# Independent Review of the Coordinated Long-Term Operation of the Central Valley Project and State Water Project

**Prepared for:**
National Marine Fisheries Service

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# Executive Summary

My review of the CVP/SWP 2019 Biological Opinion was based Chapters 2.1–2.6 plus Appendices. Unavailable for review was the introductory chapter, which presumably would include a description of the proposed action (PA), and the cumulative effects and synthesis chapters. These unavailable chapters precluded a thorough top-down review from objectives, to methods, to results and conclusions.

The draft BiOp did a very good job of identifying the potential stressors and describing and/or quantifying potential risks to life stages of salmon and green sturgeon. Much of the analysis relied on late-fall Chinook salmon analyses where the majority of scientific information and research exists. Inferences to steelhead and green sturgeon often relied on presumed similarities of the life history of the fish species. The BiOp could be strengthened by a better characterization of the similarities and dissimilarities to the life histories of Chinook salmon and of the other species of concern and how dissimilarities might mitigate or extenuate assessed risks and the magnitude of effects. The approach of assessing effects on killer whales based on factors affecting Chinook salmon abundance is reasonable and sound.

The Analytical Approach to assessing effects is clear described and the concept appears sound. Without the Synthesis chapter, it is not possible in this review to evaluate whether the approach was followed through to its logical end. The description of the Analytical Approach should be augmented to explicitly discuss how absolute assessments of the PA potential effects are integrated with the analyses of relative comparisons of current (COS) vs. PA projected effects. While the COS vs. PA contrasts are insightful, the charge of the BiOp is to assess the effect of the PA per se.

One concern in the use of the stated Analytical Approach is the coarse scale of the H, M, and L categories of magnitude of effect. For example, the joint probability of proportion exposed x frequency of exposure for a medium (M) effect category has a range of 0.005 to 0.70, a 140-fold difference (Table 2.1.3-2). That range goes from improbably to a more than likely chance of occurrence all within the designation of a medium effect.

Section 2.1 is needing an update. As written, it conveys an impression that the BiOp is not necessarily using the most up-to-date information and models. Section 2.1.4 and 2.1.4.1 are not reflective of the actual material and methods used and cited in the river divisional assessments (2.5.2 to 2.5.7).

Models such as the Delta Passage Model, Chinook Salmon Life Cycle Model, and the Delta Salvage Model, while valuable and appropriate, do not appear to have been recalibrated for the most recent available information. The consequence could be small or the consequence could be that the models do not necessarily accurately reflect current conditions or the full range of conditions being experienced in the delta. Documenting of the models is fine, but the assumptions of such complex models are too numerous to evaluate singularly. The only recourse is to evaluate model fit and compare predictions vs. actual observations. Here again, the most recent years of data could be used in the model validation and hopefully reinforce their credibility and their value in the effects assessment.

Overall, the available chapters for review represents a substantive body of evidence that should provide a credible and objective assessment of the potential effects of the proposed action.

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# 1 Introduction

## 1.1 Background

I was requested to review the CVP/SWP 2019 Biological Opinion. The material provided for review was Chapters 2.1 through 2.9. What was not included was the introduction, which I assumed would include the objective of the BiOp and description of the proposed actions (PA). Also missing was the synthesis of effects chapter (2.7) that I assumed included conclusions regarding jeopardy and amounts of critical habitat. These omissions precluded a thorough top-down review of the BiOp. To partially fill in the gaps, I used Chapter 4 (Proposed Actions) of the Bureau of Reclamation Biological Assessment (BA) to describe current (COS) and proposed actions (PA) at the CVP/SWP. I also reviewed the 2009 BiOp chapter on synthesis to get a feel of the types of material to expect in the last chapter.

