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Some Good News on Climate Change: High mountain streams act as strongholds for cold-water species

Contrary to broad perceptions, high mountain streams are warming more slowly than low-elevation streams and rivers. Studies by Rocky Mountain Research Station (RMRS) scientists and their collaborators show that they will sustain populations of cold-water species, including fish such as threatened bull trout and cutthroat trout, even as the climate warms. This is also good news for other animals dependent on cold-water systems, including birds such as the American dipper and harlequin duck, mammals such as river otters, and insects such as stone flies and mayflies, which are critical to flyfishing.

Trout in the Rocky Mountain region and salmon in the Pacific Northwest, cold-water species, play a critical role in local food webs. They also have cultural significance to tribes and recreational and economic significance throughout the regions. In 2016, U.S. freshwater anglers spent about $27.5 billion on trips and equipment outside of the Great Lakes.

“Temperature is destiny” for cold-blooded animals such as fish, says Daniel Isaak, research fisheries scientist with RMRS. “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” many aspects of a fish’s life, including which species comes out on top when coldwater-sensitive natives meet nonnatives.

Initial predictions from some stream temperature models suggested that high-elevation streams might be especially sensitive to climate change, says Charlie Luce, RMRS research hydrologist. But that didn’t seem right to Luce, because high-elevation headwater streams get very cold in winter and warm only slightly over the course of the summer as the sun’s energy increases, because they are fed by still-cool groundwater.

Managing cold-water fish is directly relevant to the USDA Forest Service mission under laws such as the National Forest Management Act, the Clean Water Act, and the Endangered Species Act (ESA). Many streams

Headwater streams in the Rocky Mountains are often heavily shaded by nearby trees and derive most of their flow from snowmelt, which makes them both cold and resistant to additional warming caused by wildfires or climate change. USDA Forest Service photo by Dan Isaak.

and rivers in the Northwest have been listed as impaired for water temperature, which is frequently a key driver of federal species listing decisions.

Through a series of research projects (see box about NorWeST), Isaak, Luce, and collaborators built a prototype model predicting stream temperatures from air temperatures and elevations in a river basin in Idaho.

Next, they sought to scale up the model to cover the western third of the country. They crowdsourced stream temperature data from more than 100 resource agencies around the region. The resulting NorWeST database—includes more than 220 million individual recordings at nearly 23,000 unique stream monitoring sites.

"The big picture thing motivating it, at least from my perspective as a fish biologist," Isaak says, "was trying to understand the vulnerability in all these cold-water dependent, sensitive species and the risks going forward" with a changing climate. "Are they going to go extinct?"

The massive data collection effort and the scientific information derived from it helped refute the common perception that high-elevation streams would be more sensitive to climate change.

Luce, Isaak, and colleagues showed in a 2014 paper based on NorWeST data that there's a temperature dependence to the response to climate change. "High-elevation streams are relatively insensitive" to warming under climate change, says Luce.

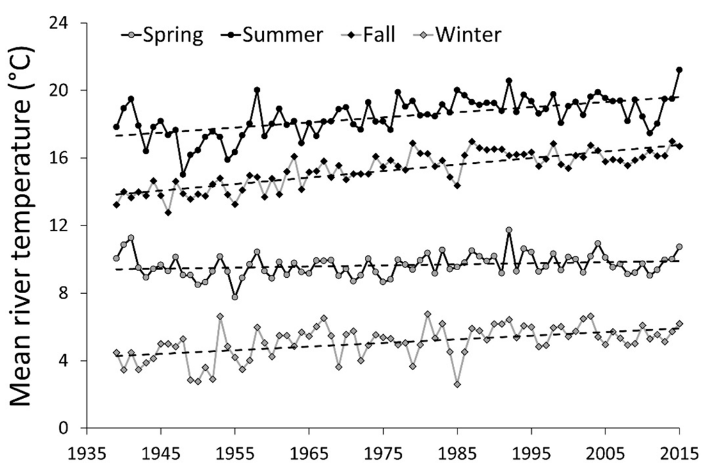
Over the past decade, Isaak and Luce have further explored this finding. In a paper published in 2023, they examined long-term monitoring records for stream temperature, air temperature, and stream discharge across broad elevation gradients to better understand potential future trends in cold-water fish. Based on reduced rates of observed warming in high-elevation streams, they concluded that "predictions

Summary

Driven by a desire to understand and predict how stream environments are changing in association with climate change, and where sensitive aquatic species might persist in long-term climate refugia, a team of Rocky Mountain Research Station scientists set out to develop highly accurate stream temperature and flow scenarios.

