Long-Term Operation – Biological Assessment

Appendix AB-M – Folsom Reservoir Flow and Temperature Management

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Appendix M Folsom Reservoir Flow and Temperature Management

M.1 Introduction

Folsom Reservoir flow and temperature management address the tradeoffs for minimum releases and the use of available cold water pool in Folsom Reservoir for water supply, power production and steelhead and fall-run Chinook salmon in the American River.

M.2 Initial Alternatives Report

An Initial Alternative Report (*LTO 2021 Consultation Initial Alternatives Appendix M – Folsom Reservoir Flow and Temperature Management 20220127 DRAFT*) developed potential options for the long-term operation (LTO) of the Central Valley Project (CVP) and State Water Project (SWP) to inform alternative formulation by seeking the bounds of potential decisions and a contrast between approaches. Initial alternative options generally considered flow actions, non-flow actions, and the use of real-time information. Management questions, analyses, and findings provided information for public draft Environmental Impact Statement (EIS) alternatives.

M.2.1 Management Questions

United States Department of the Interior, Bureau of Reclamation's (Reclamation) management questions to inform the formulation of alternatives included:

- What habitat is created for steelhead and fall-run Chinook salmon at different releases?
- What is the additional water temperature capability at different storage levels?
- How does planning minimum storage for both the end of September and the end of December improve potential cold water habitat?
- What planning-minimum reservoir storage maintains water supply intakes in Folsom Reservoir?
- What risks occur from operating to a 50% exceedance forecast early in the water year?
- What water temperature targets reasonably protect steelhead, while leaving sufficient cold water for fall-run Chinook salmon?
- How do releases on the American River affect Shasta Reservoir, the *Bay–Delta Water Quality Control Plan* (Bay-Delta WQCP), and exports?

M.2.2 Initial Analyses

Reclamation completed a literature and data review regarding Folsom operations related to redd dewatering and stranding.

M.2.3 Initial Findings

Folsom Reservoir flow and temperature management address the tradeoffs for minimum releases and the use of the available cold water pool for water supply and steelhead and fall-run Chinook salmon in the American River. The alternatives analyzed and compared the effects of American River operations in the No Action Alternative to Alternative 1, Alternative 2, and Alternative 3. The CalSim II and HEC-5Q models were used to conduct the analysis for the flows and temperature elements of cold water pool management for Folsom Reservoir. Assumptions were made based on criteria for the current Folsom Reservoir flow and temperature conditions, regulatory requirements and projection for future conditions.

The Alternatives for Folsom flow and temperature management focus on analyzing changes to the Modified Flow Management Standard (MFMS) by adjusting the end-of-December carryover target and the MFMS Minimum Required Release.

M.3 Public Draft Environmental Impact Statement Scenarios

Under the National Environmental Policy Act, Reclamation compares action alternatives to a "no action" alternative. Under the Endangered Species Act, Reclamation's discretionary actions over an environmental baseline determine the effects on listed species.

M.3.1 Run of River

[Placeholder]

M.3.2 No Action

[Placeholder]

M.3.3 Alternative 1 – WQCPs

[Placeholder]

M.3.4 Alternative 2 – Multi-Agency Consensus

[Placeholder]

M.3.5 Alternative 3 – Modified Natural Hydrograph

[Placeholder]

M.3.6 Alternative 4 – Reservoir Flexibility

[Placeholder]

M.4 Performance Metrics

Performance metrics describe criteria that can be measured, estimated, or calculated relevant to informing trade-offs for alternative management actions.

M.4.1 Biological

Biological metrics consider direct observations and environmental surrogates.

- Days of 65 degrees Fahrenheit (°F) or lower water temperature at Watt Avenue, starting from May through September for steelhead juveniles
- Days of 56° or lower water temperature at Watt Avenue starting from mid-October through December for fall-run Chinook salmon spawning
- Juvenile survival probability downstream of Watt Avenue
- Juvenile survival probability to Chipps Island
- Redd dewatering numbers

M.4.2 Water Supply

Water supply metrics consider the multipurpose beneficial uses of Folsom Reservoir.