## 1.2 General Observations

The Analytical Approach does a good job of describing how jeopardy and critical habitat assessments are expected to be performed for a Proposed Action (PA). However, when it comes to the divisional assessments of the effects of the actions, a considerable amount of the actual analytical analyses was based on a comparison of the Current Operating Situation (COS) and the Proposed Action (PA). Consequently, some analyses of effects were based on the absolute condition of the PA and others on the Δ change in conditions between COS and PA. While both types of information are useful, the Analytical Approach only addresses the absolute assessment of the PA. The description of the Analytical Approach needs to be amended to describe the incorporation of both absolute status and change in status information and an explanation for why both forms of assessment are useful

The sections on Evidence Available for Analysis (2.1.4) and Primary Analytical Models (2.1.4.1) need to be updated to what is actually being used in the draft BiOp. A starting point may be the section on New Science (4.8) of BOR BA. Numerous references and models used in this draft BiOp are not included in these reference lists. These sections need to be updated to better represent the Literature Cited sections of the river division chapters. For example, the Perry (2018) model is used extensively in Section (2.5.4) but not listed as a source material.

## 1.3 Review Activities

Besides reviewing the supplied chapters of the draft BiOp and its appendices H and I, the following reference materials were also examined:

Anderson, J. J. 2018. Using river temperature to optimize fish incubation metabolism and survival: a case for mechanistic models. (preprint).

Buchanan, R. A., P. L. Brandes, J. R. Skalski. 2018. Survival of juvenile fall-run Chinook salmon through the San Joaquin River Delta, California, 2010–2015. North American Journal of Fisheries Management 38:663–679.

Buchanan, R.A., J. R. Skalski. 2019. Relating survival of fall run Chinook salmon through the San Joaquin Delta to river flow. Environmental Biology of Fishes (submitted).

Johnson, R. C., S. Windell, P. L. Brandes, J. L. Conrad, J. Ferguson, P. A. L. Goertler, B. N. Harvey, J. Heublein, J. A. Israel, D. W. Kratville, J. E. Kirsch, R. W. Perry, J. Pisciotto, W. R. Poytress, K. Reece, and B. G. Swart. 2017. Science advancements key to increasing management value of life stage monitoring networks for endangered Sacramento River winter-run Chinook salmon in California. San Francisco Estuary and Watershed Science 13(3):1–41.

Lindley, S. T., R. S. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. R. McEwan, R. B. MacFarlane, C. Swanson, J. G. Williams. 2007. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin. San Fransicso Estuary and Watershed Science 5(1).

Martin, B. T., A. Pike, S. N. John, N. Hamda, J. Roberts, S. T. Lindley, and E. M. Danner. 2016. Phenomenological vs. biological models of thermal stress in aquatic eggs. Ecology Letters 20(1):50–59.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-NWFSC-42.

Perry, R. W. A. C. Pope, J. G. Romine, P. L. Brandes, J. R. Burau, A. R. Blake, A. J. Ammann, and C. J Michel. 2017. Flow-mediated effects on travel time, routing, and survival of juvenile Chinook salmon in a spatially complex, tidally forced river delta. Canadian Journal of Fisheries and Aquatic Sciences 75:1886-1901, https://doi.org/10.1139/cjfas-2017-0310.

Perry, R. W., J. G. Romine, N. S. Adams, A. R. Blake, J. R. Burau, S. V. Johnston, and T. L. Liedtke. 2014. Using a non-physical behavioral barrier to alter migration routing of juvenile Chinook salmon in the Sacramento-San Joaquin River Delta. River Research and Applications 30:192–203.

Perry, R. W., J. G. Romine, Pope, A. C., and S. D. Evans. 2018. Effects of the proposed California WaterFix North Delta Diversion on flow reversals and entrainment of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) into Georgiana Slough and the Delta Cross Channel, northern California. U.S. Geological Survey Open File Report 2018-1028, https://doi.org/10.3133/ofr20181028.

Pope, A. C., R. W. Perry, D. J. Hance, H. C. Hansel. 2018. Survival, travel time, and utilization of Yolo Bypass, California, by outmigrating acoustic-tagged late-fall Chinook salmon: U.S. Geological Survey Open-File Report 2018-1118, https://doi.org/10.3133/ofr20181118.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 2016. California WaterFix Biological Opinion. Prepared by the U.S. Department of Commerce, https://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/CAWaterFix/WaterFix%20Biological%20Opinion/cwf_final_biop.pdf

In addition, two conference calls with the other two independent reviewers and staff of Anchor and NMFS were conducted on 3 June and 7 June 2019.

# 2 Responses to Questions

## 2.1 How well does the analytical approach explain how the exposure, response, and risk from project operations will be assessed for: individuals, populations, and diversity groups of the listed species? physical and biological features of designated critical habitats?

