Native bull trout prefer cold glacier-fed streams. (Photo by Joel Sartore.).

Turning Conservation on its Head

By Dan Isaak

Building a Climate Shield: Protecting Our Coldest Streams to Preserve Biodiversity

The realization struck me as I drove the winding mountain highways along rivers and streams through Montana and Idaho to my home in Boise. Those of us in the conservation community working with cold-water species had been thinking about the problem in the wrong way. We had the world upside down!

As a fisheries scientist with Forest Service research, I have spent much of the last 15 years contemplating why some populations of native cutthroat trout and bull trout, two endangered native species that anglers love to catch, were being lost while others persisted. And I wasn't alone—this basic conundrum had perplexed much of the fisheries community for a much longer time. Then I realized that most of the places where species losses occurred were in warmer, low elevation streams and rivers where they had been systematically displaced (or eaten) by a long list of popular nonnative sport-fishes like bass, pike, brown trout, rainbow trout and lake trout. But what if instead of that bottom up view, we viewed the world from the top down, starting high in the mountains? That view—from a much colder vantage point—would reveal robust and widespread populations of bull trout and cutthroat trout, even some amphibian species like tailed frogs—everywhere we looked! How could those two views be of the same world, especially one where decades of rapid climate change have occurred and nonnative species seem ubiquitous?

Temperature is Destiny

The answer to that riddle is, quite simply, that temperature is destiny

for ectothermic animals, be they fish or frogs. Each species has a narrow range of temperatures where its physiological processes have evolved to work best. As a result, the spatial arrangement of stream temperatures across landscapes dictates where organisms live and breed, how fast they grow, and which ones win competitive battles when different species come into contact. In my research, I'd seen these basic patterns, manifested through species distributions, play out time and time again on streams across the Northwest during summer field sampling campaigns. That fundamental bit of aquatic ecology now held the key to something far more profound. The huge temperature gradients across mountain landscapes, combined with the preference that native species like bull trout and cutthroat trout have for particularly chilly streams, explained the dichotomy between bottom-up and top-down views. It also raised an intriguing conservation possibility: we could use climate as an ally to help exclude non-native species and to identify specific streams that would serve as long-term climate refugia for native species. Quite the grand plan, I thought to myself, but implementing it would require stream climate maps of unprecedented accuracy across a huge area, including some 150,000 miles of rivers and streams in the Northwest.

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Data, Data Everywhere

The problem, as I knew all too well, wasn't a lack of data. It was too much data. Or rather, too much data that wasn't organized to be useful. A few years before my world-flipping epiphany my research group had done a project to develop a stream temperature model for a small river network in central Idaho. The project's budget was limited. So, rather than collect new temperature data, we solicited existing data from biologists that worked within the basin. They sent lots of data. And they kept sending it. Soon we were buried in data that would take us months to organize. But once we organized the data into a large database, we were able to build a stream temperature model so accurate we could predict where different species occurred in the network.

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The biologists that sent us the data validated the accuracy of our predictions and started using the stream temperature maps themselves. They loved having an organized database that gave everyone access to everyone else's data. Once they had a picture of the overall efforts, they began organizing their future temperature monitoring to minimize redundancy and fill in gaps on streams with little data.

