lifestages in the Action Area of the lower Yuba River.

**Water Temperature-Related Effects on Steelhead**

The steelhead lifestage-specific periodicities used for this evaluation of monthly mean water temperatures under the Cumulative Condition relative to the current conditions are as follows.

- Adult immigration and holding (August through March)
- Spawning (January through April)
- Embryo incubation (January through May)
- Juvenile rearing and downstream movement (Year-round)
- Smolt (yearling+) emigration (October through mid-April)

**Adult Immigration and Holding**

The immigration of adult steelhead in the lower Yuba River occurs from August through March, with peak immigration from October through February (RMT 2013). Examination of monthly mean water temperatures over the 87-year simulation period at the Smartsville Gage indicates that monthly mean water temperatures during the August through March adult immigration and holding time period would remain below the WTI.

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3 Water temperature suitabilities for the juvenile rearing and downstream movement lifestages are evaluated together because they have the same upper tolerance WTI.
value of 65°F at the Smartsville Gage under either the Cumulative Condition or the current conditions.

At Daguerre Point Dam, monthly mean water temperatures remain below the 65°F WTI value from October through March. Water temperatures remain below the 65°F and 68°F WTI values with about a 98% probability during August. During September, water temperatures remained below the 65°F WTI value with about a 98% probability, and remained below the 68°F WTI value under both the Cumulative Condition and the current conditions.

At the Marysville Gage, monthly mean water temperatures would remain below the WTI value of 65°F from October through March. The 65°F and 68°F WTI values would be exceeded with the same probability (< 5%) during August and September at the Marysville Gage under the Cumulative Condition and the current conditions.

**SPAWNING AND EMBRYO INCUBATION**

During the January through May steelhead spawning and embryo incubation period, mean monthly water temperatures at the Smartsville Gage remain below the WTI value of 57°F under both the Cumulative Condition and the current conditions. At Daguerre Point Dam, water temperatures remain below the 57°F WTI value during January through April under both the Cumulative Condition and the current conditions. During May, water temperatures at Daguerre Point Dam would remain below the 57°F WTI value about 97% of the time under both the Cumulative Condition and the current conditions.

**JUVENILE REARING AND DOWNSTREAM MOVEMENT**

Although the WTI value of 68°F was established for both the juvenile spring-run Chinook salmon rearing and downstream movement lifestages, the index value is applied at Smartsville and Daguerre Point Dam for rearing (year-round), and at Daguerre Point Dam and Marysville for juvenile downstream movement (April through September). Consequently, the probability of exceeding the 68°F index value is evaluated year-round for all three locations for these combined lifestages.

Examination of monthly mean water temperatures over the 87-year simulation period at the Smartsville Gage indicates that monthly mean water temperatures during the year-
round juvenile rearing and downstream movement combined lifestages remain below the WTI value of 68°F at the Smartsville Gage under both the Cumulative Condition and the current conditions.

At Daguerre Point Dam, monthly mean water temperatures from October through June would not exceed the WTI value of 68°F under either the Cumulative Condition or the current conditions. From July through September, water temperatures remain below the 68°F WTI value about 99% of the time under both the Cumulative Condition and the current conditions.

At the Marysville Gage, during the April through September downstream movement lifestage of juvenile steelhead, monthly mean water temperatures remain below the WTI value of 68°F under both the Cumulative Condition and the current conditions from April through June. During July, August and September, water temperatures exceed the 68°F WTI value with an equal probability (< 5%) under both the Cumulative Condition and the current conditions.

**SMOLT (YEARLING+) EMIGRATION**

The RMT (2010b; 2013) review of all available data indicate that steelhead smolt (yearling+) emigration may extend from October through mid-April. Examination of monthly mean water temperatures over the 87-year simulation period at both Daguerre Point Dam and the Marysville Gage indicates that monthly mean water temperatures would remain below the WTI value of 55°F with about a 99-100% probability from November through April under both the Cumulative Condition and the current conditions. Water temperatures during October are essentially equivalent under the Cumulative Condition and the current conditions, and would nearly always exceed the 55°F index value.

**SUMMARY OF WATER TEMPERATURE-RELATED EFFECTS ON STEELHEAD**

Minor water temperature changes would occur under the Cumulative Condition relative to the current conditions. The foregoing evaluation of changes in water temperatures under the Cumulative Condition relative to the current conditions indicates no substantive effects for any of the steelhead lifestages in the Action Area of the lower Yuba River.
**WATER TEMPERATURE-RELATED EFFECTS ON GREEN STURGEON**

Consistent with RMT (2013), the water temperature-related assessment for green sturgeon critical habitat evaluates the differences in the probability of occurrence that water temperatures at Daguerre Point Dam and at the Marysville Gage in the lower Yuba River are outside of reported suitable ranges for each of the lifestages, under the Cumulative Condition relative to the current conditions, as follows:

- **Adult immigration/holding/post-spawning holding** (February through November) 
  
  (44°F to 61°F)

- **Adult spawning and embryo incubation** (March through July) (46°F to 63°F)

- **Juvenile rearing and outmigration** (Year-round) (52°F to 66°F)

**ADULT IMMIGRATION, HOLDING, AND POST-SPAWNING HOLDING**

Water temperatures from 44°F to 61°F are used to represent the suitable range for the adult immigration, holding, and post-spawning holding lifestages. The combination of these lifestages encompasses late February through November. At Daguerre Point Dam, water temperatures remain within this range with 100% probability from February through May, and during October and November. Water temperatures would remain within this range with about 98% probability from June through September under both the Cumulative Condition and the current conditions.

At Marysville, water temperatures would remain within this range with a 100% probability from March, April, October and November, and with about 98% probability during February and May. Water temperatures would exceed the upper end of the range with about equal probability of occurrence (about 40%) during June under both the Cumulative Condition and the current conditions. Water temperatures would exceed the upper end of the range with an additional probability of occurrence under the Cumulative Condition of about 5%, 6%, and 13% during July, August and September, respectively.

**SPAWNING AND EMBRYO INCUBATION**

Water temperatures from 46°F to 63°F are used to represent the suitable range for the spawning and embryo incubation lifestages, which occur from March through July. At
Daguerre Point Dam, water temperatures would remain within this range with 100% probability during April and May, and would remain within this range during March, June and July with about a 98% probability.

At Marysville, water temperatures would remain at or below the upper value (63°F) of the suitability range with 100% probability during March through May under both the Cumulative Condition and the current conditions. Water temperatures would exceed the upper end of the range with about an equal probability during June under both the Cumulative Condition and the current conditions. During July, water temperatures would exceed the upper end of the range with an additional ~3% probability under the Cumulative Condition.

