Long-Term Operation – Biological Assessment

Appendix N – New Melones Stepped Release Plan

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Appendix N New Melones Stepped Release Plan

N.1 Introduction

The New Melones Stepped Release Plan addresses the volume of instream flows that can occur over a multi-year hydrology without affecting reservoir levels to the extent of depleting the water pool to cause the release of warm water.

N.2 Initial Alternatives Report

N.2.1 Management Questions

The United States Department of the Interior, Bureau of Reclamation's (Reclamation) management questions for the formulation of an alternative include:

- What is the relationship between releases and downstream water temperatures?
- What reservoir storage levels result in the release of warm water?
- Does the long-term instream release result in storage levels that would result in the release of warm water that would affect salmonid survival?
- What risks occur from operating to a 75% exceedance forecast early in the water year?
- What hydrograph shape optimizes Central Valley steelhead anadromy and survival? Is there a flow intensity threshold to cue migration?
- What is the optimal pulse flow timing by water year type to increase salmonid survival, increase life history diversity, and contribute to successful spawning in the adult population? What migratory phenotypes (i.e., fry, parr, smolts) are more likely to survive under different flow regimes?
- How do releases on the Stanislaus River affect the Water Quality Control Plan (WQCP) and exports?

N.2.2 Initial Findings

What is the relationship between releases and downstream water temperatures?

- Modeling is under development.

What reservoir storage levels result in the release of warm water?

- Modeling is under development.

Does the long-term instream release result in storage levels that would result in the release of warm water that would affect salmonid survival?

- Modeling is under development.

What risks occur from operating to a 75% exceedance forecast early in the water year?

A sensitivity was run to analyze changes to New Melones operations if different forecast exceedances are used. The Stepped Release Plan uses the San Joaquin River Index to set flows and allocations. The forecasts are only different between February and April, so changes are limited. The 75% forecast is very similar to the final. February, when the forecast is most uncertain is when the forecast is likely to be different than the final water year type under the 75% forecast. Using the 90% forecast, which can reduce flows, results in consistently higher storage (since operations at New Melones are largely independent of storage, the additional storage can stay in the reservoir until evaporation or flood control increases reduce it).

What hydrograph shape optimizes steelhead anadromy and survival? Is there a flow intensity threshold to cue migration?

Spring pulse flows occurring during the steelhead outmigration period are designed to increase life history diversity by cuing anadromy and improving migratory habitat in the Stanislaus River, San Joaquin River, and southern Delta (Appendix C; National Marine Fisheries Service 2009). Spring pulses typically consist of multiple pulses that extend flow variability later into the season, allowing opportunities for broader salmonid outmigration timing. Higher flows cue outmigration, and can reduce water temperature and inundate more shallow-water habitat. Maximum pulse flows are generally constrained to 1,500 cubic feet per second (cfs) due to seepage concerns in agricultural lands adjacent to the Stanislaus River (Appendix C).

What is the optimal pulse flow timing by water year type to increase salmonid survival, increase life history diversity, and contribute to successful spawning adult population? What migratory phenotypes (i.e., fry, parr, smolts) are more likely to survive under different flow regimes?

Each year, several pulse flows occur to benefit different life stages of Central Valley steelhead and other salmonids, as specified by Action III.1.3 of the 2009 National Marine Fisheries Service Biological Opinion. The 2011 Reasonable and Prudent Alternatives Amendment to Action III.1.3 specifies that pulse flow timing, magnitude, and duration may be adjusted based on water year type, with longer durations of pulses and higher intensities of peaks during wetter years, and other adjustments based on a variety of other considerations (Table 4). Maximum pulse flows are generally limited to 1,500 cfs and a duration of 10 days due to seepage concerns in agricultural lands adjacent to the Stanislaus River (Table 4).

Fall pulse flows usually occur in October through early November prior to peak spawning by adults, and timing may vary based on environmental conditions to achieve suitable habitat (DO and temperature) conditions for migration and holding. These multi-peak (3-4 peaks) flow pulses are designed to attract adult Central Valley steelhead to the Stanislaus while deterring adults from spawning in areas that may be subsequently de-watered (National Marine Fisheries Service 2009; Appendix A).