The “Analytical Approach” in the BiOp describes in reasonable detail how jeopardy/no jeopardy (Figure 2.1.3-1) and adverse/no adverse modifications of habitat (Figure 2.1.3-2) are evaluated. Table 2.1.3-1 is also helpful in describing how effects of proposed actions are tallied. Table 2.1.3-2 also describes how the magnitude of effects are defined. This information is directly relevant to assessing a proposed action (PA).

However, the conceptual description of the “Analytical Approach” does not match well with the actual analyses of effects in Chapter 2.5. Most of the actual quantitative assessments in 2.5 are based on various model runs where the goal was to compare COS vs. PA. I understand why this approach was taken. Often, models are more accurate in comparative assessments than in predictions of absolute conditions. Nevertheless, the charge of the BiOp is a risk assessment of the PA itself, not a relative comparison of the change from COS to PA. Somewhere in the Analytical Approach, an explicit discussion of these two types of data (i.e., relative change vs. absolute) is necessary and how these two types of information are used jointly to inform decisions in jeopardy.

## 2.2 How effectively is the analytical approach applied in the effects analysis on the listed species and designated critical habitats?

The priorities in the effects assessment should include among other factors:

a. water temperature,
b. flow values,
c. delta cross-channel operations,
d. operations of the state and federal pumping stations,
e. changes in critical habitat.

Each river divisional analysis should consider these and other potential stressors that are relevant to the area. Each divisional description (Sections 2.5.2–2.5.6) starts with a tabular summary of proposed actions and stressors (Note Table 2.5.4-1 is incomplete) and each concludes with a tabular summary of exposures and responses to the PA. Water temperature, flows, and critical habitat are relevant to all divisions, while the delta cross-channel and pumping operations are potential stressors in the delta.

The amount of quantitative analyses varies by division. These differences in evaluation depended on which stressors were relevant to an area and the availability of quantitative models. Table 1 below summarizes the various responses quantitatively compared COS vs. PA by division.

Table 1

**Completion of direct COS vs. PA quantitative comparisons by river division**

| **Division** | **COS vs. PA direct comparisons** |
|---|---|
| American River | • Temperature exceedance |
| | • Water temperature |
| | • Weighted usable area (habitat) |
| | |
| Trinity | • Temperature exceedance |
| | • Weighted usable area |
| | |
| Delta | • Water velocity |
| | • Flow |
| | • Smolt survival, travel time, routing proportions |
| | • Entrancement index of fish salvage |
| | • Estimated losses at export facility |
| | |
| Stanislaus/San Joaquin | • Water temperature, suitability |
| | • Flow, flow year type |
| | • Inundated floodplain access |
| | |
| Upper Sacramento/Shasta | • Water contract deliveries |
| | • Flow |
| | • Weighted usable area |

The delta has been the focus of juvenile salmonid tagging studies for decades. It is therefore reasonable to expect modeling of smolt movements and survival to be best performed here. It was fortunate the Perry et al. (2018) model was available to help assess delta cross-channel and pumping station operations. While the Perry (2018) model uses Sacramento fish releases, no comparable model exists for San Joaquin fish releases.

Water temperature effects on salmonid eggs are modeled using the Anderson et al. (2018) model. The model was applied to the Sacramento River but why not elsewhere in the draft BiOp?

It is apparent different authors wrote the different divisional assessments. The different river divisions have different numbers of stressors, different suites of stressors, and different levels of available information. Nevertheless, one might expect all divisions would be concerned with flow, water temperature, and usable habitat area. Yet, Table 1 above does not support this conclusion. To a casual reader these omissions could be seen as obvious data gaps. In each river division, a table of common stressors and associated data gaps would be helpful and transparent. Following the table, text should be added explaining how major gaps were handled.

## 2.3 To what extent does the approach for assessing effects provide a scientifically defensible approach for evaluating effects to listed species and their designated critical habitats throughout the action area?

