

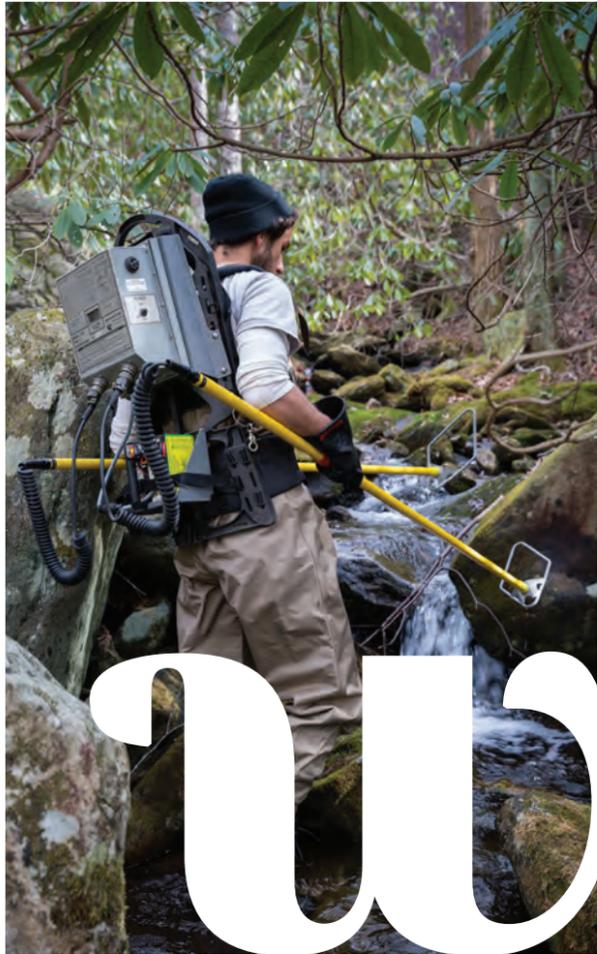
A mountain Stream Returns

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The Commission is working to restore mountain streams and habitat to benefit populations of brook trout, North Carolina's only native trout



PATRICK CLAYTON/ENGBRETSON UNDERWATER PHOTOGRAPHY



What would you say if someone asked you for two words to describe the mountains of North Carolina? Would you call upon visits to individual places, think about images you have seen on postcards or remember the first time you touched a raised-relief map (you know, the fascinating 3-D maps that allow you to feel elevation changes)? Regardless of what shapes your description, chances are your vision of the mountains is one that captures its unique splendor.



What if the image and description you just formulated could be applied to a fish? If you could make that leap, I suspect you are envisioning an animal that must be special, beautiful and important to a lot of people. Lucky for us, there is a fish that fits such a description: a brook trout.

As North Carolina's only native trout, brook trout have a biological significance. The amazing fish with distinctive markings and vibrant colors (especially in the fall) also have a long and storied history with mountain residents and visitors. Prior to the introduction of rainbow trout from the western states and brown trout from Europe, brook trout (also called specks or speckled trout thanks to their markings) were the only trout you could catch. As such, they were popular sources of food and sport for those lucky enough to encounter them.

However, as their habitats degraded and their populations mixed with non-native trout over the past 150 years, our brook trout have become far less plentiful in the mountains. So, the North Carolina Wildlife



Resources Commission is working to restore native brook trout populations through research (especially, genetic testing) and habitat improvements.

WHAT HAPPENED TO the Brook Trout?

Intensive logging practices of the 1800s and early 1900s introduced significant changes to landscapes across our mountains, and with that, there was much alteration to waters and the brook trout populations that lived within them. In some cases, well-intentioned individuals noticed that those pretty little fish that were once here are now gone, and they decided to bring some back by stocking some more. Unfortunately, that attempt to help had unintended consequences because the only brook trout available for stocking were from hatcheries in the Northeast, and by the 1920s, thousands upon thousands of this non-native, domesticated strain of brook trout were being stocked all over North Carolina. As a result, there was an introgression of those non-native hatchery genes into the remnant populations of brook trout, and in some cases, these introductions ultimately established populations of hatchery-origin fish.

Today, the Commission stocks approximately 300,000 brook trout annually for anglers within our Hatchery-Supported and Delayed-Harvest trout waters. The Commission does not stock on top of wild brook trout populations and only uses fish that are sterile and incapable of reproducing.

In addition to the historic brook trout stockings, the introductions of brown trout and rainbow trout were successful in establishing populations of each species, which now compete with brook trout for available food and habitat.

Through time, the loss of habitat has remained an issue for brook trout, which require clean and cold water. As watersheds become altered (for example, the loss of riparian zones, stream-crossing structures like culverts that prevent movement, increased sedimentation), conditions within the streams change and can shift away from the stringent biological requirements of trout species. Today, most of North Carolina's brook trout populations are relegated above barriers (often waterfalls or slides) within streams at least 3,000 feet above sea level, and the waters below the barrier are often occupied by the self-sustaining rainbow trout and brown trout stocked long ago.