Winter instability flows usually occur between January and February (may occur in both months) and may be timed to coincide with winter storms, as well as with emergence of fall-run Chinook fry. These flows are shaped to simulate winter storms, with rapidly increasing flows followed by slowly descending flows. Higher flows may inundate shallow water habitat, leading to benefits for rearing juvenile salmonids that may take refuge from predators and receive potential growth benefits from increased terrestrial inputs (Appendix B).

Spring pulse flows usually occur between April and June. These multi-peak (3-6 peaks) flow pulses are designed to increase flow variability to allow for a broader range of salmonid outmigration timing, increasing life history diversity. These flows are intended to cue anadromy of steelhead and outmigration of smolts and improve migratory habitat downstream, as well as convey outmigrating salmonids (smolts) more rapidly. Pulse flows may also inundate shallow water habitat, leading to benefits for rearing salmonids that may take refuge from predators and receive potential growth benefits (Appendix C).

Sturrock et al. (2020) found that greater flow volume and variability was associated with earlier outmigration, and thus a greater proportion of fish outmigrating as fry. Winter flows had a large impact on whether or not fry outmigrated downstream, with reduced winter flows leading to later salmon outmigration, composed of smaller numbers of larger fish, and ultimately leading to lower production. Annual abundances of emigrant per spawner were correlated with flow variability and mean rearing flows across all migratory phenotypes. In general, while fry and smolts were the more dominant phenotypes for outmigration, survival was higher for intermediate-sized (parr) fish outmigrating in the spring.

How do releases on the Stanislaus River affect WQCP and exports?

There are only small impacts to the WQCP and exports from the Stanislaus River Initial Alternatives.

N.3 Public Draft Environmental Impact Statement Scenarios

Under the National Environmental Policy Act (NEPA), Reclamation compares action alternatives to a “no action” alternative. Under the Endangered Species Act (ESA), Reclamation’s discretionary actions over an environmental baseline determine the effects on listed species. No single environmental baseline to evaluate the effects under ESA or impacts under NEPA. ESA requires a comparison to the environmental baseline which is informed by ROR and Alternative 1. NEPA requires a comparison to NA.

N.4 Performance Metrics

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

N.4.1 Biological

Fisheries metrics consider direct observations and environmental surrogates including:

- **Water Temperature for Juveniles and Eggs**
    - The survival temperature threshold for juvenile steelhead is less than or equal to 68 degrees Fahrenheit (°F) from May 1 to October 31.
    - The temperature threshold for steelhead egg incubation is less than or equal to 54°F from December 1 to May 31.

The steelhead on the Stanislaus River generally move upstream to spawn between July and March; juvenile steelhead out-migrate between January and June (National Marine Fisheries Service 2014). Reservoir releases combined with other environmental conditions will affect water temperature, dissolved oxygen level, and other habitat attributes that will influence the timing, condition and survival of eggs in the spawning redds. Decrease in flows generally results in warmer water temperatures in the winter; however, winter water temperatures are colder than adult migration temperature needs. The New Melones Stepped Release Plan promotes increased storage at New Melones Reservoir, which can help the development of a larger cold water pool. More cold water in the reservoir may help lower water temperatures downstream of Goodwin Dam, which would benefit steelhead in all life stages in the lower Stanislaus River.

The fisheries metrics address the volume of instream flows that can occur over a multi-year hydrology without affecting reservoir levels to the extent of depleting the cold water pool to cause the release of warm water.

N.4.2 Water Supply

Water supply metrics consider the multipurpose beneficial uses of New Melones including:

- Central Valley Project (CVP) water service contracts
- Senior water right holders (Oakdale Irrigation District and South San Joaquin Irrigation District)
- State Water Resources Control Board Water Right Decision 1641 standards and its dissolved oxygen requirement
- Flood conservation pool release

CalSim II would support the evaluation of water supply metrics.

N.4.3 National Environmental Policy Act Resources

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

N.5 Methods Selection

Reclamation solicited input from the stakeholders and agencies for the knowledge base paper (Steelhead Juvenile Production Estimate). Reclamation identified the following datasets, literature, and models to help in evaluating the New Melones Stepped Release Plan.

N.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, were initiated on the Sacramento River and its tributaries (Fortier et al. 2014). Appendix G provides pertinent information for the datasets for steelhead.

- 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. Available: https://oceanview.pfeg.noaa.gov/CalFishTrack/.