**JUVENILE REARING AND OUTMIGRATION**

The juvenile rearing and outmigration lifestages used the same WTI value range (52°F to 66°F). At Daguerre Point Dam, water temperatures would remain below the upper value of the suitability range (66°F) with a 100% probability from October through June, and with about a 98% probability from July through September under both the Cumulative Condition and the current conditions.

At Marysville, water temperatures would remain below the upper value of the suitability range (66°F) with a 100% probability from October through May. From June through September, water temperatures would remain below the upper value of the suitability range (66°F) with about a 95% probability or more under both the Cumulative Condition and the current conditions.

**SUMMARY OF WATER TEMPERATURE EFFECTS ON GREEN STURGEON**

Minor water temperature changes would occur under the Cumulative Condition relative to the current conditions. The foregoing evaluation of changes in water temperatures under the Cumulative Condition relative to the current conditions indicates no substantive effects for any of the green sturgeon lifestages in the lower Yuba River.
7.5.2 Other Future Non-Federal Activities

The following activities may affect flows or other conditions in the lower Yuba River. For the reasons discussed below, none of these activities is likely to have any adverse cumulative effects on any of the listed species discussed in this BA or their critical habitats.

7.5.2.1 BVID Agricultural Return Flow Recapturing Project

Browns Valley Irrigation District is planning to construct a pumping plant and a pipeline to recapture and recycle irrigation return flows that the district is discharging into Dry Creek (BVID 2011). BVID will convey recycled flows from a pumping plant on Dry Creek to rice fields presently irrigated exclusively by diversions from the lower Yuba River. The warmer reclaimed water will be delivered into BVID’s Pipeline Canal and applied by its customers to rice lands where the elevated water temperature benefits rice production. Application of tailwater recaptured from Dry Creek to the agricultural lands within BVID’s service area will reduce the district’s demand for water diverted directly from the lower Yuba River, thus balancing the reduction in inflow to the river that results from pumping from Dry Creek with an equivalent reduction in diversion. The project is of regional significance because it will reduce diversions from the lower Yuba River (Yuba County 2007).

The project proposes to recapture up to a maximum of 10 cfs of irrigation return flow from Dry Creek during the irrigation season, which typically runs from April through October (BVID 2011). It is estimated that the influx of irrigation return flow raises Dry Creek’s temperature by an average of 4–5°C and introduces sediment, nutrients, and other constituents into the Dry Creek approximately 1.8 miles upstream of its confluence with the lower Yuba River (BVID 2009). By pumping water from Dry Creek downstream of the confluence with Little Dry Creek when Dry Creek flows are primarily comprised of return water from irrigated lands, the project is expected to improve water quality by removing some of the thermal and pollutant load from Dry Creek before it reaches the lower Yuba River. BVID will continue to meet existing minimum flow requirements with releases of cool, good quality water from Collins Lake. Any time that BVID is
recapturing irrigation return water, there will be an equal and concurrent reduction in BVID’s diversions from the Yuba River at its Pumpline facilities (BVID 2009). Use of the recaptured return water for the rice fields will reduce BVID diversions of cool surface water from the lower Yuba River, and this substitution will retain cool water in the lower Yuba River, which will benefit fisheries resources and aquatic habitat (BVID 2009).

7.5.2.2 The Trust for Public Lands Excelsior Project

The Excelsior Project is a collaborative conservation effort on the lower Yuba River, featuring 924 acres of wetlands, oak woodlands, gold-rush archeological remnants, and miles of critical riparian salmon spawning habitat (Excelsior Chronicles 2010). As many as 60 homes were planned along the lower Yuba River on the property once owned by the Excelsior Mining Company. The Trust for Public Lands, in collaboration with CDFW, intends to turn part of the land over to the University of California Sierra Field Research Station for salmon studies and restoration work before eventually opening it to the public (Fimrite 2009). Recently, the California Wildlife Conservation Board, in concert with the Trust for Public Lands, voted to acquire the 528-acre Yuba Narrows Ranch, ensuring that this property would be permanently protected as open space. In July of 2011, CDFW acquired the Yuba Narrows Ranch, which includes frontage along almost two miles of critical salmon spawning habitat along the lower Yuba River, and will be managed and permanently protected as open space. The conservation easement will permit access from Highway 20 into the Yuba Narrows Ranch, providing miles of hiking and acres of recreational opportunities. It is anticipated that portions of the property, including the Miner’s Ditch Trail, will become open to public access. Additionally, it is anticipated the acquisition of the historic 157-acre Black Swan Ranch portion of the Excelsior property, which is located near the confluence of Deer Creek and overlooks Englebright Reservoir and the lower Yuba River, will be completed during 2013 (Excelsior Project 2013).

Beginning in the fall of 2011, conservation easements were placed on parcels of the Excelsior Ranch. The blue oak woodlands that occupy the large majority of the Excelsior Ranch will be permanently protected as open space, and managed jointly by the Ranch’s steward-owners, who will also play a significant role in oversight of the Black Swan and
Yuba Narrows conservation areas. In this way, more than 870 acres (over 95%) of the Excelsior property will be permanently protected as open space.

7.5.2.3 **Yuba Goldfields Sand and Gravel Mining Operations**

The Yuba Goldfields area is designated and zoned “Extractive Industrial” under the Yuba County General Plan, which allows surface mining as a permitted use. Operators within and adjacent to the Yuba Goldfields currently supply construction materials, including asphaltic concrete, to projects within southern Placer and Yuba counties.

**Teichert Aggregates**

The Teichert Aggregate’s operation mines and processes sand and gravel deposits in addition to hard rock, immediately adjacent to the Yuba Goldfields approximately five miles northeast of Marysville, California, and two miles south of the Yuba River. The mine operates on an approximately 590-acre site and mines to depths of approximately 200 feet (Placer County 2007). Mining operations use a dragline to excavate mined materials in saturated conditions (below groundwater levels). According to Placer County (2007), production is 500,000 tons per year to 1 million tons per year (mty) depending on specific market demands. For purposes of assessing cumulative effects, it was previously assumed that this facility would be operating at its maximum estimated production rate of 1 mty (Placer County 2007).