- North-of-Delta agricultural deliveries (average and critical/dry years)
- South-of-Delta agricultural deliveries (average and critical/dry years)
- State Water Resources Control Board Water Right Decision 1641 (D-1641) standards
- Flood conservation pool releases ("spills")

CalSim II would support the evaluation of water supply metrics.

M.4.3 NEPA Resources

Analysis of the range of alternatives, as required by the National Environmental Policy Act, is anticipated to describe changes in multiple resource areas. Key resources are anticipated to include surface water supply, water quality, power, aquatic resources, terrestrial biological resources, regional economics, land use and agricultural resources, recreation, cultural resources, socioeconomics, environmental justice, and climate change.

M.5 Methods

Reclamation solicited input from the stakeholders and agencies for the knowledge base paper focused on steelhead biology and life-history expression (Steelhead Juvenile Production Estimate). Reclamation identified the following datasets, literature, and models to help in evaluating Folsom reservoir flow and temperature management.

M.5.1 Datasets

Several efforts to characterize historical and ongoing steelhead monitoring programs in the California Central Valley have been completed over the past two decades. A few years after the completion of the Central Valley Steelhead Monitoring Plan, a series of related monitoring projects, identified as the Central Valley Steelhead Monitoring Program (CVSMP), were initiated on the Sacramento River and its tributaries (Fortier et al. 2014).

- Annual American River steelhead spawning survey reports completed mostly annually since 2002.
- Annual American River Chinook salmon escapement survey reports
- CalFish (2019). CalFish – A California cooperative anadromous fish and habitat data program. Middle Sacramento River salmon and Steelhead monitoring. Available: https://www.calfish.org/ProgramsData/ConservationandManagement/CentralValleyMonitoring/SacramentoValleyTributaryMonitoring/MiddleSacramentoRiverSalmonandSteelheadMonitoring.aspx.
- SacPAS: Central Valley Prediction & Assessment of Salmon provides a platform for data queries of juvenile steelhead salvage and loss. Available: http://www.cbr.washington.edu/sacramento/data/juv_salvage_loss.html.
- Use CalFishTrack to understand juvenile steelhead routing and survival into the Delta. https://oceanview.pfeg.noaa.gov/CalFishTrack/.
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- https://www.waterforum.org/habitat2022/
- https://www.waterforum.org/the-river/habitat-management/
- https://www.waterforum.org/wp-content/uploads/2020/09/18-1027_LAR_Salmonid_Rearing_Site_ID_Report_FINAL_2020-08-31.pdf

M.5.2 Literature

The documents listed below were compiled from the 2019 Biological Opinions, 2020 ITP, fact sheets produced for the February 2021 joint Delta Science Program – U.S. Bureau of Reclamation Steelhead Workshop, and a Google Scholar search.

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M.5.3 Models

Models support testing alternative operations and predicting environmental responses. The following models were available to Reclamation and relevant to addressing management questions:

M.5.3.1 Water Operations

CalSim II is a generalized reservoir-river basin simulation model that allows for specification and achievement of user-specified allocation targets, or goals (Draper et al. 2004). CalSim II represents the best available planning model for CVP and SWP system operations and has been used in previous system-wide evaluations of CVP and SWP operations (Bureau of Reclamation 2015). Reclamation and California Department of Water Resources (DWR) are advancing CalSim 3, but the model was not ready for these purposes.

M.5.3.2 Temperature

HEC-5Q is a reservoir routing and temperature model. Over the past 15 years, various temperature models were developed to simulate temperature conditions on the rivers affected by CVP and SWP operations (e.g., Sacramento River Water Quality Model [SRWQM] San Joaquin River HEC-5Q model) (Bureau of Reclamation 2008). Recently, these models were compiled and updated into a single modeling package referred to here as the HEC-5Q model. Further updates were performed under the LTO EIS modeling that included improved meteorological data and subsequent validation of the Sacramento and American River models, implementation of the Folsom Temperature Control Devices and low-level outlet, implementation of the Trinity auxiliary outlet, improved temperature targeting for Shasta and Folsom Dams, as well as improved documentation and streamlining of the models and improved integration with the CalSim II model (Bureau of Reclamation 2015). A summary of previous model calibration and validation details can be found at the following link: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/petitioners_exhib

it/dwr/part2/DWR-1084%20RMA%202003%20SRWQM.pdf. Reclamation is developing an updated water temperature modeling platform, but the model is not yet available for broad use.