Timing is Everything

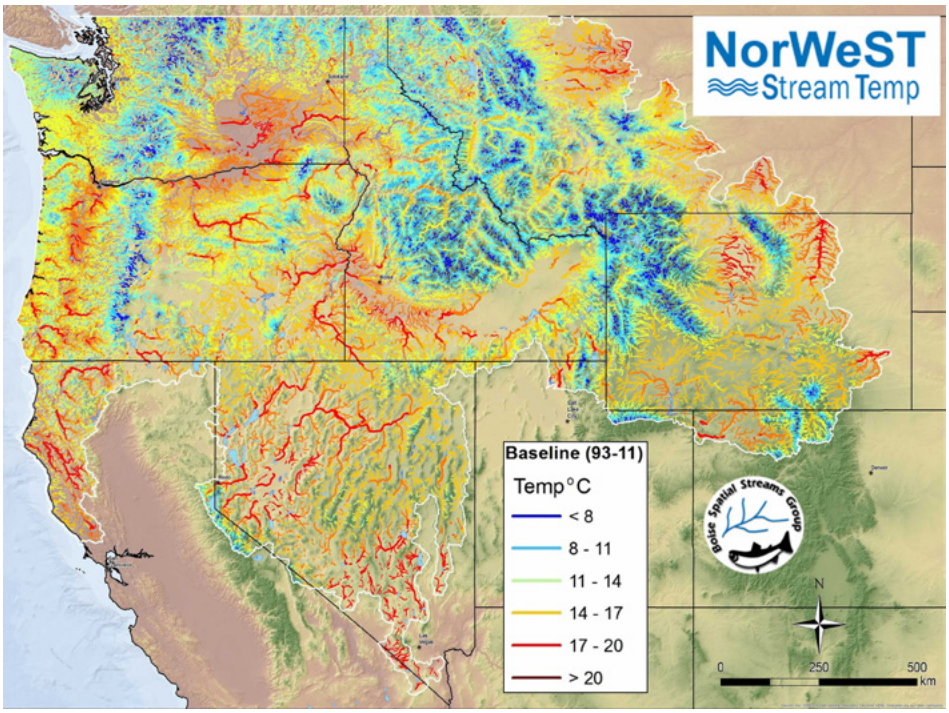
In early 2011, shortly after our research group had mastered the technical aspects of temperature data mining, the Great Northern and North Pacific Landscape Conservation Cooperatives came into being, and funded a regional expansion of the approach through the NorWeST project. More than 150,000 miles of streams now have climate maps, and the project has proven so successful that it continues to grow, which means we're organizing messy temperature datasets to this day. The NorWeST data team recently completed a comprehensive interagency temperature database and climate scenarios for the state of California and the project is set to expand throughout the remainder of the American West later this year.

Along the way, our small team will have organized a mind-boggling 200 million hourly temperature records from more than 20,000 stream sites and developed scenarios for almost 500,000 miles

of stream. This massive database includes the contributions of hundreds of individuals working for more than 100 state, tribal, federal, private, and municipal resource organizations.

Turning the World Right-side Up

The NorWeST stream climate maps, combined with large datasets describing fish species distributions, confirmed my original insight. Once the data was organized, it was easy to see that cutthroat and bull trout populations were abundant in climate spaces that were too cold for invasion by most of their competitors. Those basic insights were encapsulated in the Cold-Water Climate Shield research project, which now provides user-friendly digital maps and GIS databases showing which streams throughout the Northwest are most likely to serve as climate refugia this century.



A NorWeST stream temperature climate map used in the Climate Shield project to highlight refuge streams for cold-water species. This project started in the northwest and has grown to encompass all rivers and streams in the American West.

Author Dan Isaak is a researcher for the US Forest Service, Rocky Mountain Research Station. He studies how native stream fish communities throughout the American West are affected by natural landscape gradients and human alteration of those gradients.

The maps and databases have been broadly adopted by many agencies for conservation planning and the work has inspired other groups to develop similar applications for other species. Most recently, the Environmental Protection Agency (EPA), in coordination with the Oregon Department of Environmental Quality, began using the NorWeST database to map cold-water refugia for salmon in larger rivers throughout the Northwest.

As the conservation and social networks among organizations strengthen, my hope is that they will build another type of climate shield to reinforce protection for the Northwest's iconic cold-water species. Then, who knows, maybe later this century we will turn the world right-side up again with regards to our greenhouse gas emissions and will get this climate thing under control. At that point, we'll have brought with us a bunch of cold-water critters that future generations can enjoy and marvel at in the post climate-change world.

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