According to SMGB (2010), mineral production at Teichert Aggregate’s Marysville facility was curtailed by more than 90 percent of the operation’s previous maximum annual mineral production due to economic conditions in 2009. However, the operator submitted an Interim Management Plan (IMP) to the California State Mining and Geology Board (SMGB) for review and approval in 2010, and the operator indicated intent to resume surface mining operations at a future date. The SMGB recommended approval of the IMP for the Teichert Marysville Facility for a period of up to five years (SMGB 2010).

**Western Aggregates**

The Western Aggregates facility mines and processes sand and gravel deposits within the Yuba Goldfields south of the Yuba River and north of Hammonton-Smartville Road
The mine operates on approximately 2,000 acres, excavating sand and gravel deposits from previous gold dredge tailings. Mined aggregate material is hauled to an onsite processing plant that includes crushers, screeners, and a conveyor. The mitigated negative declaration for the mine (adopted March 23, 1977) estimated the mining rate to be about 600,000 tons per year (Placer County 2007).

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

The conservation easement will prohibit development or mining on the encumbered lands (except for disturbance that may be necessary for habitat restoration), and will outline a range of potential prescriptions for habitat restoration (YubaNet 2008). The project also will incorporate pedestrian access to the lower Yuba River through several walk-through gates to be established at locations to be agreed upon at a future date.

The parties plan to implement the project in three phases. Initially, the project will protect and conserve land from vehicular damage to habitat. Concurrently, SYRCL will lead design and feasibility studies for physical habitat restoration. In the second phase, habitat for salmon and riparian wildlife will be restored through a series of projects over the encumbered lands. Finally, the project contemplates implementing long-term enhancement and monitoring of these restored habitats. The timing of the completion of the three phases is unknown at this time because of the funding needs of the project (YubaNet 2008). Western has initiated a Yuba Salmon Enhancement Fund through a "challenge grant" to SYRCL of $50,000, and Western has agreed to match SYRCL's fund-raising of the project dollar - for dollar for the first $50,000 raised by SYRCL (YubaNet 2008). The four parties to the Agreement in Principle also must obtain the consent of certain third parties who have varying interests in some of the lands contemplated for the conservation easement (YubaNet 2008).
The Baldwin Contracting Company, Incorporated and Springer Family Trust has proposed to expand its aggregate mining operations in the Hallwood area of east-central Yuba County, just west of the Yuba Goldfields off SR 20 (Placer County 2007). Baldwin Contracting conducts mining operations on 275 acres and is planning a phased expansion of about 200 acres over a period of 14 to 20 years, with expansion occurring 30 acres at a time. The expansion would result in mining of an additional 500,000 tons per year to 1 million tons per year. Applications were submitted to Yuba County for a change of zone, a General Plan amendment, and a Yuba County surface mining permit, and to the California State Office of Mines and Geology for a permit amendment (Placer County 2007). The existing excavation area in the Yuba Goldfields was previously mined for aggregate and gold, and the expansion area is currently in fruit orchards and has not been mined (California RWQCB 2010). Aggregate reserves exist to a depth of approximately 75 feet in both areas (California RWQCB 2010). A Report of Waste Discharge was submitted to the Central Valley Regional Water Quality Control Board for expansion of an existing aggregate facility, which was approved in 2010.

### 7.5.2.4 Yuba County General Plan Update Draft EIR

The Yuba County General Plan Update Final EIR, in part, evaluated cumulative biological impacts in 2030 associated with implementing the general plan (Yuba County 2011). The cumulative effects assessment stated that past development in Yuba County, ranging from conversion of land to agricultural production to recent expansion of urban development, has resulted in a substantial loss of native habitat to other uses. This land conversion has benefited a few species, such as those adapted to agricultural, urban, and rural-scale developed uses, but the overall effect on native plants, animals, and habitat has been negative. Although many future projects and plans included in the cumulative scope of this analysis would be required to mitigate those impacts, in compliance with the CEQA, Federal ESA, California ESA, and other State, local, and Federal statutes, many types of habitats and species are provided no protection. Therefore, it can be expected that the net loss of native habitat for plants and wildlife, agricultural lands, and open space areas that support important biological resources in Yuba County and related areas
will continue (Yuba County 2011). The cumulative loss of habitat for special status species, such as habitat for riparian and aquatic species (e.g., California red-legged frog, giant garter snake, and western yellow-billed cuckoo) have already resulted in drastic declines in numbers of these species (Yuba County 2011). The evaluation focused on terrestrial species and their habitats.

In Yuba County, most established riparian vegetation occurs along the largest rivers; the Feather River, Yuba River, and Bear River, and south Honcut Creek. Important riparian corridors also occur along Dry Creek and other tributaries to Honcut Creek and the Yuba River. Riparian vegetation is present in the surrounding region along the Sacramento River and in the Sutter Bypass. Agricultural, residential, and industrial water use and land development have resulted in a significant cumulative reduction in the extent of riparian habitats in the County and surrounding region. Implementing Action NR 5.3, which requires private and public projects to provide setbacks to protect riparian habitat as a condition of project approvals, is expected to substantially reduce impacts on riparian habitats, although complete avoidance may not be possible while still allowing full build out of the designated land uses. Therefore, the 2030 General Plan would have a cumulatively considerable contribution to this significant cumulative impact.

The County anticipates that implementation of the Yuba-Sutter Natural Community Conservation Plan (NCCP)/Habitat Conservation Plan (HCP) would reduce cumulative biological resources impacts. The Yuba-Sutter Regional NCCP/HCP will provide an opportunity to mitigate potential impacts to biological resources that may occur through implementation of the General Plan. The NCCP/HCP is still in draft form, but the County anticipates that it will be finalized and adopted before the 2030 General Plan is fully implemented.

### 7.5.2.5 Yuba-Sutter Regional Natural Community Conservation Plan/Habitat Conservation Plan

According to Yuba County et al. (2011), the Yuba-Sutter Regional NCCP/HCP will address actions associated with future urban development, irrigation improvements, local flood control projects, and road improvements within Yuba and Sutter counties. During the early planning stages, a group of independent science advisors provided

Fish species to be considered in the NCCP/HCP include spring-run Chinook salmon, fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, Sacramento splittail and Pacific lamprey (Conservation Biology Institute 2006). The reach of the lower Yuba River extending through and somewhat beyond the Yuba Goldfields was identified as having important Chinook salmon spawning habitat worthy of special attention in conservation, restoration, and enhancement measures. Fisheries-related recommendations included the need for additional information on the known distribution of fish species in local streams and associating these to the degree possible with information on flow regimes, known or suspected barriers, and other habitat quality variables (e.g., presence or absence of nonnative aquatic species; width and quality of riparian vegetation). This information would be used to identify potential actions that could aid in the recovery of local fish populations by removing physical passage barriers, removing water contaminants, altering the timing, duration, or magnitude of stream flows, or restoring riparian vegetation and/or adjacent upland buffering (Conservation Biology Institute 2006).