M.6 Lines of Evidence

Reclamation's management questions for the formulation of an alternative include the following.

M.6.1 Habitat Suitability

Steelhead and fall-run Chinook salmon experience optimal flows for spawning at approximately 2000 cfs in the lower American River (USFWS 2003). However, close to 80% of the maximum spawning habitat is still available to these species at flows of 800 cfs to just over 3500 cfs. Below 800 cfs, spawning habitat availability drops off precipitously. Likewise, low flows may be problematic for rearing habitat. Yearling steelhead are found in bar complex and side channel areas characterized by habitat complexity in the form of velocity shelters, hydraulic roughness elements, and other forms of cover (Surface Water Resources Inc. 2001). At low flow levels, the availability of these habitat types becomes limited, forcing juvenile steelhead densities to increase in areas that provide less cover from predation. With high densities in areas of relatively reduced habitat quality, juvenile steelhead become more susceptible to predation as well as disease.

Not only is the magnitude of releases important to salmonid habitat, but fluctuations in flow in the lower American River have been documented to result in steelhead redd dewatering and isolation (American River Group 2017; American River Group 2018; Hannon and Deason 2008; Hannon et al. 2003; Water Forum 2005). Redd dewatering can affect salmonid eggs and alevins by impairing development and causing direct mortality due to desiccation, insufficient oxygen levels, waste metabolite toxicity, and thermal stress (Becker et al. 1982; Reiser and White 1983). Isolation of redds in side channels can result in direct mortalities due to these factors, as well as starvation and predation of emergent fry. Isolation of juvenile fish exposes individuals to warm water temperatures and fish and avian predation within habitats that are disconnected from the river, likely increasing their mortality risk. If the isolated habitat is not reconnected to the river with a subsequent increase in river stage, all steelhead in that habitat are assumed to die.

M.6.2 Temperature and Storage Levels

Modeling is under development.

Figure M-1 and Figure M-2 show the degree days above a May through October temperature target of 65°F at Watt Avenue Watt Avenue as a function of Folsom end-of-April and end-of-September storage level.

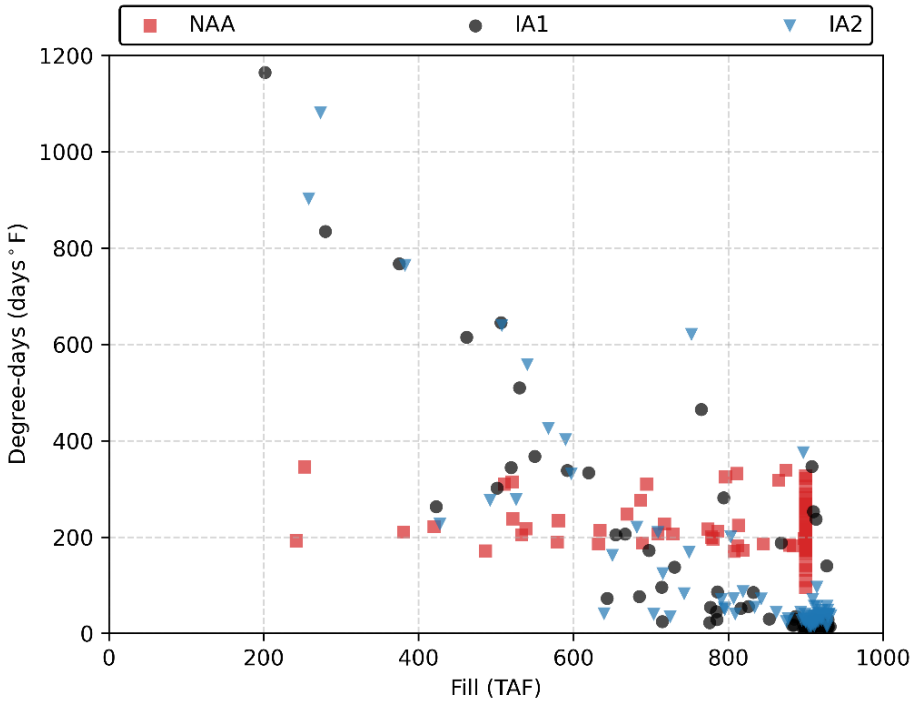

Figure M-1. Degree Days above the Temperature Target as a function of Folsom End-of-April Storage.