The researchers applied a novel approach to data collection that involved soliciting copies of stream temperature and species distribution survey records from many different organizations and then organizing and integrating these records into unified databases for analysis. The collaborative approach, often referred to as crowdsourcing, yielded immense and consistently formatted data sets comprising thousands of observations at a small fraction of the cost that would have been required to collect new data. The approach had an added benefit of engaging the management and conservation communities in the coproduction of science.

The accurate species distribution models that resulted from this research can be applied broadly throughout the ranges of many species to predict which individual streams are most and least likely to continue supporting populations in the future so that managers can plan conservation strategies accordingly. In many cases, the analyses have indicated that high mountain cold-water streams will act as climate refugia for economically important cold-water fish and other sensitive species even as the climate warms.



Water temperatures within streams and rivers have been increasing rapidly across the globe in recent decades in association with warming air temperatures, as illustrated in long-term monitoring records like this one from Bonneville Dam on the Columbia River in the northwestern United States. These records also suggest that warming is occurring at different rates throughout the year. In the case of the Columbia River, warming has occurred most rapidly during the summer and fall, when air temperature increases are the largest and the buffering effects from snowmelt runoff are the weakest.

of above average warming effects on headwater organisms for this region may be overly pessimistic."

"Many of the same processes that protect the stream from warming up and keep it cold now are also going to keep it from warming in the future," Luce says. The streams that stay cooler over the summer are protected by snowpack, deep groundwater, and thick forest canopies.

Isaak says that high mountain cold-water streams are not totally resistant to climate change, and they're "still going to warm up and impact biological communities, so they'll require thoughtful management to conserve them. But they're not nearly as vulnerable as we thought when we first started our research."

Crowdsourced Data from Interagency Partnerships

One thing that sets NorWeST apart from other models is the collaborative nature of the data it's built upon. Isaak, Luce, and others started conceptualizing the model with early work in Idaho but recognized that it'd be much stronger with a lot more data. They put out an interagency call throughout the West for stream temperature and related data.

Brian Staab, regional hydrologist with the Forest Service, Pacific Northwest Region, knew that his region had enormous amounts of stream temperature data already. He initially worked with Luce to provide the data used in the 2014 paper, and then worked with Isaak to process additional data and join it with other data sets. The possibilities of what researchers and managers could do with the database were recognized by Staab. He and others amplified Isaak's call for data and encouraged people from many

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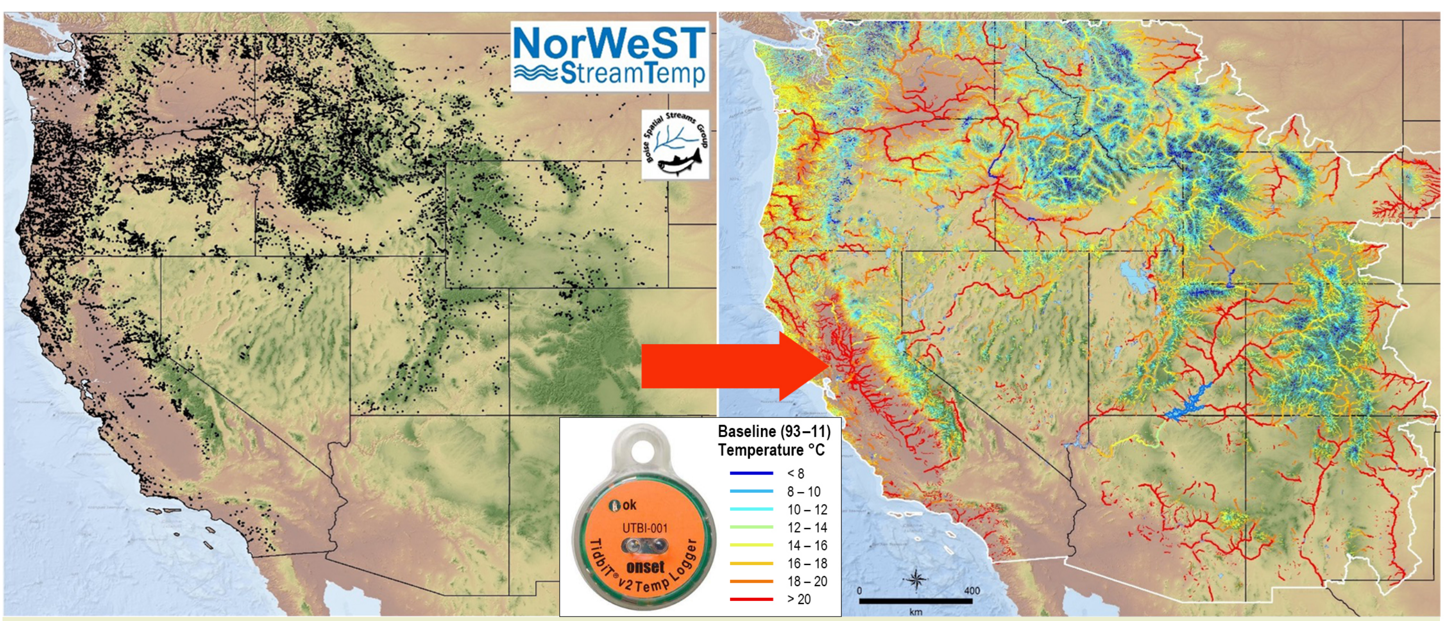
> —Charlie Luce



