RECLAMATION Managing Water in the West

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The Knowledge Stream

Research Update

Determining How Runoff and Temperature Changes Are Linked to Fish Habitat

Evaluating climate-induced runoff and temperature change on stream habitat metrics for endangered or threatened fish

Bottom Line

This research helps provide the tools needed to inform planners and designers how climate change can alter the hydrologic runoff and water temperature inputs to stream and floodplain reaches used by endangered or threatened fish species.

Better, Faster, Cheaper

This type of model framework is useful for planning and evaluating habitat improvement projects for ESA-listed salmonids in the context of anticipated global climate change. Water temperature information at a finer scale will help better analyze and design rehabilitation projects for endangered or threatened fish species. This two-dimensional (2-D) model capability is particularly useful in unconfined channel areas that provide important habitat for juvenile salmonids and other fish.

Principal Investigator

Jennifer Bountry
Hydraulic Engineer
Sedimentation and River Hydraulics Group
Technical Service Center
303-445-3614
jbountry@usbr.gov

Research Office Contact

Miguel Rocha
Science and Technology Program Research Coordinator
303-445-2841
mrocha@usbr.gov

Problem

Stream rehabilitation projects have been ongoing under numerous programs for many years. Rehabilitation actions are often based on altering channel hydraulics and form to provide appropriate velocities, depths, and sediment sizes preferred by the fish species of interest. These actions are engineering solutions designed to increase the quantity of available habitat from a physical perspective. However, it is generally not clear if actions improve the quality of the habitat, if the habitat generated is sustainable over the long term, and whether fish will ultimately use it.

Salmonids, in particular, require adequate availability of food, but linkages between altered hydraulics and the food web are almost never evaluated, even though these connections could cause a failure to meet the basic rehabilitation objectives. Critical links between fish growth and survival and watershed and river-scale processes (hydraulic residence time, fluctuation in flood plain and side channel inundation, and water temperature) need to be understood.

Stream temperatures are an important component of aquatic habitat throughout the year. To further complicate matters, climate change has become an increasing concern in salmon programs under the Endangered Species Act (ESA), because many streams are already believed to be at an upper threshold of tolerable water temperatures during low-flow, later summer, and fall periods. These linkages are directly related to the flow runoff and water temperature which, in turn, are impacted by climate change.

Solution

This research provides a water temperature model that can be integrated into a set of linked models to help predict the short- and long-term effects of climate change and resource management actions on river processes. The model framework will add the capability of linking watershed and reach-scale hydraulic and water temperature models (and reach-scale numerical models) with biological models that will predict age-specific and life stage-specific fish production based on habitat and food availability.

Collecting stream on the Methow River, Washington.

Application

This model can be applied in several analyses, including evaluating temperatures in complex river systems with many flow paths and floodplain interaction. The model will be useful in evaluating the impact of restoration strategies on stream temperature. For example, if restoration strategies include construction of side channel habitat or levee setbacks, the model can be used to evaluate the impact to stream temperature due to these actions.

The current specific applications of the model include the Methow River, in eastern Washington, which is a well-mixed river with steep slopes and fairly shallow depths. A reach with a warmer tributary and cold water springs was selected for a variety of temperature conditions. This means that the water temperatures are similar from the top to the bottom of the river in a given spot. The 2-D model captures the lateral variations, particularly where there are many channel paths.

The model is also being tested on the San Joaquin River, California, which is a regulated system with gravel pits. The San Joaquin River Restoration Program is interested in evaluating the effect of gravel pits on stream temperature and how potential channel reconfiguration can improve stream temperatures for salmon.

Future Plans

Reclamation is working with the U.S. Geological Survey to use this model framework as a basis to develop the biological modeling tools and assist with temperature data collection protocols. Future research applications might link this model with groundwater inputs to identify important habitat areas (temperature refuges) for fish on a given stretch of river.

Now that the water temperature module is up and running, future research steps include water temperature sensitivity analysis to weather parameters. These factors are represented in the model, but how important factors such as solar radiation, atmospheric radiation, and heat losses are influencing water temperature predictions also need to be understood.

