Northern Rocky Mountain Science Center

Clint Muhlfeld [(1)], Greg Pederson [(1)], Dan Fagre [(1)], Carl Key [(1)], Jeff Kershner [(2)]

[(1)] USGS-Northern Rocky Mountain Science Center, West Glacier Field Station
[(2)] USGS-Northern Rocky Mountain Science Center, Bozeman Center Headquarters

The Potential Impacts of Climate Change on Native Aquatic Ecosystems of the Northern Rocky Mountains.

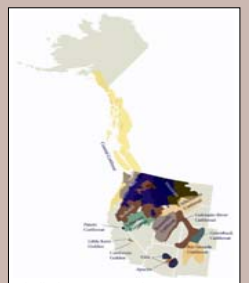
Background:

State and federal agencies and non-governmental organizations are increasingly consumed with the recovery and restoration of native trout and salmon throughout the western United States. Almost all of the native inland cutthroat species, grayling and bull trout have been proposed for listing under the Endangered Species Act and a number are currently listed as "threatened". Trout, grayling, and char historically inhabited a variety of freshwater habitats, but have declined due to habitat degradation, fragmentation, and introductions of nonnative species. The remaining intact populations of native fish species are largely restricted to small, fragmented headwater habitats, which are increasingly vulnerable to wildfires and subsequent flooding. Complicating these issues is global warming and associated climate change, which are likely to increase air and water temperatures, increase the risk of wildfire, change the timing and quantity of water from snowpack, increase winter flooding in some areas, and provide habitat conditions that favor introduced species. Understanding how effects of climate change will influence habitat for native fish is critical for effective management and recovery of these species.

Composite climate risk map of historic and current range for Westslope cutthroat trout. Adapted from William et al. 2007

Project:

Scientists at the USGS—Northern Rocky Mountain Science Center (NOROCK) and their partners from U.S. Forest Service and Trout Unlimited are examining how climate change may be impacting the habitats of native fish species throughout the Rocky Mountains and the interior western United States. The goal is to provide tools that will help managers predict potential climate change induced impacts on native fish. Specific research questions the team are exploring include:



Distribution of western native trout throughout North America. Adapted from Western Native Trout Initiative, 2008.

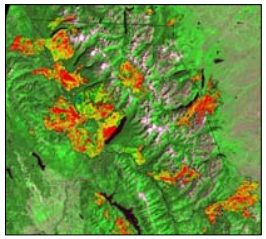
- What is the geographic distribution of target species or populations in relationship to current temperature and stream flow regimes?
- How are stream flow and temperature regimes likely to change in response to a warming climate, and which habitats and populations will be affected most?
- How will these large-scale changes in climate affect native fish distributions across the western United States?
- How well does the relationship between climate and fish distribution reflect actual measurements in a basin?

Native westslope cutthroat trout (above) and bull trout (right) have persisted in the Crown of the Continent Ecosystem ~11,000-14,000 years. They have the coldest temperature requirements among inland salmonids species.

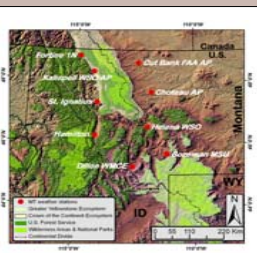
Approach – Fine scale analysis:

In order to fully understand the impacts of climate change on aquatic resources at multiple spatial scales, the team will implement the second phase of the project in 2009, which will assess the utility of coarse-grained, large scale models of climate impacts versus finer-grained approaches to "downscale" climate impacts. This multi-scale approach will provide resource managers with the necessary information to develop stream or drainage-specific habitat and fish management programs to mitigate for climate change.

This study will predict how native fish distributions and life histories may be modified under various warming climate scenarios in the Crown of the Continent Ecosystem. This information may be used by managers to develop pro-active conservation measures to maintain and protect native bull trout and westslope cutthroat trout populations. Fine-scale analyses will focus on systems with higher-resolution data at reach and stream scales. Data include current and historic water temperatures, flows, fire regimes, and fish species distributions. The focal Salmonid species of this study are the threatened bull trout and the westslope cutthroat trout, both of which are highly sensitive to elevated temperatures.



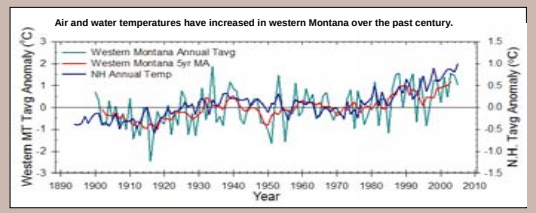
The frequency and intensity of wildfires have increased in Glacier National Park over the past 100 years. This cumulative map shows the most recent major fires, 1967-2007. Red areas are those most severely burned.



Map of western Montana showing weather stations used in this study, sensitive ecosystems associated with National Parks, and other protected federal lands.

Salmonids are often considered a keystone species for aquatic and terrestrial ecosystems, and may be an especially important indicator of ecosystem health in the face of climate change. They provide an excellent early warning indicator of climate warming because their body temperature is dependent on the temperature of their surroundings, and they have characteristically narrow tolerances of thermal fluctuation.

This study will: (1) synthesize current data on the distribution and temperature requirements of native bull and cutthroat trout; (2) compile all current and historic data for water temperature, air temperature, flow and precipitation, and their relationships to elevation, basin area, vegetation, and wildfire regime etc. in each stream; (3) assess the relationship of these factors and the distribution (occurrence) of native salmonids; (4) map the current fish distributions, temperatures and habitats in a GIS framework ; (5) explore the distributions of thermally suitable habitat for each species and life history type under warming climate scenarios (50, 100, 150 and 300 years); (6) identify populations and species that are at greater risk of extirpation in the face of climate change; and (7) assess the future effects of invasive aquatic species.



Air and water temperatures have increased in western Montana over the past century.

These results will be contrasted with two other fine-scale studies that the team is working on in the west (Idaho and Colorado) to compare climate impacts among and within salmonid species across broad geographic areas in the western United States. Additional sub-species with significant data for conducting fine-scale analyses potentially include the Rio Grande cutthroat trout and Gila trout.