

Lake Powell Surface Elevation and Release Temperatures: Scenario-based data interpretation

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Overview

This is an R Markdown document. This document combines data for Lake Powell release temperature, water surface elevation, and temperature profiles to show the lake water surface elevations needed to achieve temperature scenarios of less than 15oC, between 15 and 18oC, and above 18oC. These release temperatures are the release temperatures at which 1) warm-water native- and non-native fish interactions become important, and 2) native warm-water fish can no longer tolerate.

Contents

A first plot shows temperature suitability for cold-water non-native, water-water native, and warm-water nonnative fish.

A second plot shows the Water Surface Elevation vs. Turbine release temperatures by month which is the Yaculic spreadsheet model output.

A third plot adds observed water surface elevations vs. turbine release temperature. The observed data is plotted as a range of daily min and max temperatures

A fourth plot adds lake temperature profile data at the Wahweap station. A translation is used to plot the profile data at a lower water surface elevation and depth that will give release at the turbine elevation of 3490 feet. For example, a temperature profile point of 18oC 10 feet below (depth = 10 feet) an observed water surface elevation of 3610 feet becomes a new water surface elevation of 3500 feet and turbine release temperature of 18oC (3500 feet is 10 feet above the turbine elevation of 3490 feet). Similarly, a temperature profile point of 15oC measured 20 feet below an oserved water surface level of 3610 feet becomes a new water water surface elevation of 3510 feet and turbine release temperature of 15oC (20 feet above the turbine elevation of 3490 feet). These translations assume that solar radiation is the primary driver of temperature in the epilimnium and that water temperatures at shallow depths will be similar regardless of whether the water surface elevation is 3490, 3500, 3520, etc. feet.

A fifth plot shows ranges and uncertainty in water surface elevations by month for different scenarios of release temperatures. These ranges and errors are tabulated from the water surface elevation and release temperature data shown in plot #4. The plot visualizes the reservoir surface elevations needed to achieve different temperature scenarios. The ranges in water surface elevation are large.

Data sources

1. Fish temperature suitability - Table 2 from Valdez, R. A., Speas, D. W., and Kubly, D. M. (2013). "Benefits and Risks of Temperature Modification at Glen Canyon Dam to Aquatic Resources of the Colorado River in the Grand Canyon." U.S. Bureau of Reclamation, Salt Lake City, UT. https://gcdamp.com/images_gcdamp_com/b/bf/GCD-Temp_Mod-Valdez_%26_Speas_9-17-2013.pdf.

2. Yacoulic Spreadsheet model of monthly release temperature as a function fo surface water elevation. TemperatureModel_GrandCanyonStorage.xlsx
3. Time series of Glen Canyon Dam release temperature provided by Bryce M. 15-minute time step. GCD_release_water_temp.csv
4. Time series of daily Glen Canyon Dam elevation - USBR (2020). Water Operations: Historic Data, Upper Colorado River Division, U.S. Buruea of Reclamation. <https://www.usbr.gov/rsvrWater/HistoricalApp.html>
5. Lake Powell Temperature Profiles. Vernieu, W. S. (2015). “Historical Physical and Chemical Data for Water in Lake Powell and from Glen Canyon Dam Releases, Utah-Arizona, 1964 –2013.” Data Series 471, Version 3.0. <https://pubs.usgs.gov/ds/471/pdf/ds471.pdf>.

