Peer-review Report for:

Water Quality and Habitat Suitability Modeling of Anderson Ranch Reservoir

October 28, 2020

Originating office: Bureau of Reclamation, Columbia-Pacific Northwest Region, Regional Office, 1150 N Curtis Rd., Boise, ID, 83706

Reclamation roles:

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Date peer review received:

April 2019

Peer-review Scope:

A water quality model was developed in CE-QUAL-W2 for Anderson Ranch Reservoir and calibrated to reproduce historical reservoir operations and facilitate exploration of water quality conditions. The purpose of this peer-review summary report is to summarize expert review and feedback for the calibrated model. The calibrated model was modified to evaluate operational flexibility under existing ESA limitations (as identified in the USFWS 2005 and the 2014 Biological Opinion) and the potential effects on water quality and fish habitat resulting from different proposed Anderson Ranch Dam raise scenarios. The data provided by this modeling study informs both the Anderson Ranch Biological Assessment and the Boise River Feasibility Study.

Peer reviewers considered experts in water quality and the specific software used were asked to review the preliminary model documentation and provided an in-depth review the model files and configuration, including the 2-dimensional model grid used to physically represent the reservoir, model hydrological and meteorological inputs, model parameters for dynamic processes with the reservoir, and model calibration. The reviewers were also asked to provide recommendations for parameter adjustments and model improvement.

Note, although the original peer-review plan anticipated the model might be used for exploring the effects of a lease of power privilege, inter-basin water transfer, and other changes in reservoir operations, as the study evolved the work was restricted to focusing on calibrating the model to reproduce and characterize historical conditions and using the model to explore the potential effects of different dam raise scenarios.

Peer Reviewers

The nature of this project, familiarity with the model used, and background in interpretation of model results requires a specific type and level of expertise. Peer reviewer selection was limited to persons with at least 10 years' experience and expertise in water quality and water quality modeling using CE-QUAL-W2. Since relatively few persons meet these qualifications, the developers of the CE-QUAL-W2 water quality modeling software at Portland State University were selected as peer reviewers for the project based on their educational background, professional experience, peer recognition in their field, and their extensive experience applying the software to a range of river and reservoir systems and unique insight on proper configuration of water quality models. Although they developed the modeling environment, provided peer-review, and provided feedback on modeling questions, they were not directly involved in the development of the model for Anderson Ranch reservoir (i.e. no conflict of interest).

The following individuals were selected as peer reviewers:

1. Scott Wells (P.E.; Ph.D.)
    - Expertise: Water quality modeling in CE-QUAL-W2.
    - Title:

        Professor
        Water Quality Research Group
        Department of Civil and Environmental Engineering
        Maseeh College of Engineering and Computer Science
        Portland State University

2. Chris Berger (P.E.; Ph.D.)
    - Expertise: Water quality modeling in CE-QUAL-W2.
    - Title:

        Assistant Research Professor
        Water Quality Research Group
        Department of Civil and Environmental Engineering
        Maseeh College of Engineering and Computer Science
        Portland State University

Summary of reviewer comments, responses and corresponding changes

1. Model executables are outdated
   a. The model was updated to use the most current version of the software in June 2020 (version 4.2.1) and converted to use the new excel-based spreadsheet control file.
2. The reviewers suggested that the reservoir water-level calibration could be improved.
   a. The water balance utility included with the modeling software was used to improve the water level simulations and more closely match the historical values for the calibration models.
3. The model grid used to represent the reservoir was considered reasonable but could be improved by using a standard longitudinal resolution and a finer vertical resolution.
   a. It was not considered necessary to adjust the model geometry, but this should be considered for future studies.
4. Model boundary conditions such as air temperatures, dew point temperatures, wind speed, wind direction, cloud cover, solar radiation, reservoir shading, inflows, inflow temperatures, and inflow organic and inorganic water quality constituents were evaluated. The reviewers recommended some corrections to the input data and associated parameters, which were all implemented, with the following exceptions.
   a. The reviewers suggested using a dynamic shading to account for shading due to topography and bank vegetation. A dynamic shading file was constructed but the model was found to produce better calibration results using a constant shading percentage throughout the reservoir.
5. Various parameter adjustments were suggested, which were all implemented with the following exceptions.
   a. The reviewers remarked that model does not include a spillway.
      i. It was considered unnecessary to add the spillway since it was not used in the years studied. Future studies that simulate reservoir dynamics at higher water levels may need to add the spillway.
   b. Algae parameters for nitrogen and phosphorus were relatively high compared to defaults
      i. Parameter values were reduced based on published values as reported in the CE-QUAL-W2 manual. New values were still higher than the defaults for some algae groups, but are within the ranges reported in the manual for the major algae types identified in the water samples.

Post-review correspondence with reviewers, model adjustments, and scenario additions

Following the review, the model calibration for simulating reservoir vertical temperature and dissolved oxygen profiles was improved to better match historical values. These variables specifically constrain the habitat available for cold water fish and other biota, which was of particular interest for the biological opinion. Based on communication with the peer reviewers, participation in a week-long water quality modeling workshop, and further knowledge of the software gained from the manual, several model improvements were identified and addressed as follows.

1. To better simulate winter turn-over as cold inflows displace water in reservoir bottom, the placement of inflows by density was re-enabled. This was a reversal of a reviewer-suggested change to improve run time.
2. Reservoir bottom temperatures were higher than historically measured values
    a. Sediment temperature was reduced from 12° to 8° C to better match observed temperature attenuation at reservoir bottom (1 m depth sensor measurements).
3. Near-surface temperature profiles did not match historical
    a. Light extinction due to suspended sediment and organic matter were increased to better reproduce the higher temperatures near the surface measured by sensors historically.
    b. Algal growth rates, growth temperature ranges, phosphorus dependency, nitrogen dependency, and settling rates were adjusted to better represent three major algal groups observed in water samples (i.e. cold water diatoms, warm water blue-green algae, and green algae groups) and better simulate the observed peaks and subsequent declines in dissolved oxygen due to algae blooms in the Spring and Summer.
4. Sediment decay rates and temperature ranges were adjusted to better simulate the low dissolved oxygen levels observed at depth.

Following the above model adjustments, the calibrated model for 2016 through 2017 was then applied using input data from 2001 to better understand the conditions that led to a loss of cold-water habitat at that time. Additionally, in order to characterize the effects of potential 3-foot and 6-foot dam raises, the calibrated model was run for the different years starting at higher reservoir levels corresponding to the static additional reservoir volumes that would be added by each dam raise. Although the water in the new storage space would likely be used gradually during the year, assuming the new storage space would be full throughout the year provided an estimate of the maximum potential effect of the dam raise scenarios.