Miniature sensors made it easy to collect stream temperature data several decades ago and stimulated monitoring efforts by fish biologists and hydrologists at thousands of sites across the western U.S. The NorWeST project organized these data into a single database for analysis and developed high-resolution stream temperature scenarios for past and future conditions from the database.

agencies to submit their data. People who submitted data provided feedback to improve data products and execution of the project, and thus were more likely to use the model once it was released because they were co-creators of the science.

As the team amassed the data, they realized they'd have a huge task to clean and organize it all into a centralized database for analysis. They applied for and received funding from the Great Northern Landscape Conservation Cooperative, a now-defunct collaborative program housed within the U.S. Fish and Wildlife Service, to support this effort, which took 3 years just to get the temperature data from the Forest Service's Pacific Northwest Region.

The data crowdsourcing allowed the model to be built using temperature records from about 23,000 unique stream sites in the western United States, many multiples more than would have been possible if Isaak's team had to collect all the data from the field themselves. A journal article in 2017 estimated that a data collection effort of this size would have cost $10–$15 million.

"If we have concentrated science teams that can organize how those data are collected, where they're collected, and how the data are stored," Staab says, "and then build the model to go big, that's how we make a difference."

Isaak and Mike Young, a recently retired Rocky Mountain Research Station fisheries scientist, began matching up the high-resolution stream temperature scenarios with large biological datasets that had also been crowdsourced from multiple management agencies. They could see a clear overlap between the threatened trout species' locations and the coldest streams, and they developed models that captured this phenomenon to predict the most likely locations that would continue to support the species. This project came to be known as Climate Shield because cold temperatures were so integral to the occurrence of bull trout and cutthroat trout, while also protecting many of their populations from invasions by nonnative species (see Climate Shield box).

Climate Shield Model Identifies Critical Cold-Water Habitat Now and in the Future

The Climate Shield project involved the integration of high-resolution NorWeST stream temperature scenarios and streamflow scenarios with data about the occurrence of species such as bull trout and cutthroat trout to develop accurate models describing the cold habitat conditions these species need to persist. Once developed, the models were used with future climate scenarios to identify climate refugia within stream networks across the West.

Like NorWeST, all the model outputs for species-specific climate refugia are formatted as high-resolution GIS shapefiles and distributed through a website so managers and conservationists can apply the information to make spatially explicit decisions.

Climate Shield is "not only telling us where we can protect the species," says Sean Finn, science coordinator in the U.S. Fish and Wildlife Service Science Applications Program, "but it's telling us where we should not invest money, because it's very unlikely the species is going to persist there through time. There are very few datasets that can do that."

The research team is now replicating the approach for a much broader array of species by tapping into large crowdsourced eDNA datasets that provide information on all species that occur within streams, rivers, lakes, and ponds. The eDNAtlas database and website host many thousands of survey results for dozens of species, including Chinook salmon, steelhead and rainbow trout, Pacific lamprey, and tailed frog. The next update of the eDNAtlas database will include results from about 30,000 sites associated with about 100 aquatic species in the western United States.