Table 2.1.3-1 provides types of information used to determine the biological significance of a stressor. Table 2.1.3-2 identifies the components of severity, proportion exposed, and frequency of exposure used in defining the magnitude of the effect. Severity is expressed as an ordered, categorized variable (e.g., high, medium, or low). The proportion of the population exposed and frequency of exposure are probabilistic values that can be combined to produce a joint frequency. In Table 2.1.3-2, it indicates a medium proportion (0.02 to 0.70) combined with a high/medium frequency (0.25 to 1.0) results in a medium magnitude of effect (i.e., given severity is either low or medium). Yet the range of the product $P_{\text{prop}} \cdot P_{\text{freq}}$ is 0.005 to 0.70, a 140-fold difference. This range within which a medium result can occur seems way too crude to be meaningful. Two different conclusions of medium can have vastly different risks from unlikely (i.e., 0.005) to commonplace (0.70). Other combinations in Table 2.1.3-2 illustrate other wide and insensitive ranges in effect magnitude.

Without having the Synthesis chapter to review, I do not know if magnitudes of effect for stressors are compared between the 2009 BiOp and the 2019 BiOp (i.e., COS vs PA). The joint probability of $P_{\text{prop}} \cdot P_{\text{freq}}$ could change many, many-fold and the categories for combined effect would not change, potentially resulting in a false sense of no change in the status and trends for the effects.

## 2.4 How well does the draft biological opinion use best available scientific and commercial information in the effects analysis and findings?

The draft BiOp is a work in progress at the time of this review. Consequently, current impressions may not reflect the final product. Sections 2.1.4 to 2.1.6 do this draft report a disservice. The provided list of resources only includes two references more recent than 2016 and fails to include important new information published since. This introductory chapter needs to be updated with the actual resources listed and used in Chapters 2.5–2.6.

In the substantive chapters of 2.5–2.6, the authors of the draft report are, however, using the best available information to my knowledge and are making sincere attempts to understand the risks imposed by the PA. Actions of the PA are deconstructed into individual stressors that might have an effect on different species and life stages. Within the individual River Division sections, these potential stressors are then evaluated individually either quantitatively or by verbal argument using available literature.

## 2.5 Does the draft biological opinion adequately address data gaps and uncertainties? Specifically:

### *2.5.1 Are uncertainties and assumptions in the effects analysis clearly stated and reasonable based on current scientific knowledge?*

The Perry et al. (2018) model used a Bayesian multistate mark-recapture model with time-varying individual covariates to model late-fall Chinook salmon smolt survival and movements through the Sacramento–San Joaquin Delta. The analysis was based on 17 tag releases between 2007–2011. They found survival to be related to river flows in three reaches with bidirectional flows. They also found delta cross-channel operations resulted in reduced survival associated with water removal. Routing probabilities were also found to be related to total discharge and the fraction of discharge associated with a route.

The draft BiOp reasonably summarizes some of the limitations of the Perry model (Sections 2.5.5: pp 30). It should also mention the model was based on water years 2007–2011, so modeled conditions outside that range may be suspect. The draft also properly warns of the limitations of using the Perry model for steelhead and rejects its use for green sturgeon. In Perry et al. (2018: Effects of the proposed California WaterFix…), they needed to use bias-corrected DSM2 flow predictions. It does not appear similar corrections to the DSM2 flow predictions were used in the draft BiOp.

The winter-run Chinook salmon life cycle model (Appendix H) is a complex multistage life-cycle model with over 27 transitions each incorporating multiple assumptions. The assumptions are too numerous to list and/or discuss the robustness of the assumptions. Perhaps the singular most-important assumption is that the modeling approach is based on Newman (2003) and CWT data. More detailed and refined information on smolt survival can be found in more recent acoustic-tag studies of Perry et al (2018) and Buchanan et al. (2018). This model appears to fit the historic CWT date well, but untested against the newer acoustic-tag data. One concern of any life-cycle model is the time-step. For instance, Perry et al. (2018) found smolt survival to be related to the frequency and duration of bidirectional flow events that occur on a daily or semi-daily basis.

The Delta Passage Model (DPM) is used to predict survival and abundance of late-fall run Chinook salmon smolt using nine river reaches, four junctions, and based on Perry et al. (2010) acoustic-tag data and Newman (2008) CWT data among other information. The model uses one-day time steps. It would seem this model should be updated to the more recent Perry et al. (2018) analyses. Appendix I does a good job of describing model the limitations and assumptions.

