Searching for Conservation Success: the future of freshwater biodiversity in Southern Appalachia

By Bryan Bozeman

Southern Appalachia – the mountainous region from northern Georgia to southwestern Virginia – is an area with abundant natural resources and a large and growing human population. Streams and rivers in Southern Appalachia support some of the highest levels of freshwater biodiversity in North America. Many of the fish, salamander, and mussel species found here do not exist anywhere else in the world. Unfortunately, the growing human footprint in this region threatens freshwater biodiversity by developing the landscape and degrading important stream and river habitat. Mature, deciduous forests that once lined stream banks are being thinned and replaced with impervious surfaces or agriculture, which results in warmer, muddier, less complex streams. Because the human population in Southern Appalachia is expected to continue to grow rapidly, it is important that we develop effective conservation strategies that reconcile human use of the landscape with the integrity of streams and rivers.

Research Approach

The goal of my dissertation research is to identify conservation opportunities for freshwater biodiversity in Southern Appalachia. I approach this goal from multiple, interdisciplinary angles across scales of space and time.

In order to conserve and manage a species, we must understand its habitat requirements. Fish that live in streams select specific positions from which they face upstream into the current and capture prey flowing downstream. These stream positions are called microhabitats. We think that fish select microhabitats that allow them to maximize their net energy intake; we use models to predict the location of ideal microhabitats in streams. We can compare energetic potential of different microhabitats by estimating the energetic benefits (e.g. amount of available prey) and costs (e.g. metabolic cost of swimming) incurred by a fish that occupies a given position. Unfortunately, difficulties associated with estimating these variables and inconsistencies regarding which variables are important for fish energetics have prevented us from incorporating microhabitat selection models into broader conservation plans. I am addressing this shortcoming by comparing several versions of a microhabitat selection model to better understand how inclusion of different variables – and how

Significance

- Inform fine-scale habitat selection modeling approaches: This research will compare a suite of modeling techniques to identify their strengths and weaknesses in effectively evaluating habitat quality for stream fish species.
- Contextualize landscape and climate factors driving trout competition: Understanding how broad scale landscape and climate context mediate competitive interactions between Brook and Rainbow Trout will help managers ensure healthy populations of both species in an uncertain future.
- Explore the potential of science communication as a conservation tool: Investigating how science communication messages are received, processed, and judged by audiences will help scientists engage with the public in meaningful, lasting ways that inspire actual behavior and belief change.

we quantify those variables – influences model output and conservation potential.

In addition to fine scale investigations of fish habitat selection in streams, it also is important to understand how broad scale patterns of landscape development and climate drive fish distribution. Southern Appalachia's only native trout is the Brook Trout, which is threatened by a warming climate, increasingly fragmented and degraded habitat, and competition from nonnative Brown and Rainbow Trout. In many cases, the combined effects of these stressors restrict Brook Trout populations to high elevation, headwater streams, often separated from Rainbow Trout by physical barriers that keep them from further encroaching into what little Brook Trout habitat remains. However, there are some cases where Brook Trout have managed to maintain competitive dominance over Rainbow Trout in the same stream without a barrier. I am studying the landscape and climate context of coexisting Brook and Rainbow Trout populations to better understand what factors allow Brook Trout to coexist with Rainbow Trout. This is important information for managers who are tasked with maintaining healthy populations of both species.

Lastly, understanding the social dynamics underlying socioecological systems is also critical for developing effective conservation strategies. In recent decades, scientists have devoted much time and effort into science communication to inform the public on scientific progress. However, public trust of science has not improved during this same time period, and there remains a lack of consensus about society's role in precipitating environmental crises. This likely is attributable to the fact that science communication is often delivered via didactic, one-way messages that are unfamiliar to the public. Communicating science using narrative is an attractive alternative mode of science communication because humans are universally familiar with stories, and process and respond to them differently than didactic messages. Hidden Rivers is a science communication narrative film that champions freshwater biodiversity in Southern Appalachia. I am investigating the conservation potential of science communication narratives by measuring the degree to which people engage with Hidden Rivers and whether or not they are subsequently motivated to support or engage in freshwater biodiversity conservation in Southern Appalachia.

A native Brook Trout (Salvelinus fontinalis) from northern Georgia.

Conclusion

My dissertation research aims to contribute to the conservation of freshwater biodiversity in Southern Appalachia. Streams in this region support a disproportionate number of rare fish, salamander, and mussel species. However, landscape development within Southern Appalachian watersheds reduces the limited quality and quantity of habitat available to these species. Effective freshwater biodiversity conservation strategies are urgently needed. My research aims to identify tangible opportunities for freshwater biodiversity conservation in Southern Appalachia by highlighting factors important for stream fish habitat use at both fine and broad scales of space and exploring the potential for science communication narratives to inspire conservation beliefs and behaviors. I am hopeful that this research will inform conservation and communication strategies so that, collectively, we can build a future in which Southern Appalachian freshwater biodiversity is recognized, valued, and protected.

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