Cutthroat trout are an iconic species throughout the Rocky Mountains where their populations still flourish in the coldest streams and rivers. USDA Forest Service photo by Mike Young

Rocky Mountain tailed frog. Photo by W. Lynch.

Species and water don't obey jurisdictional boundaries, so they need to be cooperatively managed. NorWeST and Climate Shield together allow managers to share data and collaborate more effectively and efficiently across agencies to help manage these species and resources.

Delivering Information at a Scale on Which Managers Are Working

Climate change is expected to lower streamflows with reduced snowpacks, extended summer drought periods, and greater evaporation caused by higher air temperatures. To model past and predicted future streamflows throughout the Northwest, Luce and colleagues built on an interagency effort led by the Bureau of Reclamation and integrated flow data from rivers with the Variable Infiltration Capacity large-scale hydrologic model (see Streamflow box).

Combining the results of NorWeST, Climate Shield, and streamflow modeling was helpful in bringing global and regional climate models down to a level where managers could really use them on the ground. The three tools are spatially broad but high resolution and scalable. They are tailor-made to meet managers' needs.

Luce explains that development of the three databases and models was driven by the need for land managers, fisheries managers, and others to determine scientifically how to identify the most efficient places to apply limited time and funding resources to stream and watershed restoration. They wanted to identify places where treatment effects would be long-lasting for long-term protection of species.

The models together allowed land managers to gain a much more detailed understanding of how climate change may affect the streams in their jurisdictions in the future, but did not require them to have great computing power or statistical expertise.

Land managers and scientists "are using these data at a large range of scales, from multimillion-acre scales down to individual watersheds," says Staab.

The models were critical to the recent species status assessment for bull trout led by Sean Finn, science coordinator in the U.S. Fish and Wildlife Service Science Applications Program. This process evaluated bull trout habitat throughout its known range in the Lower 48 states to determine where investments in habitat restoration and conservation make the most sense to maintain the species. A species status assessment can inform a listing decision, a recovery plan, or a management or action plan.

Scott Barndt, adaptive management project manager, mature and old-growth forests, with Forest Service Ecosystem Management Coordination, notes that the models

Streamflow Projections for a Changing Climate

Temperatures, precipitation patterns, and the amounts of annual snowpack are expected to change as the climate warms, which will change streamflows. This affects the physical structure of streams and habitat conditions for aquatic organisms.

Luce and colleagues used flow data measured at river gages with the Variable Infiltration Capacity large-scale hydrologic model produced by the University of Washington Climate Impacts Group to expand flow predictions throughout entire drainage networks. Like NorWeST, the streamflow scenarios, database, and associated maps are broad in coverage, fine in resolution, and available for both historical and future climate conditions. The dataset summarizes a dozen different descriptors of flow for three time periods—historical (1977–2006), midcentury (2030–2059), and end of century (2070–2099)—as well as absolute and percent change over time. Users can download the complete suite of maps and metrics for the spatial area of their choice, including changes to annual streamflow, size and frequency of flood events, timing of seasonal flow patterns, severity of droughts, and other parameters. The data now cover the whole country.

The streamflow projections tell people how the magnitude of flows or flood frequency might change with climate change. "The timing of flooding is particularly important to fish," Luce explains. "The number of winter floods is a pretty robust metric out of the model. It shows where streams flood in the winter months and can scour nests where fish such as salmon and bull trout deposit their eggs in the fall, which leaves their populations vulnerable to climate change–modified flooding."

The streamflow data and resulting maps from the model help ecologists and water resource managers better plan for future changes in streamflow and evaluate the effects of these changes on other forest and rangeland resources.

may even point to places where bull trout are not currently found but that provide all the habitat characteristics the fish need to thrive. If there is a natural barrier, such as a waterfall, invasive species such as brook trout may be kept out of the upstream reach, thereby allowing native bull trout introduced to the stream to thrive there. Such "assisted migration" jump-starts a population in a new area.

The models "helped us show managers, partners, and funding sources the urgency and the reasons we were choosing the places we did to invest," Barndt says.

The models have even been applied in court cases. In 2019, the U.S. Environmental Protection Agency (EPA) was ordered as the result of a lawsuit to develop a plan for managing water temperature in the Columbia River to protect ESA-listed salmon and steelhead. EPA set water quality standards in the Columbia, including requiring sufficient and well-distributed cold-water refugia—locations where these cold environments would persist—to help support salmon as they migrate upriver. NorWeST data were used to map these refugia for the water quality standards. Many of the Columbia's cold-water tributaries originate on National Forest land.