In general, the draft BiOp does a good job of identifying the uncertainties and assumptions of the effect analyses. My only criticism is that often these discussions of limitations are embedded in the larger text and become lost. It would serve the readers if such discussions concerning model and analysis assumptions were called out in their own subdivisions of the draft BiOp where appropriate.

### *2.5.2 How extensively are gaps in aquatic species life history information considered and appropriately addressed?*

The draft BiOp focuses extensively on Chinook salmon not only because they are an important species of concern but also because much of the available science within the delta is on this species.

Data gaps on steelhead are filled in using Chinook salmon as a surrogate in parts of the divisional assessments. It would be helpful in Section 2.1 to identify more specifically the similarities and differences in their life cycles that could have an important effect on the interpretation of effects. For example, because steelhead smolt outmigrate older and larger than Chinook salmon smolt, how might that affect outmigration survival and entrainment into water facilities?

The above suggestion is even more pertinent when assessing risks for green sturgeon. The draft suggests the McElhany et al. (2006) viable population analysis for salmonids can also be applied to green sturgeon due to their similarities in life cycle and freshwater/ocean use (Section 2.1.3.1.1). Differences in the duration in-river and repeated spawning of sturgeon will influence age-specific effects. Again, an explanation of the general pattern of the differences in age-specific life cycle processes between Chinook salmon and sturgeon could be helpful in interpreting results.

Given the dynamics of the southern resident killer whale, I agree the single most-important element to assess is the potential effect of Chinook salmon availability and abundance as a prey species. Factors that may decrease Chinook abundance should also be considered detrimental to the killer whales. No more assessment seems needed or warranted with regard to killer whales.

## 2.6 How adequately does the draft biological opinion address the key operational effects of the proposed action? Specifically:

### *2.6.1 Do the analyses provide sound information and analyses to adequately characterize the effects of operations on spawning, incubating, rearing, and outmigrating salmonids and sturgeon?*

Both the quantitative and qualitative analyses provide valuable information for evaluating effects on species and their life history stages. The draft BiOp does a good job of integrating available information and evaluating the potential for effects of the PA. The delta divisional analysis (2.5.5) is a very good example of the great level of detail taken in the effect assessments. Provided graphs and tables are helpful in conveying the relevant information. However, when the assessments included comparisons between COS and PA, it was unclear how the information will be incorporated into the final evaluation of the magnitude of effect. For example, if the comparison indicated a worsening of conditions, was that assessment sufficient in itself to conclude adverse effects of the PA are likely? The inferential value of the comparative analyses should be explained in each of the relevant sections of the draft BiOp.

### *2.6.2 How thoroughly do the data, analyses, and findings presented in the biological opinion capture the risks to individuals and populations, and to critical habitat, from the proposed action? Are there significant risks that have been overlooked or other scientific information that should be considered?*

The draft BiOp does a good job of identifying potential stressors and life stages at potential risk of effects. For each of these identified sources of potential effects, the draft BiOp describes and/or quantifies the likelihood of an effect. However, without the cumulative effects and synthesis chapters, it is not possible to assess with the material at hand whether the risks have been properly characterized (i.e., H, M, L) and fully accounted for.

### *2.6.3 Have the appropriate analytical tools (i.e., models) been used for the analysis and what, if any, additional currently available tools should have been considered? Were available models appropriately applied and interpreted in the analysis?*

The suite of analytical models used in the draft BiOp are adequate to the task. In some cases, it would have been very desirable to update the model calibrations with more recent data when available. For example, based on Appendix I, the Delta Passage Mode was last calibrated using water years through 2003 (Appendix I: 5.D-226) and sensitivity analyses using data through 1991 (Appendix I: 5.D-227). The Chinook Salmon Life Cycle Model, used carcass survey data through 2014 (Appendix I: 25–27), harvest data through 2014, and run indices through 2014 (Appendix I: 28). A similar comment concerning the Delta Salvage Model and water years can be found in comment 2.8.2. In many parts of the draft BiOp, data are presented through 2017, a reasonable time scale due to information lag times. But other places, the data seems unnecessarily out-of-date. For example, catch and salvage data for green sturgeon are only presented through 2012 or 2014 (Figure 2.5.5-24 and -25). The draft BiOp should be reviewed to find obvious places where data updates should be readily possible. The updates may not change any of the conclusions, but in the spirit of using best available information, the updates should be performed.