Results

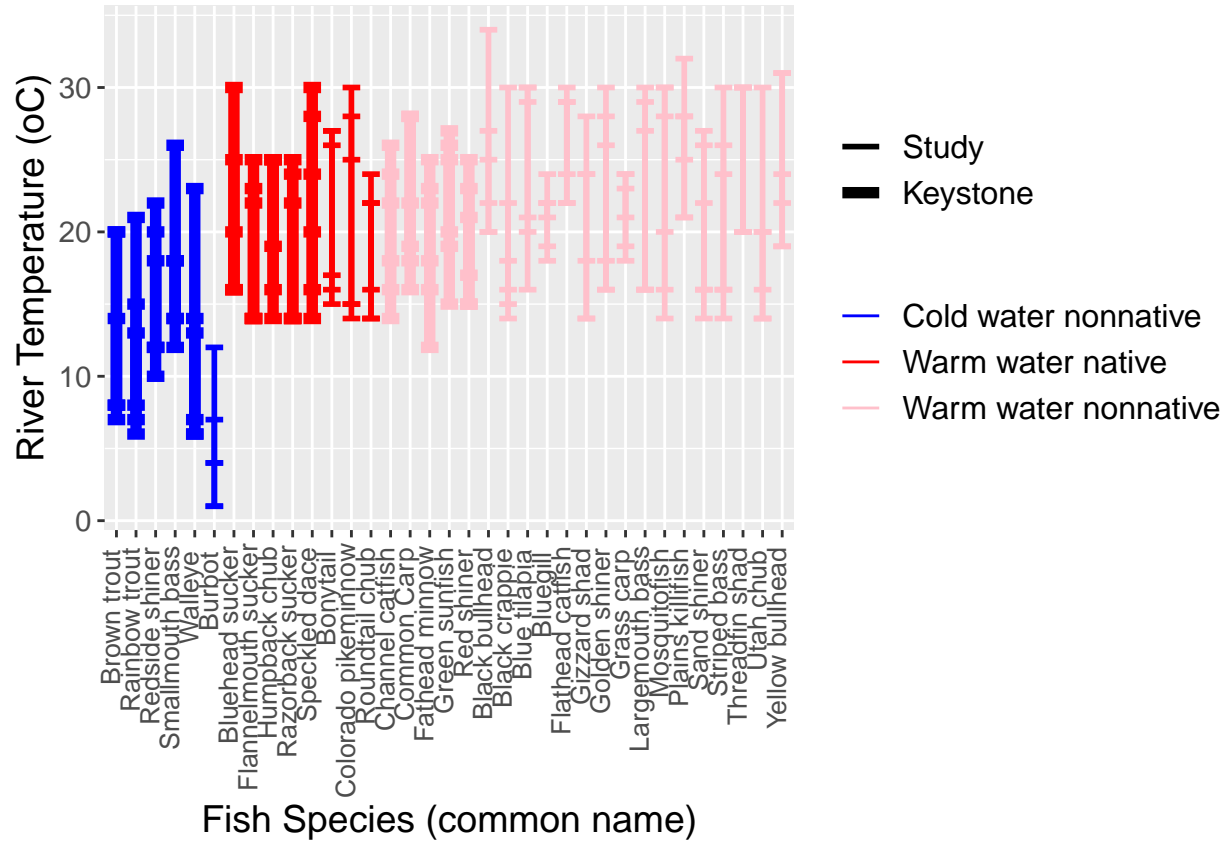


Figure 1. Grand Canyon fish temperature suitability: growth, incubation, and ovulation stages (Valdex et al, 2013)