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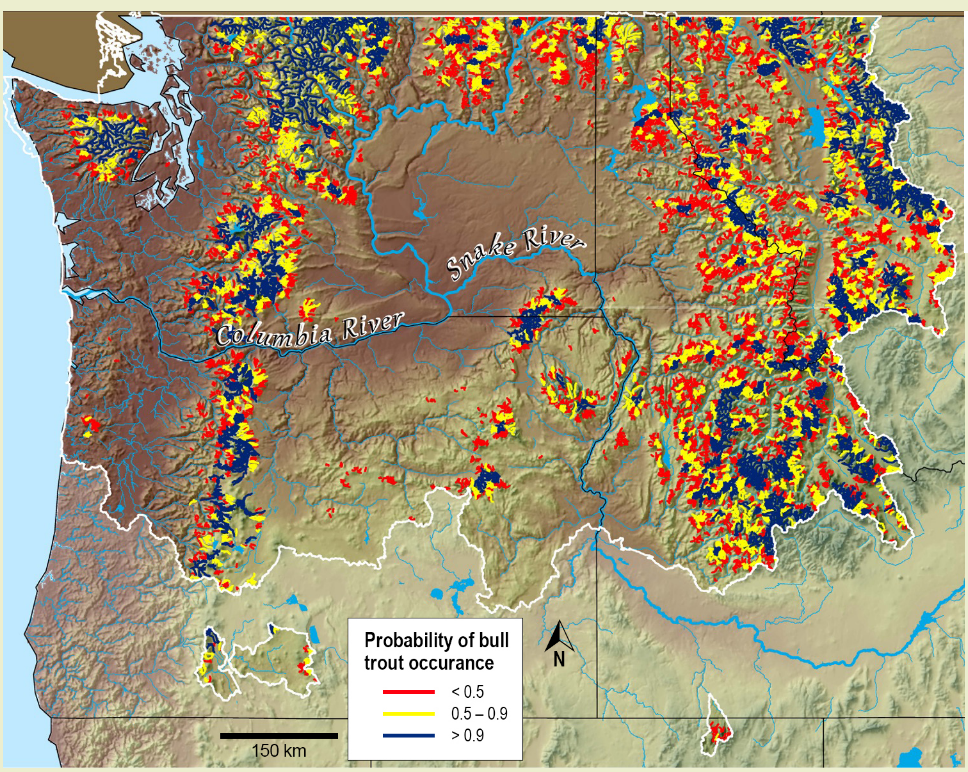
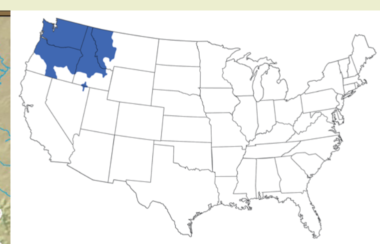
>
> —Scott Barndt

Luce says that being able to map expected changes in stream temperature and flow and associated changes in species presence can help address equity and justice issues. In response to a lawsuit brought by Tribes in Washington State over cumulative effects of many small water withdrawals on low flows and even localized dewatering of streams, and the consequences for fish, managers used NorWeST and the streamflow model to develop guidance for potential climate change exacerbation of flow and temperature changes.





The NorWeST temperature scenarios were combined with large biological survey efforts to understand the thermal requirements of different species and predict where habitats for cold-water dependent species would persist in the future despite a changing climate. The map above shows the predicted distribution of bull trout habitats, with those habitats shown in dark blue predicted to serve as long-term climate refugia. Such refugia typically encompass small percentages of species' present ranges and are often heavily reliant on high-elevation mountain landscapes and lands administered by the U.S. Forest Service.

Of course, animals and water cross jurisdictional boundaries. Partners in managing cutthroat trout include Yellowstone National Park; Montana Fish, Wildlife, and Parks; Idaho Department of Fish and Game; and other agencies. The state game and fish agencies are legally the managers of fish and wildlife, but the development of the three models was a way to show the benefits of partnering with the Forest Service, Barndt says. “This was a great opportunity to find common ground.”