### 7.5.2.6 City of Wheatland, Reclamation District 2103, and Reclamation District 817 External Flood Source Flood Protection Projects

Four levee improvement alternatives have been identified as part of this project to mitigate the flooding issues associated with the City of Wheatland General Plan Area. The fourth alternative is the Reclamation District 2103 Bear River Levee Remediation, which is sponsored by local land developers and is designed to provide 200-year protection for the upper portion of the Bear River levee. This project would provide additional flood protection and management for the Upper Bear River and the City of Wheatland.
This project represents an historic opportunity to acquire three priority conservation areas along the Yuba River. The acquisition of these properties will help ensure the security of water quality in the Yuba River, protect threatened and endangered fisheries, create new recreational opportunities, and increase public access. These properties are part of the Yuba River Wildlife Area Conservation Conceptual Area Protection Plan (CAPP), which coordinates CDFW’s acquisition and management activities on more than 81,000 acres of the Yuba River corridor.

**Retain Flood Control Options:** Protection of the project properties will increase long-term flood control options by protecting critical watershed lands in the river corridor and ensuring ownership and management patterns below and above stream of major water supply, power generation, and flood control facilities.

**Restore and Protect Salmon and Steelhead Habitat:** The project will protect, preserve and restore riparian and aquatic habitat for State and Federally listed Chinook salmon and steelhead trout and implement important conservation elements of the Yuba River CAPP, the Yuba River Conservancy, and the Lower Yuba Technical Work Group.

**Create Habitat Connectivity:** This project provides tremendous opportunities for habitat connectivity, including:

- **East-West connectivity along the Yuba River.** The properties included in this project will provide protection for up to 14.5 miles of Yuba River through a 21-mile corridor.

- **Downstream river connectivity.** Invaluable river corridor connectivity between Englebright Dam and Parks Bar necessary for the restoration of existing salmon and steelhead.

- **Blue oak woodland corridor.** The project also represents crucial properties in the center of a roughly twenty-mile north–south oak woodland corridor that stretches from the CDFW Daugherty Wildlife Area to the Spenceville Wildlife Area and Beale Air Force Base.
Protect Agricultural Lands: The project will preserve and protect important agricultural lands, including grassland and rangelands along the river corridor that provide important wildlife habitat, riparian zones and protect sensitive aquatic environments.

7.6 Aggregate and Net Effects of the Proposed Action

In addition to determining whether the Proposed Action is likely to adversely affect any listed species or their critical habitats, this BA provides information to assist NMFS in evaluating whether the “aggregate effects” of the Proposed Action are likely to “reduce appreciably the likelihood of both the survival and recovery” of each listed species, or “appreciably diminish[] the value of critical habitat.” Under the aggregate effects assessment approach, the Environmental Baseline and the status of the species are viewed together by NMFS to determine the ability of each listed species to withstand additional stressors associated with subsequent actions without jeopardizing the continued existence of the species. Thus, an assessment is made as to whether current conditions, measured against the status of a species, leave any “cushion” to accommodate additional adverse impacts without causing jeopardy to the species. As NMFS (2009a) indicates: “if the species’ status is poor and the baseline is degraded at the time of consultation, it is more likely that any additional adverse effects caused by the proposed or continuing action will be significant.”

As detailed in this BA, ongoing and future activities and conditions not necessarily within the control of the Corps are likely to continue to place substantial stress on the species at the ESU/DPS level. For the ESU-wide Environmental Baseline effects assessment of the spring-run Chinook salmon, NMFS (2009a) found that the entire suite of limiting factors, threats and stressors associated with the Environmental Baseline result in an unstable ESU at moderate risk of extinction. For the DPS-wide Environmental Baseline effects assessment of steelhead, NMFS (2009a) found that the entire suite of stressors associated with the Environmental Baseline result in an unstable DPS at moderate or high risk of extinction. Although NMFS (2009a) did not clearly state whether or not the green sturgeon DPS was stable, they concluded that continued operations of the CVP/SWP
would be expected to have population level consequences for the single extant population in the mainstem Sacramento River, and that the stressors associated with the Environmental Baseline are likely to jeopardize the continued existence of the Southern DPS of North American green sturgeon and greatly increase the extinction risk of the species (NMFS 2009a).

In the lower Yuba River, available information regarding the current status of phenotypic spring-run Chinook salmon indicates that under the Environmental Baseline their abundance and trend considerations would correspond to low extinction risk according to NMFS criteria (Lindley et al. 2007). However, the RMT (2013) questions the applicability of any of these criteria addressing extinction risk, because lower Yuba River anadromous salmonids represent introgressive hybridization of larger Feather-Yuba river populations, with substantial contributions of hatchery-origin fish to the annual runs. Populations of steelhead and green sturgeon in the lower Yuba River are data deficient, and consequently cannot be concluded to be stable or at a specific risk of extinction.

Under the aggregate effects assessment approach, evaluation of the Environmental Baseline and the inability to conclude that populations of the listed species are stable would suggest that each listed species would not be able to withstand additional stressors associated with subsequent actions, and that it is… "more likely that additional adverse effects caused by the proposed or continuing action will be significant."

However, regarding spring-run Chinook salmon and steelhead, the Proposed Action will:

1. improve passage ability due to continuing to keep the fish ladder control gates open at high flow levels; and
2. improve within-ladder hydraulics and attraction flows by adjustment of within-ladder flashboards and fish ladder gated orifices; (3) improve within ladder hydraulics by removal of debris and sediment accumulation within the fish ladder bays and thereby improve passage conditions; (4) direct sheet flow that spills over the top of Daguerre Point Dam into the fish ladders, and thereby improve the ability of adult fish to locate the fish ladders and migrate upstream to spawning and rearing habitats; and (5) direct downstream migrating juvenile spring-run Chinook salmon and steelhead into the fish ladders, and thereby reduce physical injury from spilling over the dam, and potentially reduce predation due to disorientation in the plunge pool below the dam. In
addition, the Proposed Action will not introduce new stressors or substantially exacerbate ongoing stressors under the Environmental Baseline to green sturgeon in the lower Yuba River. The Proposed Action is not likely to increase risks to green sturgeon.