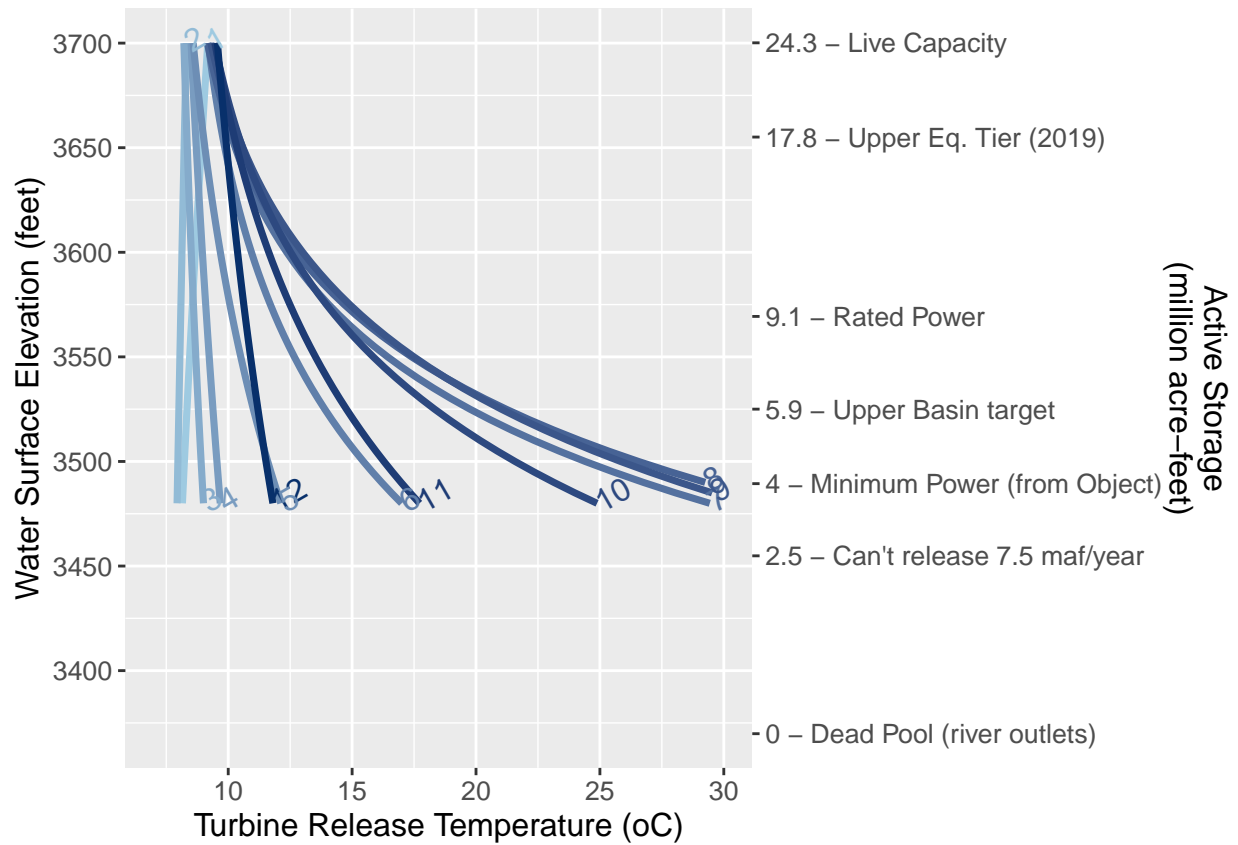


Figure 2. Spreadsheet model: release temperature vs. water surface elevation by month