The models are being applied directly to climate change effects forecasting. A team of scientists integrated NorWeST and streamflow modeling results with local information on key fish populations, water sources, infrastructure, and other resources to assess climate change vulnerability across all 18 National Forests and Grasslands in the Pacific Northwest Region. They characterized the relative vulnerabilities of the various resources in different parts of the landscape, and then they built an adaptation strategy of steps to take to help reduce those potential impacts in each forest.

“Climate Shield is sort of like a climate change assessment on steroids,” says Finn. “It takes the next step and very directly addresses how certain species may respond to potential climate futures.”

At a smaller scale, the models are used in implementing the Forest Service’s Watershed Condition Framework, a process that helps National Forest managers analyze their watersheds and prioritize individual watersheds for treatment and specific treatments within those watersheds. For example, the Gifford Pinchot National Forest recently incorporated NorWeST and the hydrologic modeling to inform its restoration plan for the Wind River near Mount Adams, Washington.

Climate Shield’s maps of streams meeting federally threatened bull trout habitat requirements were instrumental in directing researchers to streams for environmental DNA (eDNA) sampling to determine bull trout presence or absence. eDNA is a technique by which researchers filter water to extract DNA and identify all the organisms living in a water body from a single water sample. eDNA is a game-changing advance for rapid and effective habitat sampling that has greatly sped up and reduced the cost of

Electrofishing. USDA Forest Service photo by Dona Horan

data collection. In several instances, the targeting of eDNA sampling to potential habitats identified by the Climate Shield models led to the discovery of new bull trout populations that were previously undocumented.

Next Steps with NorWeST

The way NorWeST was built, with its crowdsourced data, centralized analysis, and manager need-driven model building, is a great example for future environmental data collection.

Eastern fisheries scientists and hydrologists have been clamoring for a similar database and model for years because NorWeST is so useful to land managers, but they’ve been hindered by the difficulties of dealing with so much temperature data from many different land management jurisdictions.

Bull trout are a rare and federally protected species that occurs only in the coldest streams of the Pacific Northwest. USDA Forest Service photo by B. Gamett

Much work in the West is now focused on eDNA-driven rangewide habitat assessments for other cold-water species and others that are sensitive to climate change. Scientists are crowdsourcing eDNA data using lessons learned from NorWeST and Climate Shield to understand where dozens of different species occur, and then assessing likely impacts to habitat from climate change.

Key Findings

- Integration of the NorWeST model with Climate Shield and a streamflow model indicates that previous findings that high mountain streams may be more vulnerable to future climate change are incorrect, and instead that these headwaters serve as climate refugia for cold-water species, where the consequences of warming are slowed. There is cautious optimism that these species can persist longer in the changing climate.
- Crowdsourced, multiagency-input databases yield new insights and research questions. Data contributors are more likely to use the data and resulting models, facilitating interagency collaboration on cross-jurisdiction issues.
- Application of high resolution, broad spatial ecosystem models reveals gaps where better information is needed. New data collection efforts can be streamlined using the lessons learned from NorWeST, thereby creating a positive feedback loop of ever more accurate and useful data and models with greater manager buy-in.

NorWeST Database and Stream Temperature Model

In about 2007, a team of resource scientists including Isaak and Luce wanted to build a stream temperature model for the Boise River watershed in Idaho to forecast expected stream temperature changes with climate change and wildfire to better understand the effects on thermal habitat for cold-water species. They were operating on a limited budget and used “found data”—that gathered by other researchers and agencies—as the basis of their model.

Then the team was funded by the Great Northern Landscape Conservation Cooperative (GNLCC) to broaden their stream temperature modeling to encompass a larger area spanning the northern Rockies. They put out an interagency call for existing stream temperature data. The call was amplified and endorsed by people including Brian Staab, Pacific Northwest Region hydrologist, and Yvette Converse, then coordinator of GNLCC and now chief of science and resources at Grand Teton National Park.

The team received a groundswell of support and data from various National Forests, the federal Bureau of Land Management, state fish and game agencies, and other agencies, because they could foresee the value in the project’s outcomes. As the team made progress weaving together all the crowdsourced temperature datasets from different agencies, one grand database called NorWeST, which is short for North West Stream Temperature, emerged.

NorWeST was the first regional stream temperature database built on actual stream temperature data, rather than using cruder variables such as air temperature. The crowdsourced data took the team from knowledge of stream temperature at individual measuring points to stream reaches, and then to river networks. Modeling gave scientists an understanding of how sensitive stream temperature is in different places to climate variability.