Implementation of voluntary conservation measures would: (1) expand suitable spawning habitat in the Englebright Dam Reach and may encourage additional behavioral segregation of spawning spring-run Chinook salmon; and (2) provide additional LWM and corresponding habitat complexity and diversity (and therefore predator escape cover, velocity shelter, feeding stations) for rearing juvenile spring-run Chinook salmon and steelhead, relative to the Environmental Baseline.

The net effects of the Proposed Action would not increase the risks to spring-run Chinook salmon and steelhead because the Proposed Action will improve conditions in the Action Area of the lower Yuba River relative to the Environmental Baseline. In addition, the net effects of the Proposed Action will not increase the risks to green sturgeon because the Proposed Action will not result in increased harm to the species over Environmental Baseline conditions in the Action Area of the lower Yuba River.
8.0 Conclusions and Determinations

The following discussion provides the Corps’ conclusions and determinations concerning whether the Proposed Action is likely to adversely affect spring-run Chinook salmon, steelhead and green sturgeon, or designated critical habitat within the Action Area. The conclusions in this BA are based on the best scientific and commercial data available, and are intended to assist NMFS in reaching its own determinations regarding project-related effects to listed species in the context of the formal ESA consultation process.

Three possible determinations exist regarding a proposed action’s effects on listed species under the ESA (USFWS and NMFS 1998). These determinations are as follows:

- **No effect** - “No effect” is the appropriate conclusion when it is determined that the proposed action will not affect a listed species or designated critical habitat.

- **May affect, but is not likely to adversely affect** - “May affect, but is not likely to adversely affect” is the appropriate conclusion when effects on ESA protected species are expected to be discountable, insignificant, or completely beneficial. “Insignificant effects relate to the size of the impact, and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur (USFWS and NMFS 1998).”

- **May affect, is likely to adversely affect** - “May affect, is likely to adversely affect” is the appropriate conclusion if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not discountable, insignificant or beneficial. In fact, in the event the overall effect of the proposed action is beneficial to an ESA-protected species, but also is likely to cause some adverse effects, then the proposed action “is likely to adversely affect” the listed species. If incidental take is anticipated to occur as a result of the proposed action, an “is likely to adversely affect” determination should be made (USFWS and NMFS 1998).

The analyses presented in Chapter 7 of this BA was conducted to assist NMFS in determining whether the Proposed Action will cause “…some deterioration in the
"species' pre-action condition" (National Wildlife Federation v. NMFS, 524 F.3d 917 (9th Cir. 2008). Specifically for this consultation, the conservation measures associated with the Proposed Action have been implemented over the past few years, representing a reduction in stressors and improvement over the pre-action condition of spring-run Chinook salmon and steelhead.

8.1 Listed Species

The Proposed Action is comprised of the Corps’ authorized discretionary O&M activities at the existing fish passage facilities at Daguerre Point Dam, including the administration of two outgrants associated with O&M of the facilities, and specified conservation measures. The Proposed Action will improve pre-action Environmental Baseline conditions in the Action Area of the lower Yuba River for spring-run Chinook salmon and steelhead because it will: (1) improve passage ability due to continuing to keep the fish ladder control gates open at high flow levels; (2) improve within-ladder hydraulics and attraction flows by adjustment of within-ladder flashboards and fish ladder gated orifices; (3) improve within ladder hydraulics by removal of debris and sediment accumulation within the fish ladder bays and thereby improve passage conditions; (4) direct sheet flow that spills over the top of Daguerre Point Dam into the fish ladders, and thereby improve the ability of adult fish to locate the fish ladders and migrate upstream to spawning and rearing habitats; and (5) direct downstream migrating juvenile spring-run Chinook salmon and steelhead into the fish ladders, and thereby reduce physical injury and potential mortality from spilling over the dam, and potentially reduce predation due to disorientation in the plunge pool below the dam.

Implementation of voluntary conservation measures would: (1) expand suitable spawning habitat in the Englebright Dam Reach for spring-run Chinook salmon and steelhead, and may encourage additional behavioral segregation of spawning spring-run Chinook salmon; and (2) provide additional LWM and corresponding habitat complexity and diversity (and therefore predator escape cover, velocity shelter, feeding stations) for rearing juvenile spring-run Chinook salmon and steelhead, relative to the pre-action Environmental Baseline conditions.
In addition, the Proposed Action will not increase the long-term risks to green sturgeon because the Proposed Action will not introduce new stressors or substantially exacerbate ongoing stressors. Within the Action Area, the one known stressor to green sturgeon is Daguerre Point Dam, which was not designed to provide for green sturgeon passage upstream of the dam. However, the Proposed Action would not affect green sturgeon in the lower Yuba River because stressors on green sturgeon associated with Daguerre Point Dam are part of the Environmental Baseline. Consequently, the Proposed Action will not result in increased harm to the species over pre-action Environmental Baseline conditions in the Action Area of the lower Yuba River.

8.1.1 Incidental Take Considerations

Under the Federal ESA, take is defined as “…to harm, harass, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct" [ESA§3(19)]. Harass, pursue, hunt, shoot, wound, kill, trap, capture or collect can be classified as actions that would have a direct effect on a species, at the individual level. Conversely, harm, which is a form of take, is further defined to include “…significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering” (USFWS and NMFS 1998).

8.1.1.1 Sediment Management

There is some potential that sediment excavation activities directly upstream of Daguerre Point Dam may interfere with the egress of adult individuals from the fish ladders, causing temporary behavioral alteration. Sediment excavation also may result in temporary behavioral alteration of spring-run Chinook salmon and steelhead juvenile rearing and downstream migration. These potential temporary behavioral alterations could be considered to represent "harassment" as a form of take. Additionally, there is the more remote possibility of physical injury or direct mortality to juveniles from being contacted by the excavator bucket. Consequently, implementation of the sediment management plan has the limited potential to result in minor amounts of "take" of adult and juvenile spring-run Chinook salmon and steelhead individuals. Overall, however, the
long-term benefits to listed anadromous salmonids resulting from continued
implementation of sediment management activities at Daguerre Point Dam are expected
to outweigh any potential occurrences of incidental take (or harm) that may occur to
individual fish during sediment excavation activities. Therefore, the sediment
management component of the Proposed Action represents an overall beneficial effect,
but the Corps has determined that this component "may affect, is likely to adversely
affect" because of the remote possibility of low amounts of incidental take of spring-run
Chinook salmon and steelhead.