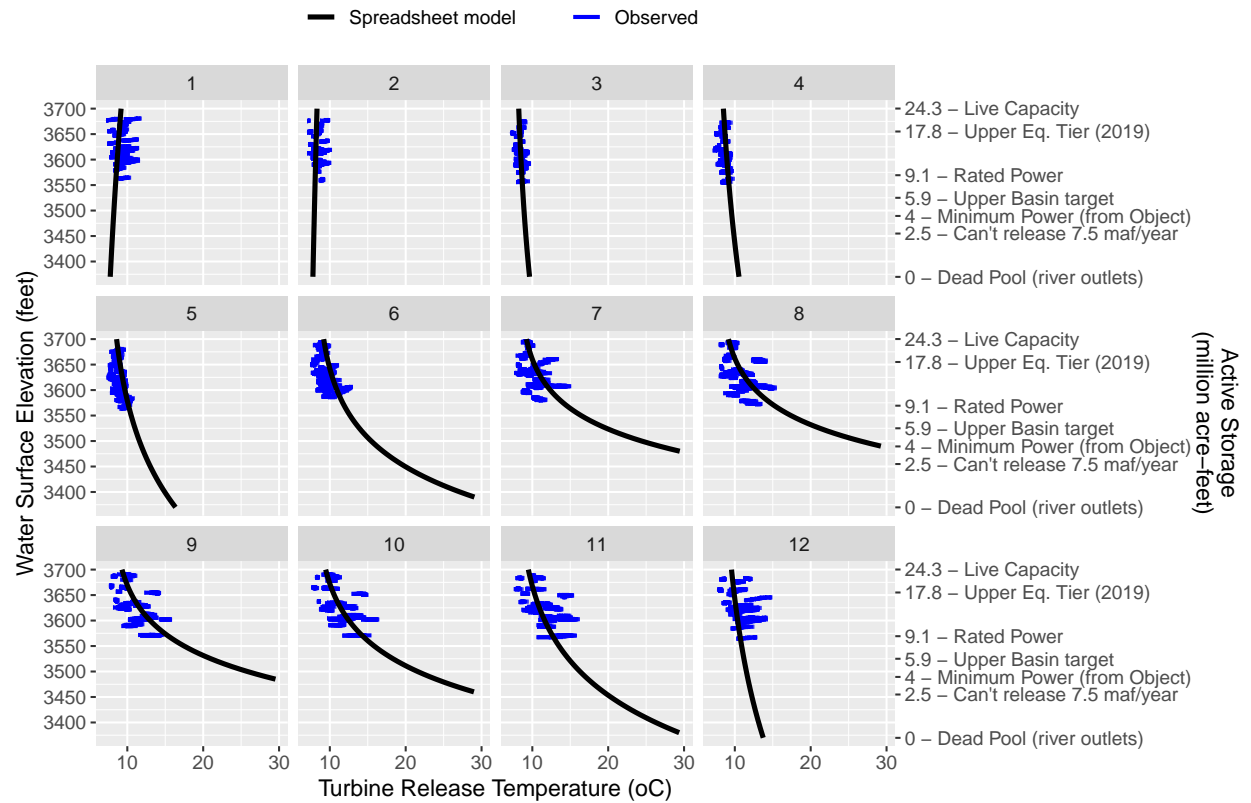


Figure 3. Compare spreadsheet model to observed release data

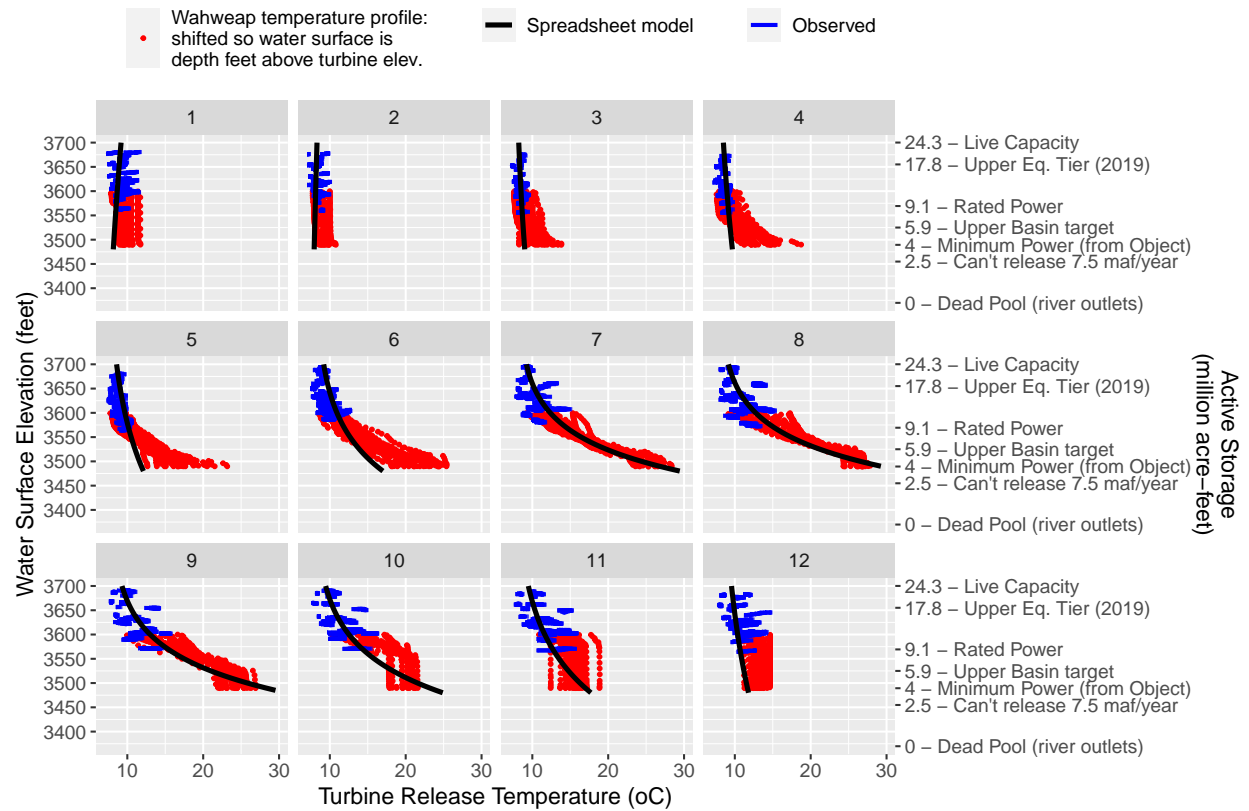


Figure 4. Compare spreadsheet model