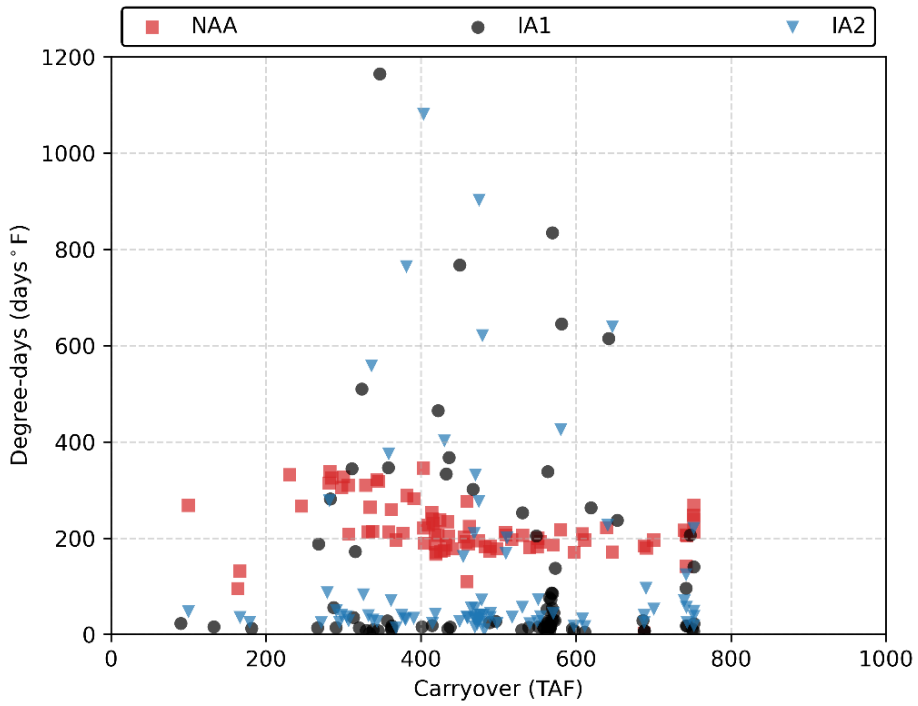

Figure M-2. Degree Days above the Temperature Target as a Function of Folsom September Carryover Storage.

M.6.3 Storage Planning Minimum and Coldwater Bypasses

Saving water over the summer until the fall period with implementation of planning minimums for end of September and end of December storage provides opportunity to provide cooler fall water temperatures. Cooler fall water temperature increases survival for juvenile steelhead rearing and for adult steelhead entering the river in the fall. Cooler water in the fall will reduce temperature related stress on holding Chinook salmon and increase survival for those eggs spawned prior to around the Thanksgiving time period. After about Thanksgiving, environmental cooling results in water temperature reaching and then dropping below 56 F. Egg survival is highest in water below 56 F at spawning time and then cooling through the winter period.

Cold water bypasses have occurred in the fall to reduce overall temperature of Folsom Dam releases. Cold water bypasses may (1) reduce prespawn mortality in fall-run Chinook salmon, (2) reduce fall-run Chinook salmon egg mortality, and (3) provide more suitable temperatures for hatchery operations. By releasing water from the lower river outlet at elevation approximately 210 feet (lowest elevation is 205.5 feet and highest elevation is 214.5 feet, average elevation is 210 feet) rather than through the powerplant penstocks, which pull from approximate elevation of 389 feet, it may reduce warm temperatures released into the lower American River. Fall releases of warmer water have been occurring more frequently since cold water accessed through the Folsom Shutters is used primarily for summer cold water releases for fisheries benefit. Summer cold water releases occur to maintain suitable rearing habitat for juvenile Central Valley (CV) steelhead.