8.1.1.2 Flashboard Management

The Daguerre Point Dam Flashboard Management Plan was developed to benefit spring-
run Chinook salmon and steelhead by improving the ability of adult fish to locate the fish
ladders and migrate upstream to spawning and rearing habitats. Ancillary benefits
include directing downstream migrating juvenile spring-run Chinook salmon and
steelhead into the fish ladders, and thereby avoiding physical injury and potential
mortality from spilling over the dam, and potentially increased predation due to
disorientation in the plunge pool below the dam.

There is a potential that the flashboards may collect debris that have an associated limited
potential to entrap downstream migrating spring-run Chinook salmon and steelhead,
which might contribute to juvenile fish mortality. However, the plan specifies that the
flashboards will be monitored at least once per week, and perhaps as frequently as daily
in conjunction with CDFW and/or PSMFC monitoring of the VAKI systems, and that all
adjustments to the flashboards will be made as necessary in coordination with NMFS and
CDFW. During the period that flashboards are installed, the flashboards will be cleared
within 24 hours of finding a blockage, or as soon as it is safe to clear them. Further,
flashboards will be removed within 24 hours, if directed by the Corps, NMFS or CDFW.
Consequently, implementation of the flashboard management plan has the limited
potential to result in temporary, minor amounts of "take" of juvenile spring-run Chinook
salmon and steelhead individuals. Overall, however, the long-term benefits to listed
anadromous salmonids resulting from continued implementation of flashboard
management at Daguerre Point Dam are expected to outweigh any potential occurrences
of incidental take (or harm) that may occur to individual fish during flashboard installation, operation and removal activities. Therefore, the flashboard management component of the Proposed Action represents an overall beneficial effect, but the Corps has determined that this component "may affect, is likely to adversely affect" because of the remote possibility of low amounts of incidental take of juvenile spring-run Chinook salmon and steelhead.

8.1.1.3 Debris Maintenance and Removal

For this Proposed Action, debris maintenance and removal activities and maintenance of the VAKI Riverwatcher in the fish ladders at Daguerre Point Dam could temporarily disrupt adult spring-run Chinook salmon and steelhead undisturbed upstream migration behavior and be considered as a form of harassment. In addition, there is a remote possibility that juvenile spring-run Chinook salmon or steelhead could be within the bays of the fish ladders during debris maintenance activities. Consequently, there is a corresponding remote possibility that physical harm or mortality could occur to individual fish, which could represent minor amounts of "take" of adult and juvenile spring-run Chinook salmon and steelhead individuals, on a temporary basis. Overall, however, the long-term benefits to listed anadromous salmonids resulting from continued implementation of debris maintenance and removal at Daguerre Point Dam are expected to outweigh any potential occurrences of incidental take (or harm) that may occur to individual fish during implementation. Therefore, the debris maintenance and removal component of the Proposed Action represents an overall beneficial effect, but the Corps has determined that this component "may affect, is likely to adversely affect" because of the remote possibility of low amounts of incidental take of spring-run Chinook salmon and steelhead.

8.1.1.4 Voluntary Conservation Measures

Some relatively minor amounts of take have the potential to result from the construction/implementation phases of the voluntary conservation measures. Gravel injection has the potential to result in disturbance of individuals due to noise and vibration. It also could result in physical injury or direct mortality of juvenile spring-run
Chinook salmon and steelhead, although it is likely that individuals would vacate the area during construction activities. Similarly, construction and placement of LWM features also have the potential to result in relatively minor amounts of take due to physical injury or direct mortality of juvenile spring-run Chinook salmon and steelhead. If it is necessary to use heavy equipment close to the river, there is a potential for noise and vibration to disturb spring-run Chinook salmon and steelhead. It is not likely that adults of either species would be directly or indirectly impacted due to natural avoidance behavior. Therefore, the voluntary conservation measures of the Proposed Action represents an overall beneficial effect, but the Corps has determined that these components "may affect, is likely to adversely affect" because of the remote possibility of low amounts of incidental take of spring-run Chinook salmon and steelhead.

Voluntary conservation measures are not likely to result in incidental take of green sturgeon, because these measures would be located several miles upstream of Daguerre Point Dam, which represents the upstream extent of the potential presence of green sturgeon in the lower Yuba River.

8.2 Critical Habitat

The Proposed Action will not adversely affect the critical habitat PCEs or their management in a manner likely to appreciably diminish or preclude the role of that habitat in the recovery of the Central Valley spring-run Chinook salmon and steelhead.

The Proposed Action will not increase the risks to the spring-run Chinook salmon or steelhead critical habitat because it will improve pre-action Environmental Baseline conditions in the lower Yuba River. Specific conservation measures will increase the suitability and availability of critical habitat for spring-run Chinook salmon and steelhead in the lower Yuba River through the ongoing implementation of a gravel augmentation program in the Englebright Dam Reach, as well as development of a LWMMP for the lower Yuba River.

The Cumulative Condition would generally result in seasonal flow increases upstream of Daguerre Point Dam (as measured at the Smartsville Gage) and seasonal flow decreases
downstream of Daguerre Point Dam (as measured at the Marysville Gage), primarily
during the summer months of July, August and September. Seasonal reductions in flow
under the Cumulative Condition would have the greatest potential to affect juvenile
spring-run Chinook salmon and steelhead rearing habitat suitability through resultant
changes in water temperature. However, analyses of both monthly mean flow- and water
temperature-related changes under the Cumulative Condition, relative to the current
conditions, would not be anticipated to adversely affect any of the spring-run Chinook
salmon or steelhead lifestages in the lower Yuba River.

Green sturgeon critical habitat in the lower Yuba River extends from Daguerre Point
Dam downstream to the confluence with the lower Feather River. A unique specific PCE
essential for the conservation of the Southern DPS of North American green sturgeon is
deepwater pool habitat. The Proposed Action will not adversely affect the critical habitat
PCEs or their management in a manner likely to appreciably diminish or preclude the role
of that habitat in the recovery of green sturgeon.

The relatively minor seasonal flow reductions under the Cumulative Condition relative to
the current conditions would be expected to result in corresponding minor reductions in
deepwater pool depth and habitat availability below Daguerre Point Dam. During low
flow conditions, deepwater pool habitat availability under the Cumulative Condition
would be essentially equivalent during all months of the evaluation period, relative to the
current conditions. Minor flow-related changes to depth or areal extent of deepwater
pool habitat under the Cumulative Condition relative to the current conditions indicate no
substantive effects to the unique specific PCE of deepwater pool habitat associated with
green sturgeon critical habitat in the lower Yuba River. Moreover, minor changes in
water temperatures under the Cumulative Condition relative to the current conditions
indicate no substantive effects for any of the green sturgeon lifestages in the lower
Yuba River.

