



U.S. Fish & Wildlife Service

The Stream Salmonid Simulator (S3)

Fish Population Dynamics Model

Background

The Klamath River Basin hosts the third largest Pacific salmon run in the continental United States. Starting in the early 1900s, six dams were built to generate hydropower or to divert water for irrigation. In the 1960s, two more water diversion dams were built on the Klamath's largest tributary, the Trinity River.

Dams manage river flow in order to generate electricity or irrigate land. Flows downstream of the dams become highly regulated, and no longer exhibit the natural flow and temperature variability that might occur due to rain or spring snowmelt.

Fisheries and water managers must often evaluate the effects of management actions, such as flow regulation or restoration activities, on native fish

populations. For many managers, it's important to predict the potential impacts of these actions before they happen.

The Klamath River Basin, home to culturally and economically significant salmon runs, is managed by numerous entities across a broad landscape, and predicting potential impacts is particularly important.

How We Help

In the early 2000s, the Arcata Fish and Wildlife Office began collaborating with Texas State University and the USGS Columbia River Research Laboratory to try and address these issues. Together, they created an integrative decision support tool designed to evaluate effects of management alternatives on juvenile salmonid populations: the Stream Salmonid Simulator (S3).

The Model

S3 is a fish population dynamics model that mimics growth, movement, and survival of juvenile salmonid populations in streams and rivers. Growth, movement, and survival are functions of variables that include flow, temperature, habitat, and fish size. S3 allows decision makers to ask complicated questions that can't possibly be monitored or observed in nature.

The model is based on the idea that river flows affect the amount of habitat available to juvenile salmon during different life stages. The amount of available habitat then influences density-dependent processes (foraging, predation, territorial behavior). These factors influence fish size, which in turn affects survival (often larger fish



Klamath River Basin. Red lines denote dam locations. Credit: Humboldt State University



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have higher survival rates) and overall abundance.

The S3 model is currently being used to predict effects of flow management on juvenile fall and spring Chinook Salmon in the Klamath and Trinity rivers. A disease sub-model was also created specifically for the Klamath River, to simulate effects of *Ceratanova shasta*, an infectious parasite, on juvenile Chinook Salmon. Additionally, a juvenile Coho Salmon model for the Klamath River is being constructed.

Inputs and Outputs

S3 is uniquely data rich. Every long-term research and monitoring dataset collected by the Arcata FWO and tribal partners is used in the model. Some of the data that has been collected includes water temperature, habitat suitability, 2-D hydrodynamic models, spawning distribution and abundance, and juvenile distribution and abundance.

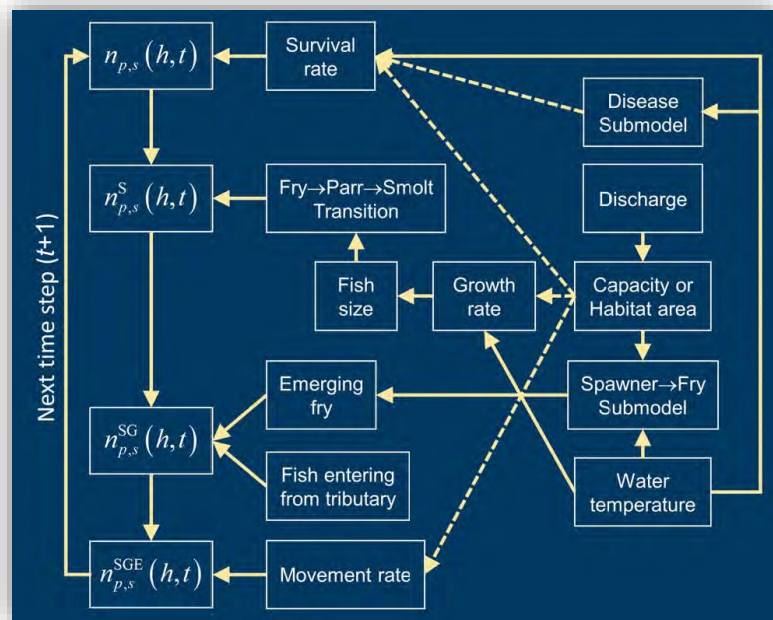
Outputs of the model include the effects that management alternatives would have on juvenile fish abundance, predicted disease mortality, and biomass.

For More Information

See the following published reports:

Perry, R.W., Plumb, J.M., Jones, E.C., Som, N.A., Hetrick, N.J., and Hardy, T.B., 2018.
<https://doi.org/10.3133/ofr20181056>.

<https://www.fws.gov/arcata/fisheries>



Schematic summary of the S3 model showing linkages between physical drivers, demographic processes, and changes in daily abundance. Dashed lines show sub-models that may be turned on or off to represent different dynamic processes in the S3 model.

Credit: USGS



Juvenile Chinook Salmon life stages, from top left, clockwise: fry, parr, smolt. Credit: USFWS



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