IMPACTS OF Isolation

This retreat to the headwaters plays an important part in the story of brook trout and how the Commission develops plans to conserve the species. Certainly, a significant portion of the work involves finding where brook trout populations remain, and to date, the Commission has documented over 700 self-sustaining populations across the mountains. However, if we think back to those early brook trout stockings of hatchery fish, we know that just finding fish is not the whole story—there is additional work that

Opposite: Commission staff utilize backpack electrofishing systems to sample high-elevation streams. Brook trout can be distinguished by the olive-green coloration of the upper sides with mottled, dark green "worm-like" markings on their backs and tails. Above: Wild brook trout are often restricted to small headwater streams in the mountains. Below: Native brook trout are handled with care as research data is gathered.





Above: To collect samples, portable electrofishing probes are used to temporarily stun fish in the immediate area. A fin from a brook trout is clipped and the sample will be used for DNA testing.

is needed to examine genetic characteristics. Being essentially isolated within these headwater streams has not allowed brook trout to exchange genes with other populations to influence genetic fitness (something that would have occurred as populations overlapped and had access to each other).

One way to think about this is to consider a population's genetic makeup as a toolbox comprised of individual tools that could be used one day to address an issue. The more often genes are exchanged, the higher the likelihood that a population acquires another tool (they might not ever need to use it, but they will have it in their toolbox just in case). Without gene exchange, populations are left with the genes (tools) they have to survive and adapt to their environments. There are biological processes that take place to address this, but ultimately populations without effective gene flow are likely to be less genetically diverse (fewer tools). The Commission has spent a lot of effort to determine the genetic characteristics of our state's brook trout.

This information spans advances in genetic technology, but to date, we have contemporary genetic information on over 400 collections and 7,500 individual brook trout. Specifically, we have a foundation of conservation genetics data that describes genetic diversity and variation across the state, an understanding of relationships between populations and an assessment of the impact of all of those historic stockings.



At this point, our story of brook trout has focused primarily on genetics. We should, however, revisit the importance of habitat. Without the required habitat, any discussions relative to the fish are essentially moot, and given the limited distribution of brook trout, the importance of habitat is magnified. Just as we discussed with their genetics, the inability to connect to other waters restricts populations to their immediate environment, so if conditions become unsuitable, the fish cannot simply move to another water.

With that in mind, the Commission works with numerous partners (private landowners; local, state and federal agencies; non-governmental organizations; multi-state efforts like the Eastern Brook Trout Joint Venture) to maintain and improve these special aquatic habitats. Actions could range from ensuring proper streamside (riparian) shading to the removal of a culvert that prevents fish passage. The activities may seem minor, but they can have long-term impacts to the health of a stream. Specifically, it could mean maintenance of cold, clean water in the case of riparian zone management and increasing fish movement with barrier removal, which improves gene flow and access to available habitat.

PUTTING SCIENCE to Work

There are numerous other efforts underway relative to brook trout conservation, but we are very excited to take some of the



We have a foundation OF CONSERVATION GENETICS DATA THAT DESCRIBES GENETIC DIVERSITY AND VARIATION ACROSS THE STATE...

information noted above to help us restore populations across their native range in the state. In particular, North Carolina now has one of the largest (if not the largest) state-level, genetic datasets to guide restoration efforts. Here is an example of how this information could be put to work:

A biologist may identify a stream with suitable habitat for brook trout, but for one reason or another, brook trout are not present today or non-native trout can be removed. One significant question is where to get fish to add to the stream slated for restoration. An approach could be to collect fish from the next closest stream and bring them to the destination stream once it is time to move brook trout. However, our genetics data allows us to make much better decisions.

We can actually test potential source populations to see if there are any impacts from historic stockings (hatchery introgression) and to see other populations' genetic variables (seeing who might have the best available tools). Multiply that information across the suite of samples we have for the state and now the best populations can be picked as sources for our restoration efforts. This is of utmost importance because of the variation within and among watersheds. With this detailed information, we can make sure that we are utilizing fish without hatchery lineages and restoring only fishes with native

genes that provide the best chance of success.

The goal of our research is to collect information that helps us make better decisions. In the case of brook trout, our recent discoveries have allowed us to transition into planning annual expansions of the species' historical range—we have two restorations planned this fall. By continuing to maintain and enhance suitable habitat, we can work to make sure existing and potential populations have places to live. Efforts like those to document the distribution and genetic makeup of populations also allow us to learn more about the native trout throughout our mountains. In the end, we have limited time and resources with which to work, so we want to make the best decisions possible for this species that means so much to so many.

We are continuing our efforts to conserve this beautiful and unique species. When we check back in 10 years to see how the 2018 restorations are doing, perhaps you will think of that amazing little trout high in the hills when someone asks you to describe the mountains. ♡

Jacob Rash is the coldwater research coordinator for the N.C. Wildlife Resources Commission and an occasional contributor to Wildlife in North Carolina. For more information on trout management activities, please visit ncwildlife.org/trout.



Clockwise, from top left: Jacob Rash, coldwater research coordinator for the Commission, records sampling data in his notebook. Wading boots are cleaned after use to minimize the chance of spreading invasive species or diseases from one stream to another. A brook trout is weighed and then measured. A biologist checks a trout's gills for gill lice, a parasite that can inhibit a fish's ability to breathe.

