Air, Water and Aquatic Environments Science Program

Rocky Mountain Research Station

Climate Change & Wildfires:

Effects on Stream Temperatures & Thermal Habitat

Research | Technology Transfer | Science Application

Key Findings:

- Stream temperature is a key factor affecting aquatic ecosystems.
- Climate change is expected to warm streams and predicting stream temperature changes will be necessary to inform proactive management.
- Stream temperatures and climate change effects can be modeled over entire stream networks using existing temperature databases in combination with new spatial statistical models.
- Mean summer stream temperatures across a central Idaho river basin warmed at the rate of 0.27°C/decade from 1993-2006. Warming rates and effects on thermal habitat varied spatially and affected species differently.

Context

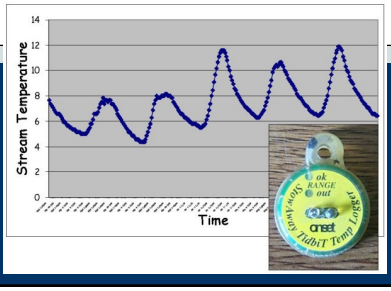
Temperature has an important influence on the distribution and abundance of stream organisms. A warming climate is expected to increase stream temperatures, but documentation of such increases is rare and usually limited to trend monitoring at a few sites. Broader understanding of climate effects on thermal characteristics of streams is needed to inform management strategies, but developing this understanding requires modeling techniques that provide valid interpolations between temperature measurement sites. Widespread use of digital temperature loggers provides abundant data in many places that may facilitate development of broad stream temperature models.

Actions

A large stream temperature database (n = 780) spanning the period from 1993–2006 was compiled from several natural resource agencies within the Boise River basin in central Idaho. A temperature model based on new statistical techniques for stream networks was developed using these data that explained 93% of the variation in mean summer temperatures (average prediction error = 0.74°C) during this period. The model was used to describe how recent wildfires and trends of increasing air temperatures and decreasing summer flows affected stream temperatures and fish habitats across the 2,500 km river network in the Boise basin.

Results

During the study period, basin average mean summer stream temperatures increased by 0.38°C (0.27°C/decade), primarily due to long-term (30 – 50 year) trends in air temperature and stream flow (Figure 1). Solar radiation increases following wildfires accounted for 9% of basin-scale temperature increases, despite burning 14% of the basin. Within wildfire perimeters, however, stream temperature increases were 2 – 3 times greater than basin averages and radiation gains accounted for 50% of warming. The total length of thermal habitat for rainbow trout was minimally affected by temperature increases, except for small shifts towards higher elevations. Bull trout, in contrast, were estimated to have lost 11% - 20% (8% - 16%/decade) of the headwater stream lengths that were cold enough for spawning and early juvenile rearing (Figure 2). Our results suggest a warming climate has begun to affect thermal conditions in the Boise River network and that biological impacts may be both species and context specific. Where key habitats appear to be at risk, decisions regarding conservation actions should account for local restoration opportunities and potential for future climatic effects. Broader application of similar temperature analyses could also be an important component of regional prioritization schemes for USFS lands.



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http://www.fs.fed.us/rm/boise/awae_home.shtml