N.5.2 Literature

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

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N.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:

N.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 the California Department of Water Resources are advancing CalSim 3, but the model was not ready for these purposes.

N.5.3.2 Water 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 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 Long-Term Operation Environmental Impact Statement modeling that included improved meteorological data and subsequent validation of the Sacramento and Stanislaus 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: DWR-

1084 RMA 2003 SRWQM.pdf (ca.gov). Reclamation is developing an updated water temperature modeling platform, but the model is not yet available for broad use.

N.5.3.3 Weighted Usable Area

Weighted usable area (WUA) analysis is a well-established methodology used primarily for quantification of spawning and rearing habitat of fish species in rivers, streams, and floodplains (Bovee et al. 1998). WUA is computed as the surface area of physical habitat available for spawning or rearing, weighted by its suitability. Habitat suitability is determined from field studies of the distributions of redds or rearing juveniles with respect to flow velocities, depths, and substrate or cover in the river or floodplain (Bovee et al. 1998). These data are used in hydraulic and habitat model simulations (e.g., PHABSIM or RIVER2D) to estimate the availability of suitable habitat at a given flow. Habitat mapping is used to extrapolate the site-specific WUA data to a river reach scale. WUA curves showing suitable habitat availability versus flow are generated from the simulations. The WUA curves facilitate evaluating how different flow regimes affect spawning and rearing habitat of important fish species.

N.5.3.4 Area of Suitable Habitat

The Area of Suitable Habitat (ASH) methodology is a recently developed program of procedures designed to achieve most of the same objectives as addressed by the rearing WUA analysis procedures. The ASH procedures were designed in part to address a potential shortcoming of the WUA methodology: uncertainties in extrapolating its intensive, site-specific simulations of habitat conditions to a river reach scale. The ASH procedures include powerful remote sensing and GIS tools, including airborne LiDar, photogrammetry, and boat-mounted SONAR, to expand sampling effort. The cost of this expanded sampling effort is a loss of resolution in the physical data that can feasibly be collected and numerically modelled. The ASH procedure is new and little tested.

N.6 Lines of Evidence

Analysis of the Long-Term Operation relies on multiple lines of evidence from datasets, literature, and models.

N.6.1 Stanislaus River Water Temperature Analysis

N.6.2 Weighted Usable Area and Area of Suitable Habitat

This section will summarize results from Attachment N.2, *Stanislaus River Habitat Availability Analysis*. This line of evidence was not used in the Initial Alternatives Report.

N.6.2.1 Biological Assessment Results

The following key takeaways are applicable for all modeled species' estimated suitable spawning and rearing habitat. The WUA and ASH analyses use the same variables for each species: habitat suitability and availability assessed from field studies of distribution with respect to flow velocities, depths, and substrate/cover and CalSim3 flows. The ASH analyses are available for estimating rearing habitat suitability and availability. No ASH procedure is available for spawning habitat.

- **Driver of Variation:** CalSim 3 flows are the primary driver of variation in the WUA and ASH analyses. The WUA curves and tables are used to look up the amount of spawning and rearing WUA available at different flows during the corresponding life history periods of the race or species. The ASH tables are used to estimate the amount of rearing ASH available at different flows.
- **Calibration and Calibration Method:** Spawning and rearing WUA and ASH were estimated for the Biological Assessment modeled scenarios from CalSim 3 flow data for each month of the 100-year period of record. The CalSim 3 operations model used to estimate spawning and rearing WUA under the scenarios employs a monthly timestep. Therefore, the WUA results should be treated as monthly averages. Monthly average WUA results faithfully represent the average conditions affecting the fish. Therefore, using monthly averages to compare WUA results is acceptable for showing differences in the effects of the different flow regimes under baseline and alternatives conditions. To estimate total WUA over all months that a life stage is present, the monthly WUA results are weighted by relative occurrence of the life stage. Weighting by the weighting factors ensures that the comparisons account for differences in the amount of spawning occurring in each month, improving the validity of the results. The monthly ASH results are treated in the same manner as the WUA results.
- **Uncertainties:** Suitability of physical habitat for salmonids is largely a function of substrate particle size, cover, water depth, and flow velocity. Other unmeasured factors (e.g., flow vortices, water quality, food supply, etc.) could influence habitat suitability, contributing to uncertainty in the results. Furthermore, if channel characteristics have substantially changed since the initial field studies, the shape of the curves might no longer be applicable. Fixed spawning periods were used in this analysis for determining effects of changes in flow on spawning WUA, however, the timing of spawning by salmon and steelhead may vary somewhat among years depending on flows (Quinn 2005). The same is true for the rearing periods used in the rearing WUA and ASH analyses.
- **Performance Measures:** Outputs of the WUA and ASH analyses are an index of habitat suitability, not an absolute measure of habitat surface area. In the literature, WUA is often expressed as square feet, square meters, or acres for a given linear distance of stream, which is misleading and can result in unsupported conclusions (Payne 2003; Railsback 2016; Reiser and Hilgert 2018). For WUA analyses, we recommend looking at the values relative to other scenarios.