## 2.7 To the extent that reviewer expertise allows informed review of Central Valley water temperature guidance (see Additional References below as needed):

### *2.7.1 Does the EPA (2003) water temperature guidance protect Chinook salmon on CVP rivers and creeks, and what implications do newer studies have for considering effects on salmon?*

Not qualified to comment.

### *2.7.2 How appropriate is the application by Anderson (2018) of age-dependent thermal mortality and spatially-dependent background mortality to understanding early life history of winter-run Chinook salmon and temperature management planning? Are the effects, including uncertainties, of this new approach captured in the analysis?*

The Anderson (2018) model was used to predict salmonid egg mortality as a function of water temperature. It was used to assess effect in the Upper Sacramento and Eastside: Stanislaus/San Joaquin divisions. The draft BiOp correctly observes that the Anderson (2018) model only accounts for egg mortality during the period of hatching, while the Martin et al. (2016) model considers the period from redd creation to fry emergence. The models also differ on how dissolved oxygen (DO) is incorporated in the models (Section 2.5.2: pp 60–61). Anderson (2018) considers three different models, the draft BiOp should reinforce which of them is being used in the evaluations.

The fact the Anderson (2018) model predictions are consistent with the Martine et al (2016) model (Figure 2.5.2-21) is of some comfort. The Martin model predicts mortality over a much longer time span (i.e., redd production to fry), than the Anderson (2018) model (during the period of hatching). Interestingly, one might expect the Anderson estimates of mortality therefore to be lower, to much lower, than the Martin (2016) estimates, but they are not. I feel some cautionary wording regarding the limitations of the Anderson (2018) predictions is merited.

## 2.8 To the extent that reviewer expertise allows informed review of analyses of effects of Delta conditions:

### *2.8.1 How well are the near-field, mid-field, and far-field effects described for different potential volitional and entrainment migration paths in the Delta (e.g., north Delta, Sacramento River, central Delta, San Joaquin River, south Delta, salvage, etc.) for different species and different basins?*

The Perry et al (2018) model on late-fall Chinook salmon is perhaps the best tool for examining near-field effects of migration path and entrainment and uses the most up-to-date acoustic-tag data. The Delta Passage Model for late-fall run Chinook salmon using both CWT and acoustic-tag data is the best available tool for assessing mid-field effects. The winter-run Chinook salmon life cycle model based on CWT data is useful for assessing mid- and far-field effects to varying degrees. None of these approaches directly cover steelhead and green sturgeon, and only indirect inferences are possible. I do not recall seeing any assessment of cross-model consistency of the predictions where feasible. Such an evaluation would be helpful in assuring the robustness of the conclusions.

### *2.8.2 How well does the period of record in the Delta Salvage Model (1995-2009) reflect the conditions of the proposed action given the change in Old and Middle River management (from 2009 when NMFS' 2009 Opinion was issued and implemented)? What period of record does the panel recommend to generate a seasonal pattern of loss for use in comparing between the operational scenarios (i.e., PA and COS)?*

A cursory review of Old and Middle River (OMR) hydrolics 1995–2019 indicates the range of flow patterns and volumes is much wider when also considering the later years 2010 to present. For example, the years 2011, 2017, and 2019 have some of the highest flows in that era. Recent years also have much larger proportions of the year with negative daily discharges. Consequently, the flows for the years 2010 and beyond may be much more representative of current and proposed actions and should be used in the modeling. This relates to the issue of using best available science and information.

# 3 Additional Thoughts, Concerns, and Suggestions for Improvements to the Analyses

No additional comments.

# 4 References

## 4.1 Materials Provided Prior to the Review

National Marine Fisheries Service, 2009. *Endangered Species Act Section 7 Consultation Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project*. File Number 2008/09022. June 4, 2009.

U.S. Bureau of Reclamation, 2019. *Reinitiation of Consultation on the Coordinated Long-Term Operation of the Central Valley Project and State Water Project Central Valley Project, California, Mid-Pacific Region, Final Biological Assessment*. January 2019.