Updated 11/17/2010 E. Leavitt

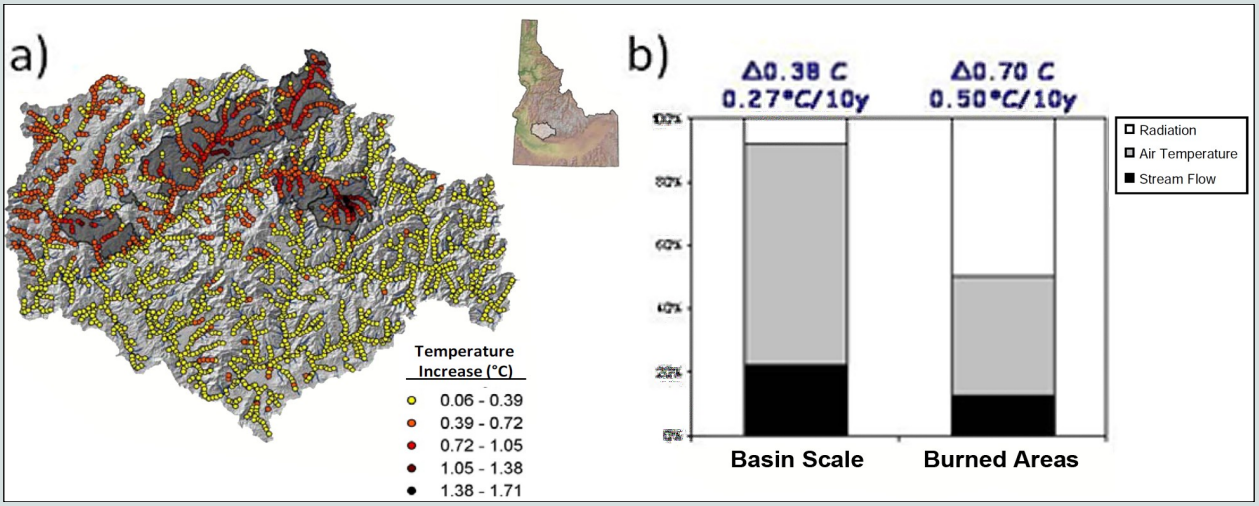


FIGURE 1. Changes in mean summer stream temperatures across the Boise River network from 1993-2006 (a) and relative influence of factors causing temperature changes (b). Total amount of stream temperature increase and rates of warming are given above bars.

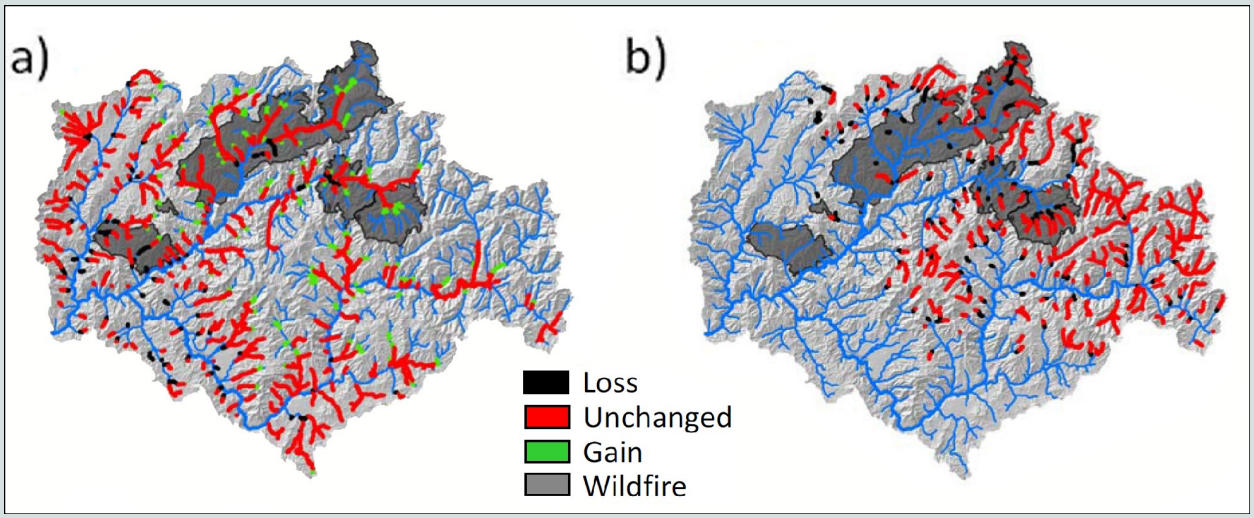


FIGURE 2. Changes in thermally suitable habitat for rainbow trout (a) and bull trout (b) from 1993- 2006 due to stream temperature increases associated with climate trends and recent wildfires.

Publications and Presentations

Isaak, Daniel J.; Luce, Charles H.; Rieman, Bruce E.; Nagel, David E.; Peterson, Erin E.; Horan, Dona L.; Parkes, Sharon; Chandler, Gwynne L. 2010. Effects of climate change and wildfire on stream temperatures and salmonid thermal habitat in a mountain river network. Ecological Applications. 20(5): 1350-1371.

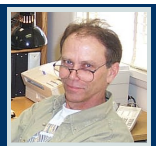
Isaak, D.J., B.E. Rieman, and C. Luce. 2009. Stream thermal regimes and aquatic ecosystems in a changing climate. Western Watersheds and Climate Change Workshop. Boulder, CO. November 17 – 19.

Isaak, D.J., B.E. Rieman, and C. Luce. 2009. Collecting, organizing, and applying stream temperature data. Western Watersheds and Climate Change Workshop. Boulder, CO. November 17 – 19.

Project Science Team

Dan Isaak
Fisheries Research Biologist
U.S. Forest Service
(208) 373-4385
Email: disaak@fs.fed.us

Charlie Luce
Research Hydrologist
U.S. Forest Service
(208) 373-4382
Email: cluce@fs.fed.us



Bruce Rieman
Emeritus Fisheries Scientist
U.S. Forest Service
(406) 677-3813
Email: brieman@fs.fed.us

David Nagel
Spatial Analyst/Physical Scientist
U.S. Forest Service
Phone: (208) 373-4397
Email: dnagel@fs.fed.us