  California Central Valley steelhead spawning WUA values do not vary much among the three phases of the Proposed Action and are lowest in wet and above normal years and highest in the drier year types. This difference is attributable to the relatively low flows at which steelhead spawning WUA in the Stanislaus River peaks. Across all water year types, the No Action Alternative had the highest WUA value (722,916) in critically dry years and Exploratory 1 (EXP1) had the lowest value (111,203) in above normal years. Among the three phases of the Proposed Action, Alternative 2 Without Temporary Urgency Change Petition (TUCP) Without Voluntary Agreements (VA) had the highest value (701,622).

Similar to spawning WUA values, steelhead fry rearing WUA and ASH values do not vary much among the three phases of the Proposed Action. Where the two analyses differ is that WUA values are lowest in wet and above normal water years and highest in the drier water year types. ASH values are lowest in critically dry years and highest in wet years. Across all water year types in the WUA analysis, the No Action Alternative had the highest WUA value (1,701,752) in critically dry years and EXP1 had the lowest value (833,297) in wet years. In the ASH analysis, the No Action Alternative had the highest value (809,180) in wet years and EXP1 had the lowest value (432,224) in critically dry years.

Steelhead juvenile rearing WUA and ASH values also do not vary much among the three phases of the Proposed Action. The juvenile rearing WUA values are typically lowest in critically dry water year types. This pattern of variation reflects the steelhead juvenile WUA curves, which show reduced rearing WUA with increased flow for the long Riverbank segment, but little overall change in the other curves. ASH values are lowest in critically dry years and highest in wet years. In the WUA analysis, EXP1 has an opposing trend compared to the other scenarios, where the lowest values are in wet water years and the highest values in dry years. Across all water year types in the WUA analysis, Alternative 2 Without TUCP All VA had the highest value (1,273,403) in wet years and EXP1 had the lowest value (880,409) in wet years. Across all water year types in the ASH analysis, the No Action Alternative had the highest value (817,641) in wet years and EXP1 had the lowest value (436,717) in critically dry years.

California Central Valley Steelhead Results

Spawning WUA for steelhead peaks at approximately 200 cfs. The mean WUA habitat value under the Proposed Action phases ranges from 360,125 in wet years to 701,622 in critically dry years (Table N-1).

Table N-1. Expected Mean Total Weighted Usable Area for Steelhead Spawning in the Stanislaus River for the Three Baseline Scenarios and Three Alternative 2 Management Scenarios

Water Year Type	EXP1	EXP3	NAA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA
Wet	114,617	205,894	364,959	360,530	360,125	360,239
Above Normal	111,203	236,196	429,481	414,070	414,070	414,068
Below Normal	135,509	325,043	460,146	448,814	448,814	448,811
Dry	136,709	449,406	673,152	645,747	645,691	645,709
Critical	372,516	641,211	722,916	701,622	700,988	701,294
All	208,251	417,082	563,238	546,636	546,322	546,453

Fry rearing WUA curves for steelhead show reduced WUA with increased flow, especially in Orange Blossom Bridge and Riverbank, which are the longest segments. The mean fry rearing

WUA habitat value under the Proposed Action phases ranges from 1,404,204 in wet years to 1,689,984 in critically dry years (Table N-2).

