# In Brook Trout, Sometimes the Risk is Worth the Reward

Shannon White
Department of Ecosystem Science and Management
Cooperative Fish and Wildlife Research Unit
The Pennsylvania State University

413 Forest Resources Building
University Park, PA 16802
slw361@psu.edu
804-387-3498

Coldwater streams flow through the Appalachian Mountains, giving life to one of region's most valuable social and economic resources: Brook Trout. The vitality of this iconic species takes center stage in fall as fish prepare to engage in spawning rituals. Vibrant orange colors are donned and battles are fought in pursuit of producing the healthiest offspring.

Today, fewer than half of historic Brook Trout populations remain within its native range on the east coast. Loss of in-stream habitat, watershed development, and nonnative species have all contributed to the decline of Brook Trout. For a species that was the lifeblood for hungry settlers in the 1800s and today accounts for millions of dollars in revenue, the loss of Brook Trout tarnishes the natural history of America.

Within the last 20 years, billions of dollars have been spent to restore habitat, reforest watersheds, and enforce harvest regulations. While these initiatives have seen some success, they will only act as a short-term band-aid as there remains one overwhelming threat that biologists have no answer for - climate change. Many Brook Trout populations already struggle to survive the summer heat, and future stream temperature rise may tip the scales toward rapid population loss.

Are Brook Trout destined for extinction? That is a future I hope to avoid with my research in the lab of Dr. Tyler Wagner of the Pennsylvania Cooperative Fish and Wildlife Research Unit at Pennsylvania State University. One challenge is that the tools available to fisheries managers focus on solving problems within a watershed and are not prepared to tackle pervasive, species-wide problems like climate change. The solution, I believe, is going back to basics and gaining a better understanding of Brook Trout ecology.

An often-overlooked aspect of species ecology is the idea of individual variation. Fish living in the same stream are extremely variable in their genetics, behaviors, and physiologies. Yet, we seldom understand what causes these variations, or how important individual variation is for conservation.

Movement is one of the most interesting, and perhaps ecologically important, behaviors with significant individual variation. Some fish are homebodies and never move more than a hundred feet for months at a time. Others are wayward wanderers, traversing miles at a time before settling, briefly, in a new pool. Why are fish so different?

This is a question I am addressing in a multi-season telemetry study of Brook Trout populations in Pennsylvania. Telemetry is a technology that allows a message to be wirelessly sent from a transmitter to a receiver. In this case, the transmitter is a small tag that I surgically implanted

into the abdominal cavity of nearly 200 native Brook Trout. Every four seconds, the transmitter sends a signal containing an ID unique to each fish. With a handheld antenna and receiver, I walk around streams to detect signals and record fish locations. In total, I recorded over 2,000 fish locations from May-November to determine where, when, and why, individual fish move.

After hunkering in large pools all summer, Brook Trout started moving in fall to find better spawning habitat and mates. Shortly after spawning, nearly half of all tagged fish moved several miles downstream to overwinter in a large river system. Why only half? In short, it's nature's way of hedging bets. At an individual level, movement is risky because its energetically demanding and exposes fish to predators. But, not every fish can stay close to home, either. At a population level, movement of trout between streams is necessary to increase genetic diversity which, ultimately, increases overall population resiliency against habitat loss. And, for fish that are successful living in larger rivers, the rewards are better feeding opportunities and more growth. Ultimately, there needs to be a balance of cautious stayers and risky movers to ensure both annual survival and population and genetic connectivity.

Through my studies, which also include behavioral and genetic analyses, we're finding that populations are more than the sum of their parts. Until we move our management goals beyond increasing population size and towards a focus on individual ecology, we may continue to fall short of preparing Brook Trout for a warmer, and more demanding, future.