

Forecasting River Temperature & Salmon Egg Survival Below Shasta & Keswick Dams

A plain-language guide to how the daily temperature and winter-run Chinook survival forecasts are produced

Sacramento River, California · Updated June 2026

This forecast exists to answer a practical water-management question: **given a planned schedule of dam releases, how warm will the Sacramento River become, and what share of winter-run Chinook salmon eggs are likely to survive?** Water temperature has a large role on whether salmon eggs incubate successfully, so being able to look a few weeks to months ahead helps plan for the temperature management season.

To do this, the system (Central Valley Temperature and Exposure Mapping and Prediction: CVTEMP) links together several connected models. Each one hands its results to the next: the reservoirs determine how cold the water leaving the dams is, the river model carries that water downstream while the weather warms or cools it along the way, and the survival model translates the resulting river temperatures into an estimate of egg mortality.

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Two halves: what we know, and what we expect

Every forecast is built in two stitched-together pieces. The first is the **recent past (Hindcast)** — the period from a few weeks ago up to today. Here the models are anchored to real, measured data: observed dam releases and measured river temperatures. This grounds the simulation in reality and lets it "warm up" so that conditions are realistic by the time today arrives.

The second piece is the **forecast** — from today out to the end of the season. Here the models switch to planned dam-release schedules, since the actual values aren't known yet. The seam between the two halves is today's date. Keeping a measured-history period in front of the forecast is what makes the forward-looking part trustworthy.

Step 1 — Gather the weather forecast

1 Pull the latest national weather model and shape it to the river

The process begins by downloading the most recent run of the Global Forecast System (GFS) model, which covers Northern California in roughly quarter-degree map squares and looks about two weeks ahead. From it the system extracts the quantities that govern water temperature: air temperature, humidity, cloud cover, wind, and the sun and sky radiation reaching the water surface. These broad map grids are then matched to the much finer set of points used by the river model and smoothed onto a regular 15-minute timeline, so the weather lines up exactly with where and when the river model needs it.

Step 2 – Bring in real-world observations

2 Collect and quality-check measured conditions

Next the system retrieves the latest measurements from the California Data Exchange Center (CDEC) public environmental sensor network: reservoir water levels and storage, inflows and outflows, and water temperatures at key points on the river. These are checked for errors and gaps, filled where needed, and converted into consistent units.

Many futures at once. The system doesn't only run a single forecast — it can run a set of **scenarios** side by side, each representing a different assumption about how much water is released, how the inflow season plays out, or what temperature target managers aim for. Every scenario goes through the full chain below independently, and they are computed in parallel so results arrive quickly. On the website you can compare them to see how different operating choices change river temperature and egg survival.

Step 3 – Model Shasta Reservoir

3 Simulate the temperature layers inside the lake

Shasta Reservoir is the largest and most important piece, because the temperature of the water it releases sets the starting point for everything downstream. A detailed reservoir model represents the lake as a stack of horizontal layers, each at its own temperature — cold, dense water settles near the bottom while warmer water floats on top. The model tracks how inflows, outflows, sunlight, and wind reshape these layers over time.

4 Correct the starting profile against real measurements

To start the lake in a realistic state, the model's vertical temperature pattern is compared against the most recent measured depth profile of the reservoir and gently nudged to match it. This correction is deliberately damped — applied only partway — so the model settles smoothly rather than over-shooting. The result is a reservoir that closely reflects today's true conditions before the forecast begins.

5 Choose how to operate the temperature-control gates

Shasta Dam has a Temperature Control Device — a set of intake gates at different depths that let operators draw water from warmer or colder layers of the lake. The model decides which gates to use over the season to hit a target release temperature, balancing the need to keep the river cool now against conserving the limited pool of cold deep water for later in the summer.

Step 4 – Carry the water through Keswick Reservoir

6 Predict the dam-outlet temperature, then refine it

Water released from Shasta flows a short distance into Keswick Reservoir before entering the river. A quick statistical relationship first estimates the temperature of water leaving Keswick from the Shasta release, using observed downstream temperatures wherever they're available. That estimate is fed back to fine-tune Shasta's release-temperature target, and the reservoir model is run a second time so the two reservoirs are consistent. A second reservoir model then routes the water through Keswick itself to produce the final temperature of the water entering the river below the dam.

Step 5 – Route temperature down the river

7 Follow parcels of water downstream as the weather acts on them

A river-temperature model takes the water leaving Keswick and follows it downstream reach by reach, warming or cooling each parcel according to the sun, air temperature, wind, and humidity from the weather data. Over the recent-past period the model is anchored to measured river temperatures so it stays accurate; over the forecast period it is driven by the reservoir output and the weather forecast. The result is a temperature estimate for the whole river over time, including at the specific monitoring locations managers care about most.

Step 6 – Estimate salmon egg survival

8 Translate river temperature into egg mortality

Finally, the river-temperature picture is fed into a salmon egg survival model. Winter-run Chinook lay their eggs in gravel nests called redds, and the eggs are highly sensitive to warm temperatures as they incubate. Using the locations and timing of spawning across many past years, the model calculates the share of eggs expected to die from elevated temperatures under each scenario. It reports a central estimate along with a range that reflects year-to-year variability and uncertainty, so managers see not just a single number but how confident the forecast is.

Step 7 – Publish the results

9 Package everything for the website

The outputs of every scenario — reservoir temperature profiles and gate operations, predicted river temperatures at each location, and egg-survival estimates — are written out in a form the website can read directly. The site then draws the interactive charts you see, letting you compare scenarios, inspect any location, and view both the measured recent past and the forecast on a single timeline.

A few terms you'll see

Scenario

One complete "what if" — a specific assumption about dam releases, water-year conditions, and temperature targets. The forecast compares several at once.

Recent past vs. forecast

The measured-history portion (up to today) versus the forward-looking portion (today onward). Charts typically show both, divided at today's date.

Temperature Control Device (gates)

Shasta Dam's depth-selectable intakes, used to draw cooler or warmer water from the reservoir to manage downstream river temperature.

Redd

A salmon nest dug in river gravel where eggs incubate. Egg survival in the redds is what the final model estimates.

Cold-water pool

The limited reservoir of deep, cold water in Shasta that must be rationed across the whole season to protect salmon during the warmest months.

This document is a general overview of how the Sacramento River temperature and winter-run Chinook egg-survival forecasts are produced. It describes the workflow conceptually; the underlying system uses established reservoir, river, and biological models linked together and refreshed regularly with the latest observations and weather forecasts.