# Science to Support Aquatic Ecosystem Resilience

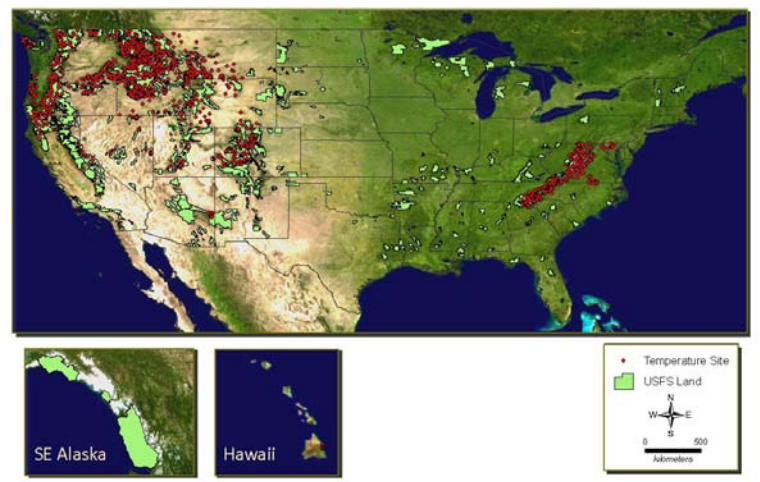
*Forest Service scientists work with managers to provide the science and tools to assess the effects of climate change on fish and fish habitats and to prioritize restoration efforts.*

## BACKGROUND

Climate change is one of the most critical long-term threats to fish population and habitat population resilience. Increasing stream temperature, altered steam flows, and changing patterns of disturbance affect the ability of aquatic habitats to support fish populations. Forest Service scientists have built on years of research and a wealth of long-term data to: model the landscape variables influencing aquatic habitat change at multiple scales; assess the interacting effects of disturbances such as invasive species, fire, and climate; and assess population responses to these habitat changes. This research improves management efficiency, identification of the highest priority habitats for protection, approaches and management tools for restoring resilient habitats and populations, as well as strategies for protecting unique species and ecosystems.

PHOTO CREDIT: KAREN NICHOLS

*Bull trout is a federally listed threatened species. Forest Service research informs how to prioritize management activities to protect this species.*




*Forest Service year-round, continuous stream temperature monitoring sites. n=1599*

## HIGHLIGHTED RESEARCH

***Maximizing efficiency of stream temperature monitoring*** *– Providing tools that allow managers to leverage multi-partner data, reduce monitoring costs, and facilitate management decisions across landscapes.*

The Forest Service has one of the largest and most valuable stream temperature monitoring networks, developed from years of landscape-scale stream temperature monitoring. These lands cover the Nation's best cold water fisheries habitat in high-elevation areas where the effects of climate change are already being measured. In addition, Forest Service climate research is strengthened by the network of Forest Service Experimental Forests and Ranges, many of which have more than 50 years of climate data.

The Forest Service leverages these data with partners to improve the efficiency of temperature monitoring. For example, a recently launched, multi-partner web-accessible database "NorWest" made accessible stream temperature monitoring data worth an estimated $10,000,000. The data had been collected by more than 60 state, federal, tribal, and private resource agencies in previous decades. Ultimately, this resource will facilitate better climate vulnerability assessments for aquatic species, enable coordinated management responses, and improve the efficiency of monitoring efforts by reducing redundancies.

## MORE INFORMATION:

For more information, visit the website: http://1.usa.gov/14cwL0j or contact Katherine Smith, Fisheries Research National Program Lead, klsmith@fs.fed.us

# HIGHLIGHTED RESEARCH CONTINUED:

***Predicting changes in fish habitats*** *– Developing new research and technology to assess the effects of climate change and other disturbance on aquatic habitats at management relevant scales.*

Forest Service scientists utilized low cost stream temperature sensors and developed new spatial statistical modeling approaches to develop regional stream temperature models and climate scenarios for 350,000 stream kilometers across the Northwest US. These models provide accurate basin- to landscape-scale stream temperature predictions under future climate scenario and are used to assess vulnerability and prioritize habitat restoration efforts for important fish species such as bull trout.

Similar approaches have been used in the eastern US to identify watersheds most likely to support brook trout in a warmer future. While groundwater resources play a large role in the sensitivity of individual watersheds to warming, existing models do not adequately explain why some watersheds are less sensitive to increased air temperatures than others. Forest Service scientists and partners are working to improve predictive power of stream temperature models and to expand regional stream temperature monitoring networks.

Forest Service scientists partnered with Earth Systems Institute to develop NetMap, a platform for rapidly conducting cost-effective watershed analysis (netmaptools.org). This tool supports climate smart management by identifying areas of watershed that are most likely to warm, are susceptible to erosion and mass wasting from wildfires and floods, and are currently most productive for fish. NetMap is available to forest managers in the Northwest and is being expanded to cover other western regions.

PHOTO CREDIT: FOREST SERVICE

*Forest Service research informs the protection of unique species and ecosystems, such as the Golden Trout Wilderness in California.*

***Understanding fish population response to climate change*** *– Improving understanding of climate driven habitat changes on fish population abundance and distribution.*

Forest Service scientists are conducting long-term population studies to quantify and model the consequences of climate change (stream temperature and flow), invasive species, barrier removal, and other factors on fish population persistence under different climate and management scenarios. For example, in a western Massachusetts study, scientists identified spatial and season-specific flow and temperature characteristics influencing brook trout survival. This research may be expanded along a large latitudinal gradient ranging from Vermont to North Carolina to inform targeted restoration actions that could help many populations persist.

Population resilience of native salmonids to fire was assessed in the Wenatchee River watershed in Washington, and these models can be used in other areas of the western US to guide fire management activities. Forest Service scientists projected that populations of spring Chinook are resilient to fire in the Wenatchee River watershed because high intensity wildfire is not predicted close to the streams that they occupy, making effects of fire on habitat minimal. However, bull trout, which are very sensitive to stream temperature, are located in potentially isolated portions of the stream network and are thus less resilient to wildfire in this system.

***Protecting unique species and ecosystems*** *– Exploring the effects of climate change on unique ecosystems and species.*

Long-term, stream monitoring across a precipitation gradient is being used to assess how changes in precipitation and replacement of native forests by invasive species alter water supply and habitat for culturally important aquatic species in Hawaii.

In the Copper River Delta, Alaska, scientists are assessing how climate change affects the invertebrate community, and in turn the fish and birds that depend on them. They examined the relation between the timing of emergence of aquatic invertebrates in the spring and the nesting of rusty blackbirds, an Endangered Species Act candidate species, to identify current and future areas likely to be utilized for nesting.

The California Golden Trout is imperiled due to introduced exotic trout, genetic hybridization, and degraded habitat, and faces further stress from climate warming. Forest Service scientists are working to identify which streams areas in the Golden Trout Wilderness (CA) are most vulnerable to warming and of priority for management responses to ensure habitats are more resilient to predicted changes in water temperature, flow, and snow pack.