8.3 Conclusions and Determinations

Conclusions and determinations take into account both the magnitude and probability of
occurrence of effects to listed species and their habitats resulting from the Proposed

“Insignificant effects relate to the size of the impact, and should never reach the scale
where take occurs. Discountable effects are those extremely unlikely to occur.”

In consideration of the foregoing effects assessments, because some incidental take
potentially could occur as a result of the Proposed Action, the Corps concludes that the
the Proposed Action “may affect, and are likely to adversely affect” Central Valley
spring-run Chinook salmon and steelhead. Potential adverse effects to critical habitat of
spring-run Chinook salmon and steelhead in the Action Area due to the Proposed Action
are expected to be discountable and/or insignificant.

As previously discussed, other than infrequent adult occupancy, no other lifestage of
green sturgeon has ever been reported in the lower Yuba River. The ongoing stressors
associated with Daguerre Point Dam’s blockage of green sturgeon are due to the presence
of the dam and configuration of the fish ladders, so they are part of the Environmental
Baseline. The Corps does not currently have the authority to lessen the potential
passage/blockage effects from these structures on green sturgeon.

The Proposed Action primarily includes physical activities within the fish ladders at
Daguerre Point Dam and actions upstream. The LWMMP (Corps 2012d) reports that
LWM placement sites are located in the approximate 4-mile reach of the lower Yuba
River downstream of the Highway 20 Bridge, often referred to as the Parks Bar to
Hammon Bar Reach, and that additional sites upstream of the Highway 20 Bridge also
may be considered. Thus, LWM placement sites are located several miles upstream of
Daguerre Point Dam. The only physical activities downstream of Daguerre Point Dam
include placement of excavated sediment above the waterline along the shore
approximately 1/4 mile downstream of Daguerre Point Dam. Physical injury or direct
mortality to listed species associated with excavated sediment placement is not expected
to occur. The foregoing effects evaluations indicate that potential adverse effects to
critical habitat of green sturgeon in the Action Area due to the Proposed Action are
expected to be discountable and/or insignificant. Therefore, the Corps concludes that the
Proposed Action “may affect, but is not likely to adversely affect” green sturgeon and its
critical habitat.
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10.0 Literature Cited


Bergman, P., S. Cramer, and J. Melgo. 2013. Summary of 2012 Fish Studies at the South Yuba-Brophy Diversion Headworks, Yuba River. Prepared for the South...
YubaWater District, BrophyWater District, Dry Creek Mutual Water Company, and the WheatlandWater District. May 2013.


California RWQCB. 2001. Draft Staff Report on Recommended Changes to California’s Clean Water Act, Section 303(d) List.


CDFG. 2002. California Department of Fish and Game Comments to NMFS Regarding Green Sturgeon Listing.


Corps. 2004. Harry L. Englebright Dam Yuba River, California Periodic Inspection and


Corps. 2007a. Biological Assessment for Daguerre Point and Englebright Dam.


June 2008.


Corps. 2009. Daguerre Point Dam Fish Passage Sediment Management Plan.
February 2009.

Corps. 2011. Photos: Installation of Metal Grades on the Daguerre Point Dam Fish
Ladder Bays During August 2011.

Memorandum on Record. August 31, 2012.

Corps. 2012a. Biological Assessment for the U. S. Army Corps of Engineers Ongoing
Operation and Maintenance of Englebright Dam and Reservoir, and Daguerre
Point Dam on the Lower Yuba River. January 2012.

Corps. 2012b. Attachment 1 (U.S. Army Corps of Engineers, Sacramento District
Itemized Comments on the NMFS’ February 2012 Final Jeopardy Biological
Opinion on the Lower Yuba River) of the Corps Response Letter to NMFS

Corps. 2012c. Photographs of the North and South Fish Ladders at Daguerre Point Dam.


Abundance, Behavior, and Habitat Utilization by Coho Salmon and Steelhead  
Trout in Fish Creek, Oregon, as Influenced by Habitat Enhancement. U.S. Forest  

Evermann, B. W. and H. W. Clark. 1931. A Distribution List of the Species of  
Freshwater Fishes Known to Occur in California. Division of Fish and Game of  
California. Fish Bulletin No. 35.  


FERC. 1992. Environmental Assessment for Hydropower License for the Narrows  
Project. FERC Project No. 1403-004. Washington, D.C.  

FERC. 2001. Draft Biological Evaluation. FERC Project Numbers 2246, 6780, 1403, and  
2266, Yuba River, California. Washington, D. C.  

FERC. 2005. Final Biological and Conference Opinion Regarding the Yuba River  
Development Project License Amendment (FERC No. 2246) for the Narrows II  

Available at www.sfgate.com.  

Fisher, F. W. 1992. Chinook Salmon (Oncorhynchus tshawytscha) Growth and  
Occurrence in the Sacramento-San Joaquin River System. Inland Fisheries  
Division, California Department of Fish and Game.  

Fontaine, B. 1988. Biological Evaluation of Fish Habitat Improvement Projects. In: A  
Training in Stream Habitat Rehabilitation. Oregon American Fisheries Society,  
Portland, Oregon.  

Foothills Water Network. 2009. Foothills Water Network Comments on Licensees’  
Revised Study Plan for Drum-Spaulding and Yuba-Bear Projects. February 9,  
2009.


Garza, J. C. and D. E. Pearse. 2008. Population Genetic Structure of *Oncorhynchus mykiss* in the California Central Valley. Final Report for California Department of Fish and Game Contract # PO485303 with University of California, Santa Cruz and NOAA Southwest Fisheries Science Center.


Keleher, C. J. and F. J. Rahel. 1996. Thermal Limits to Salmonid Distributions in the Rocky Mountain Region and Potential Habitat Loss Due to Global Warming: A


Moyle, P. B., R. M. Yoshiyama, J. E. Williams, and E. D. Wikramanayake. 1995. Fish Species of Special Concern in California. 2nd Edition. California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, California.


NAFWB. 2004. Memorandum from NAFWB to B. Curtis Regarding Water Velocity Measurements at Gravel Dike, South Yuba Brophy Diversion, Yuba River.


NMFS. 2001. Final Biological Opinion Concerning the Effects of Operations of Englebright Dam and Daguerre Point Dam on the Yuba River, California, the Threatened Central Valley Spring-Run Chinook Salmon (Oncorhynchus tshawytscha), the Central Valley Steelhead (O. mykiss), and Their Respective Designated Critical Habitats. SWR-01-SA-6020:MET. U.S. Department of Commerce.