In water year 2021, Reclamation used a cold water bypass by bypassing up to 350 cfs through the lower river outlet rather than the powerplant to target downstream temperatures close to 60°F. This bypass started on October 11 and ended on December 5, when destratification resulted in similar temperatures across reservoir elevations. All cold water was used during the bypass.

In water year 2022, Reclamation used a cold water bypass by bypassing up to 500 cfs through the lower river outlet rather than through the Folsom powerplant to target downstream temperatures. This bypass lasted from October 11 through November 26, 2022, resulting in 28,711 acre-feet bypassed, $641,852 daily weighted MWh hydropower not realized, and 5,180 tons of CO_2 production caused by replacement power.

The end of December storage planning minimum provides some insurance that in a critically dry winter there will be a level of storage left in the reservoir to provide operational flexibility to provide cooler water through the following summer than would otherwise be possible.

M.6.4 Planning Minimum and Water Supply Intakes in Folsom Reservoir

Modeling is under development.

At storage levels below 90,000 AF, the water level falls below the water supply intakes at Folsom Dam and El Dorado Hills, thereby preventing local water agencies from making critical water deliveries.

M.6.5 50% exceedance forecast early in the water year

See Attachment M.1, *Folsom Flow and Temperature Management Analysis*.

M.6.6 Effects of Releases on the American River to Shasta Reservoir, the Bay-Delta Water Quality Control Plan, and exports

See Attachment M.1 – Folsom Flow and Temperature Management Analysis

M.6.7 Historic Steelhead Redd Dewatering

Steelhead redd surveys were conducted in the American River and results reported in annual steelhead reports (Hannon et al. 2003; Hannon and Deason 2004, 2005, 2007; Chase 2010; Hannon 2013; Sellheim 2015, 2016, 2019, 2020; Sweeney 2017, 2021, 2022; Scrivin 2018). Steelhead redd dewatering was detected in the Sunrise side channel in 2003-2005, with 5 steelhead redds dewatered in each of 2003 and 2004 and 4 redds dewatered in 2005. Flow management and habitat modification completed in 2008 resolved the dewatering in that location, and dewatering has not been documented on the American River in subsequent reports.

M.6.8 Historic Steelhead Juvenile Stranding

Juvenile stranding surveys were conducted in the American River and results reported in annual reports in 2015 – 2022 (Sellheim 2015, 2016, 2019, 2020; Sweeney 2017, 2021, 2022; Scrivin 2018; Table 2). Cramer Fish Sciences conducted the stranding surveys under contract with Reclamation. The 2015 and 2016 surveys documented visual counts of juvenile salmonids stranded in disconnected pools and no attempts were made to move stranded fish back into the main channel. Surveys in 2017-2022 were conducted with assistance from California Department

of Fish and Wildlife to include seining the isolated pools and the stranded fish were moved to the main river channel. During the seining surveys salmonids were identified to species (steelhead or Chinook) and counted before being released into the main channel. Mortalities were enumerated when observed during the surveys.

Table M-1. Juvenile Salmonid Stranding Survey Results in the American River

Year	Species	Stranding Events	Effort (survey days)	Stranding Mortalities	Rescued	Notes
2022	Steelhead	1	6	233	8,164	-
2021	Steelhead	2	4	-	25	-
2020	Steelhead	2	5	-	35	-
2019	Steelhead	5	9	1	273	-
2018	Steelhead	6	8	-	370	-
2017	Steelhead	7	14	-	22	-
2016	Salmonids	3	5	1,595	-	mortalities not specified - no fish salvage attempts
2015	Salmonids	3	4	4,226	-	mortalities not specified - no fish salvage attempts

M.7 Uncertainty

There are no identified LTO special studies to reduce uncertainty regarding CVP operations on the American River.

M.8 References

Literature referenced for Folsom Reservoir Flow and Temperature Management are listed in Section M.5.2. Additional references cited or used for informational material in the document are included below.

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