Over about 6 years, the team broadened the scale of the database to encompass the western United States from the Canadian to the Mexican border and from the Pacific coast to eastern Montana and eastern Colorado.

The NorWeST database now contains data from more than 100 resource agencies and includes hourly temperature recordings at more than 22,700 stream sites. These data were used with spatial statistical network models to develop continuous maps of historical and future climate scenarios at 1-kilometer resolution for more than 1 million kilometers of streams in the western United States.

Scientists often collect data that gets set aside after the resulting publication is finished. That’s highly inefficient. By combining monitoring data from across the West, making it “work” together, and making it available to others on a well-publicized website, Isaak and Luce’s team allows researchers and land managers to analyze different questions associated with different projects but using a lot of the same data, thereby saving money. This database fits in with the “Open Science” and “FAIR Data” movements that make publicly available harmonized, quality-controlled, and well documented databases that researchers can use to further advance understanding in support of conservation.

In 2022, the NorWeST website had nearly 15,000 visits. The model allows land managers to have access to this large spatial scale database with highly detailed data without having to do legwork themselves to make that data accessible, says Converse. It allows people not to be repeating each other’s work. It’s a tremendous time saver and taxpayer-dollar-saver. Centralized analysis also increases the reliability of the information because everything passes through a consistent set of quality control measures.

Management Implications

- Long-term monitoring is essential to understand how environmental conditions are changing in the face of climate change and how species are responding to those changes.
- As sensitive species are lost from lower elevation streams more susceptible to climate change, high-elevation streams, often originating on National Forest land, will become even more important for survival of cold-water species.
- By combining the output from NorWeST, Climate Shield, and the streamflow model, researchers and land managers can identify places where assisted migration of threatened cold-water fish species makes sense—streams not currently hosting a threatened species that nonetheless provide all the habitat characteristics the fish need to thrive, as well as a natural barrier to keep invasive species out.
- Many restoration actions can improve the resilience of stream habitats and populations of aquatic organisms, including riparian vegetation improvement, maintaining in-stream flows, restoring beaver populations and habitats, improving aquatic organism passage at road crossings, removing invasive species, and implementing special protections for watersheds harboring stronghold populations of rare cold-water species.

Many cold-water fish species like these Kokanee salmon migrate upstream to complete their life cycle and may be especially vulnerable to climate change without targeted management actions to address habitat impairments like this road culvert that blocks fish movements. Photo by Clayton Nalder, USFS

Further Reading

Isaak, D.J.; Luce, C.H. 2023. Elevation-dependent warming of streams in mountainous regions: Implications for temperature modeling and headwater climate refugia. Canadian Water Resources Journal. 48(2): 167–188.

Isaak, D.J.; Wenger, S.J.; Peterson, E.E.; Ver Hoef, J.M.; Nagel, D.E.; Luce, C.H.; Hostetler, S.W.; Dunham, J.B.; Roper, B.B.; Wollrab, S.P.; Chandler, G.L. 2017. The NorWeST summer stream temperature model and scenarios for the western US: A crowd-sourced database and new geospatial tools foster a user community and predict broad climate warming of rivers and streams. Water Resources Research. 53(11): 9181–9205.

Isaak, D.J.; Young, M.K. 2023. Cold-water habitats, climate refugia, and their utility for conserving salmonid fishes. Canadian Journal of Fisheries and Aquatic Sciences. 80:1187–1206.

Isaak, D.J.; Young, M.K.; McConnell, C.; Roper, B.B.; Archer, E.K.; Staab, B.; Hirsch, C.; Nagel, D.E.; Schwartz, M.K.; Chandler, G.L. 2018. Crowd-sourced databases as essential elements for Forest Service partnerships and aquatic resource conservation. Fisheries. 43(9): 423–430.

Isaak, D.J.; Young, M.K.; Nagel, D.E.; Horan, D.L.; Groce, M.C. 2015. The cold-water climate shield: delineating refugia for preserving salmonid fishes through the 21st century. Global Change Biology. 21(7): 2540–2553.

Luce, C.; Staab, B.; Kramer, M.; Wenger, S.; Isaak, D.; McConnell, C. 2014. Sensitivity of summer stream temperatures to climate variability in the Pacific Northwest. Water Resources Research. 50(4): 3428–3443.