NMFS. 2002. Biological Opinion on the Effects of the Corps’ Operation of Englebright Dam and Daguerre Point Dam on the Yuba River, in Yuba and Nevada Counties, California, on the Threatened Central Valley Spring-Run Chinook Salmon (Oncorhynchus tshawytscha), the Central Valley Steelhead (O. mykiss) and Their Respective Designated Critical Habitats. March 27, 2002.


NMFS. 2005a. Biological Opinion Based on Review of the Proposed Yuba River Development Project License Amendment for Federal Energy Regulatory Commission License Number 2246, Located on the Yuba River in Yuba County, California, and Its Effects on Threatened Central Valley Spring-Run Chinook Salmon (Oncorhynchus tshawytscha) and Central Valley Steelhead (O. mykiss), in Accordance With Section 7 of the Endangered Species Act of 1973, As Amended.


NMFS. 2010b. Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the State Route 520 Pontoon Construction Project, Grays Harbor County, Washington (Grays Harbor, HUC 17100105). October 2010.


NMFS. 2011a. NOAA’s National Marine Fisheries Service’s Requests for Information or Study, Comments on the Applicant’s Preliminary Application Document, and
Comments on the Commission’s Public Scoping Meeting and Scoping Document
1, Yuba River Development Project, Project No. 2246-058. Letter to YCWA.

NMFS. 2011b. 5-Year Review: Summary and Evaluation of Central Valley Spring-Run
Chinook Salmon ESU. Central Valley Recovery Domain. National Marine
Fisheries Service, Southwest Region.

NMFS. 2011c. 5-Year Review: Summary and Evaluation of Central Valley Steelhead
DPS. Central Valley Recovery Domain. National Marine Fisheries Service,
Southwest Region.


NMFS. 2012. Final Biological Opinion on the U.S. Army Corps of Engineers’ Continued
Operation and Maintenance of Englebright Dam and Reservoir, Daguerre Point
Dam, and Recreational Facilities On and Around Englebright Reservoir. February
29, 2012.

NMFS and CDFG. 2001. Final Report on Anadromous Salmon Fish Hatcheries in

Nobriga, M. L. and P. Cadrett. 2003. Differences Among Hatchery and Wild Steelhead:
Evidence from Delta Fish Monitoring Programs. Interagency Ecological Program

Ecology in an Altered River Delta: Spatial Patterns in Species Composition, Life

Sensitivity to Climate Warming in California’s Sierra Nevada. PLoS ONE.
Volume 5(4).

Oreskes, N. 2004. Beyond the Ivory Tower: The Scientific Consensus on Climate


Raleigh, R. F., W. J. Miller, and P. C. Nelson. 1986. Habitat Suitability Index Models and 
Instream Flow Suitability Curves: Chinook Salmon. U.S. Fish and Wildlife 
Service.

Reclamation. 2008. Biological Assessment on the Continued Long-Term Operations of 
the Central Valley Project and the State Water Project. August 2008.

Reclamation. 2008a. Increasing Juvenile Fish Capture Efficiency at the Tracy Fish 
Collection Facility: An Analysis of Increased Bypass Ratios During Low Primary 
Velocities. Tracy Fish Collection Facility Studies, California. Volume 35. 

Reclamation. 2008b. Record of Decision on Final Environmental Impact Statement for 
Fish Passage Improvement Project at the Red Bluff Diversion Dam. Central 
Valley Project, California, Mid-Pacific Region. July 2008.

Reclamation and SJRGA. 1999. Meeting Flow Objectives for the San Joaquin River 
Agreement 1999-2010 Final Environmental Impact Statement and Environmental 
Reclamation, Sacramento, California, and San Joaquin River Group Authority, 

Reclamation, DWR, USFWS, NMFS, CDFG. 2004. Environmental Water Account Final 
Camp, Dresser and McKee, and Surface Water Resources, Inc. State 

USDA, Forest Service, Pacific Northwest and Range Experiment Station, 


– April 27, 2009.


Shapovalov, L. and A. C. Taft. 1954. The Life Histories of the Steelhead Rainbow Trout 
(*Salmo gairdneri gairdneri*) and Silver Salmon (*Oncorhynchus kisutch*) with 
Special Reference to Waddell Creek, California, and Recommendations 
Regarding Their Management. California Department of Fish and Game. Fish 
Bulletin Number 98.


Slater, D. W. 1963. Winter-Run Chinook Salmon in the Sacramento River, California, 
with Notes on Water Temperature Requirements at Spawning. U.S. Fish and 

SMGB. 2010. Approval of an Interim Management Plan for the Marysville Facility (CA 
Mine ID #91-58-0019), Teichert Aggregates (Operator), Ms. Lillie Noble 
(Agent), County of Yuba. Agenda Item Number 3 for Meeting Date: July 8, 2010. 
State Mining and Geology Board Executive Officer’s Report.

Floodplain Rearing of Juvenile Chinook Salmon: Evidence of Enhanced Growth 
and Survival. Canadian Journal of Fisheries and Aquatic Sciences 58: 325-333.

Sommer, T., C. Armor, R. Baxter, R. Breuer, L Brown, M. Chotkowski, S. Culberson, F. 
Feyrer, M. Gingras, B. Herbold, W. Kimmerer, A. Mueller-Solger, M. Nobriga, 
and K. Souza. 2007. The Collapse of Pelagic Fishes in the Upper San Francisco 

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An Ecosystem 
Corvallis, OR: ManTech Environmental Research Services Corp.

National Marine Fisheries Service, et al., Defendants. United States District Court 


SWRCB. 2001. Decision Regarding Protection of Fishery Resources and Other Issues Relating to Diversion and Use of Water from the Lower Yuba River.


Yuba County. 2007. Project Detail: Browns Valley Irrigation District. Project WQ1 – Agricultural Return Flow Recapturing Project.

Yuba County, Sutter County, Yuba City, City of Live Oak, City of Wheatland, CDFG, and USFWS. 2011. Planning Agreement by and Among the County of Yuba, the County of Sutter, the City of Yuba City, the City of Live Oak, the City of Wheatland, the California Department of Fish and Game, and the United States Fish and Wildlife Service Regarding the Yuba-Sutter Natural Community Conservation Plan and Habitat Conservation Plan. November 2011.


**Personal Communications**


Yuba Accord Project Team, HDR/SWRI, Sacramento, CA, regarding ditch operations, especially during groundwater pumping and water transfer years. April 25, 2006.