Analyzing more diverse test cases, including regulated rivers with more geographical, biological, and operational diversity, will make the model more robust and applicable to a wider variety of situations. This will also improve the model's reliability and credibility.

"The models will help Reclamation and its partners analyze how future climate may affect river rehabilitation projects to improve conditions for listed salmonids with consideration for habitat response to climate change."

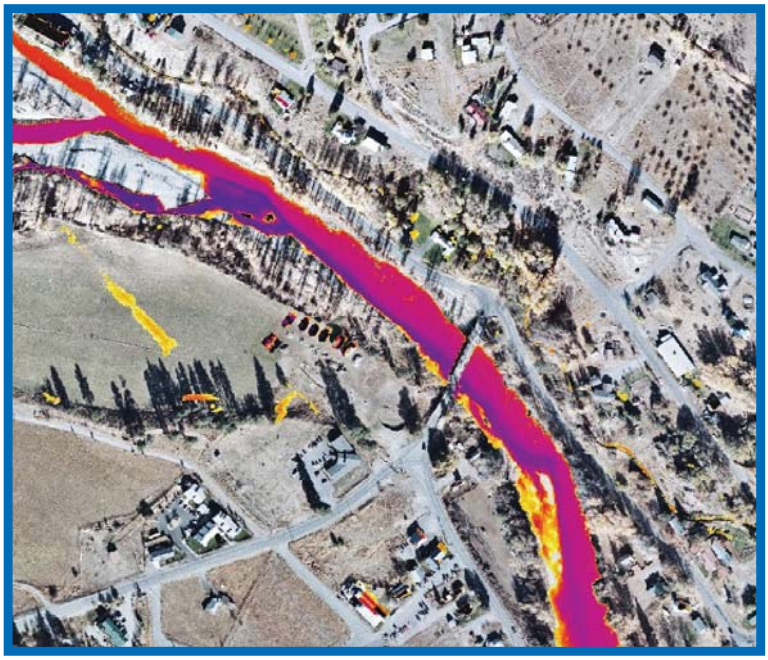
Jennifer Bountry
Hydraulic Engineer,
Reclamation's Technical Service Center

Collaborators

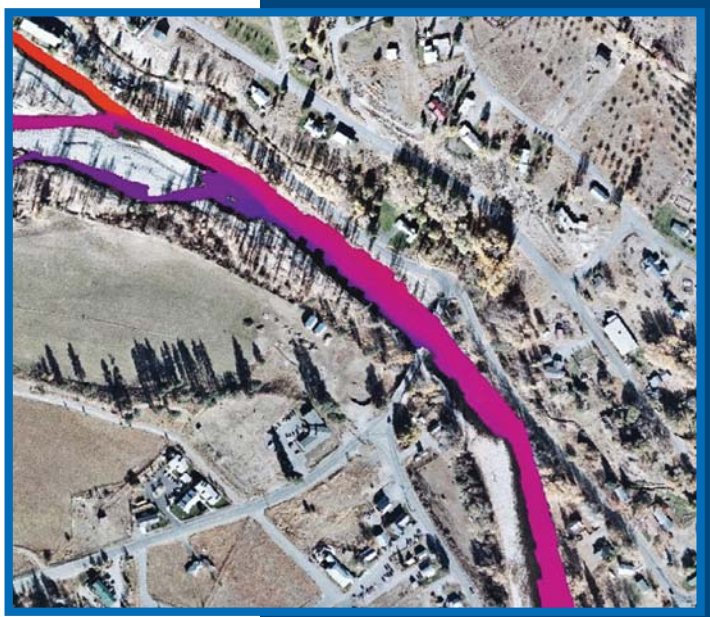
- **Reclamation's Methow Field Office**
- **USGS**
- **University of Washington**

More Information

www.usbr.gov/research/projects/detail.cfm?id=6507



Field data that shows surface and groundwater temperatures.



Model for surface water temperatures, with major groundwater inputs represented in the model.