Table N-2. Expected Mean Total Weighted Usable Area for Steelhead Fry Rearing in the Stanislaus River for the Three Baseline Scenarios and Three Alternative 2 Management Scenarios

Water Year Type	**EXP1**	**EXP3**	**NAA**	**Alt2woTUCP woVA**	**Alt2woTUCP DeltaVA**	**Alt2woTUCP AllVA**
Wet	833,297	1,128,367	1,388,530	1,404,222	1,404,204	1,404,310
Above Normal	913,061	1,109,249	1,522,756	1,532,890	1,532,893	1,532,884
Below Normal	927,958	1,100,414	1,542,707	1,571,026	1,571,025	1,571,024
Dry	1,151,740	1,238,123	1,635,983	1,689,884	1,689,849	1,689,862
Critical	939,719	1,251,912	1,701,752	1,689,934	1,689,984	1,689,977
All	947,464	1,182,124	1,575,949	1,590,012	1,590,020	1,590,042

Steelhead fry rearing ASH values show increasing fry rearing habitat from critically dry to wet water years (Table N-3). This pattern of variation reflects the consistent increases in steelhead fry ASH with increasing flow, including for the river as whole.

Table N-3. Expected Mean Total Area of Suitable Habitat for Steelhead Fry Rearing in the Stanislaus River for the Three Baseline Scenarios and Three Alternative 2 Management Scenarios

Water Year Type	**EXP1**	**EXP3**	**NAA**	**Alt2woTUCP woVA**	**Alt2woTUCP DeltaVA**	**Alt2woTUCP AllVA**
Wet	631,370	786,989	809,180	800,203	800,211	800,180
Above Normal	597,279	711,568	743,849	743,309	743,309	743,337
Below Normal	590,389	673,884	738,271	729,277	729,274	729,298
Dry	581,989	600,011	682,967	670,041	670,046	670,043
Critical	432,224	565,717	644,856	655,124	655,139	655,138
All	545,129	654,119	713,489	711,394	711,401	711,400

Juvenile rearing WUA curves for steelhead show increases in mean juvenile rearing WUA from critically dry to wet water years (Table N-4). The mean WUA habitat value under the Proposed Action phases ranges from 1,211,607 in critically dry years to 1,273,403 in wet years.

Table N-4. Expected Mean Total Weighted Usable Area for Steelhead Juvenile Rearing in the Stanislaus River for the Three Baseline Scenarios and Three Alternative 2 Management Scenarios

Water Year Type	EXP1	EXP3	NAA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA
Wet	880,409	1,181,913	1,269,808	1,272,542	1,273,384	1,273,403
Above Normal	936,491	1,091,198	1,246,012	1,258,455	1,258,457	1,258,446
Below Normal	956,314	1,024,683	1,242,934	1,258,596	1,258,596	1,258,735
Dry	1,108,528	996,797	1,216,600	1,234,875	1,234,865	1,234,863
Critical	929,893	884,748	1,185,812	1,211,607	1,211,764	1,211,684
All	959,145	1,021,100	1,230,704	1,246,593	1,246,830	1,246,825

Steelhead juvenile rearing ASH values show increasing habitat from critically dry to wet water years (Table N-5). This pattern of variation reflects the consistent increases in steelhead juvenile ASH with increasing flow, including for the river as whole.

Table N-5. Expected Mean Total Area of Suitable Habitat for Steelhead Juvenile Rearing in the Stanislaus River for the Three Baseline Scenarios and Three Alternative 2 Management Scenarios

Water Year Type	EXP1	EXP3	NAA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA
Wet	637,880	795,186	817,641	808,569	808,577	808,546
Above Normal	603,456	719,024	751,684	751,143	751,143	751,171
Below Normal	596,493	680,944	746,047	736,989	736,986	737,010
Dry	588,058	606,314	690,220	677,138	677,144	677,140
Critical	436,717	571,623	651,652	662,022	662,037	662,036
All	550,779	660,957	721,002	718,884	718,892	718,891

N.6.2.2 Environmental Impact Statement Results

To be developed

N.7 Uncertainty

Future studies of high value that may benefit from special studies include estimating the juvenile production of steelhead in the Stanislaus River to evaluate the effect flow and temperature operations has on this populations. The special study considering this is:

Steelhead JPE and OMR Management

N.8 References

Literature referenced for Stanislaus Stepped Release Plan are listed in Section N.5.2, *Literature*. Additional references cited or used for informational material in the document are included below.

CalFish. 2019. 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.

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