to observed release and transformed profile data

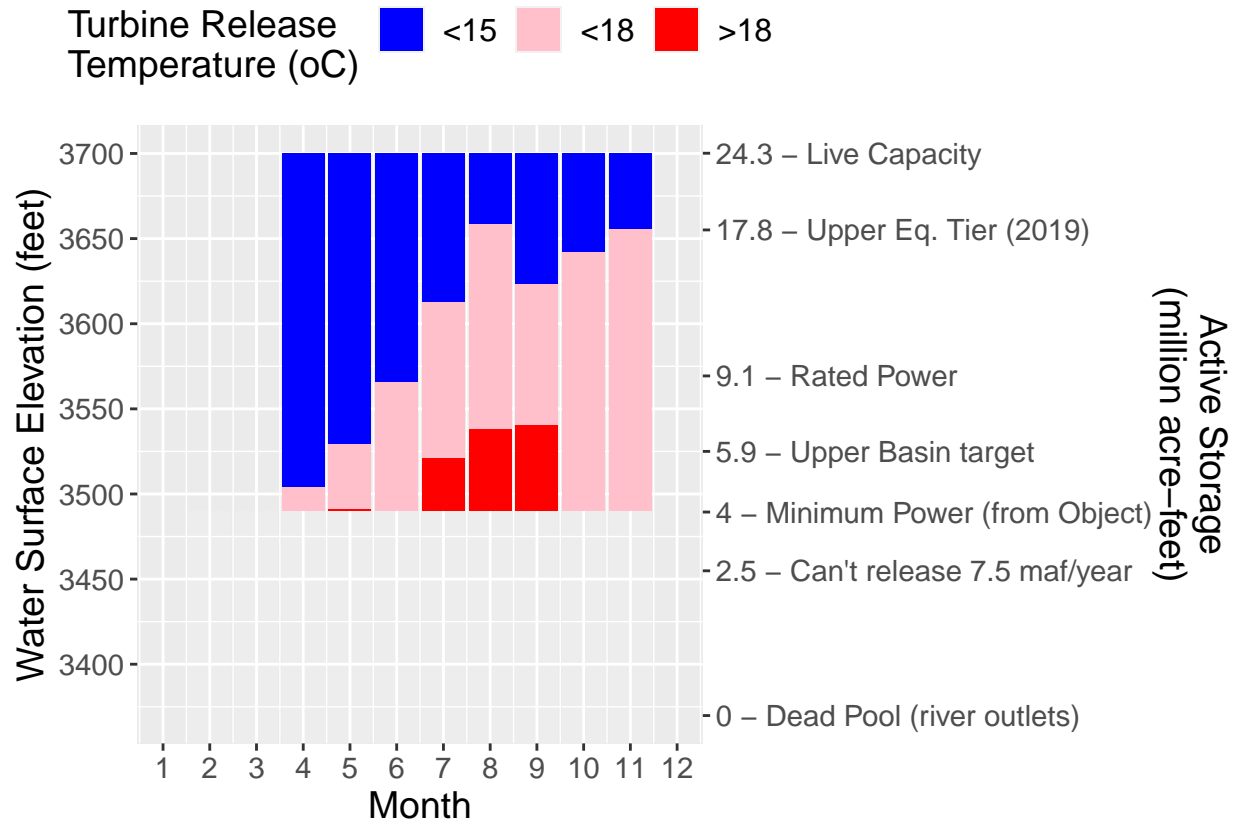


Figure 5. Lake Powell water surface elevations to achieve turbine release temperature targets