Miller, S. 2020. Black and white and shed all over. Science You Can Use Bulletin. Issue 40. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Scientist and Collaborator Profiles

The following individuals were instrumental in the creation of this Bulletin:

Daniel Isaak is a research fisheries scientist with the RMRS in Boise, Idaho, where he has worked on cold-water fish conservation and management issues across the western United States since completing his Ph.D. at the University University of Wyoming in 2001. His research focuses on understanding the effects of climate change, environmental gradients, invasive species, and natural disturbances on stream habitats and fish communities.

David Nagel is a spatial analyst with the Water and Watersheds Program of the RMRS in Boise, Idaho. His work focuses on geospatial analysis of stream networks and creation and dissemination of spatial datasets.

Charlie Luce is a research hydrologist with the RMRS in Boise, Idaho. Charlie studies hydrological and ecological interactions to understand the effects of land management and climate change on forests, snowpacks, and streams.

Sherry Wollrab is a biological science information specialist with the RMRS in Boise, Idaho. She works primarily with large spatial data sets that are used to assess physical and biological characteristics of streams.

Michael K. Young is an emeritus research fisheries scientist with the RMRS in Missoula, Montana. His ongoing work involves refining the taxonomy of aquatic species, and the use of statistical and sampling tools to characterize and delineate species distributions.

Gwynne Chandler is a fisheries biologist with the RMRS in Boise, Idaho. She enjoys organizing large datasets, specifically stream temperature, that can be used by others for their research.

Dona Horan is a fish biologist with the RMRS in Boise, Idaho. She is interested in how the distribution of fish species and populations will be affected by future changes in stream temperature and other local habitat conditions, such as complexity and productivity.

Scott Barndt is the adaptive management project manager, mature and old-growth forests, with the Forest Service's Ecosystem Management Coordination. Prior to this assignment, he worked 22 years for the Custer Gallatin National Forest, serving as fish biologist, aquatic ecologist, watershed program manager, and ecosystems staff officer. He has also worked for Montana Fish, Wildlife, and Parks and the U.S. Fish and Wildlife Service as a fisheries biologist.

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The following individuals were instrumental in the creation of this Bulletin:

Yvette Converse is chief of science and resource management at Grand Teton National Park. Previously she was the U.S. Fish and Wildlife Service (USFWS) Ecological Services field supervisor overseeing federal regulatory wildlife work in Utah, primarily the Endangered Species Act. Prior to that, Yvette was coordinator of the Great Northern Landscape Conservation Cooperative for USFWS. She believes in community-led conservation and promotes local stewardship and collaborative landscape conservation through work with federal, state, county, tribal, nongovernment, and industry partners.

Scott Spaulding recently retired as fisheries program manager for the Forest Service's, Northern Region, after 14 years in that position. He spent his career, from California to Idaho to Montana, working as a fisheries biologist on native resident and anadromous fish restoration and recovery efforts for the Forest Service, the U.S. Fish and Wildlife Service, and the Shoshone Bannock Indian Tribes.

Sean Finn coordinates the Region 6 Science Applications Science Support Team for the U.S. Fish and Wildlife Service. He works with external partners to understand and express science needs, advance landscape-scale conservation science, and codevelop partner-driven and data-informed conservation strategies. The goal of his work is to develop collaborative and complementary management actions that sustain wildlife populations, habitats, and socio-ecological systems.

Brian Staab is regional hydrologist for the Forest Service's Pacific Northwest Region where he has been developing and implementing bioregional watershed management and aquatic conservation and restoration strategies since 2006. He has a strong interest in creating and broadly deploying new, actionable knowledge about watershed processes to improve land and water resource management.

Writer's Profile

Joy Drohan is a freelance science writer and editor specializing in environmental and agricultural topics.

About the Science You Can Use Bulletin

The purpose of SYCU is to provide scientific information to people who make and influence decisions about managing land.

Nehalem Clark: Bulletin Editor / Science Delivery Specialist
nehalem.clark@usda.gov

Jessica Brewen: Bulletin Editor / Science Delivery Specialist
jessica.brewen@usda.gov

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The Rocky Mountain Research Station is one of 7 Forest Service Research & Development units. Within the 12 state RMRS footprint, we maintain 14 research locations; conduct long-term ecological research on 14 experimental forests, ranges and watersheds; and work in hundreds of research natural areas.

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