

Red Shiner Invasion of Southeastern Streams: Dynamics and Ecological Consequences

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Background

- Red shiners have invaded 11 states and occur in five Southeastern river basins.
- Red shiners often displace native congeners (members of the same genus) via competition and hybridization.
- Southeastern rivers harbor 21 species of Cyprinella, so red shiners pose a serious threat to the region's aquatic diversity and integrity.

Research Overview

Landscape

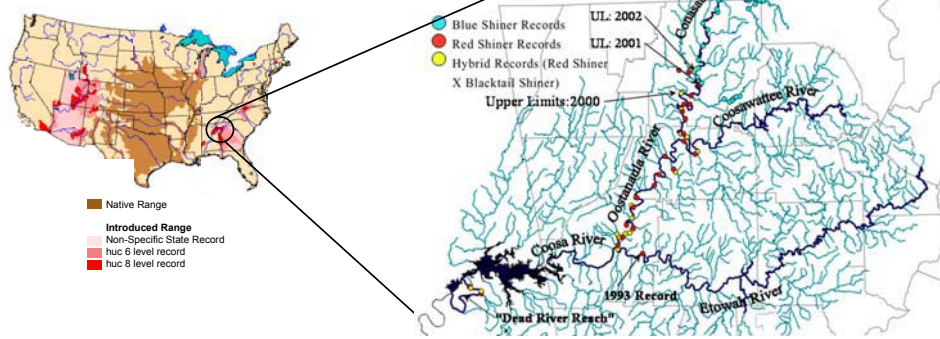
- Red shiners recently invaded the upper Coosa and are hybridizing with blacktail shiners.
- Since red shiners are common in urban streams in Atlanta, we suspect that urbanization increases the vulnerability of Coosa streams to invasion.
- Because the region is rapidly urbanizing, it provides a natural field experiment to test this "urbanization hypothesis".

- Another factor in the invasion is the presence of native minnows such as blacktail shiners.
- By comparing streams with and without blacktail shiners, we can evaluate the role of hybridization and competition in red shiner invasion.

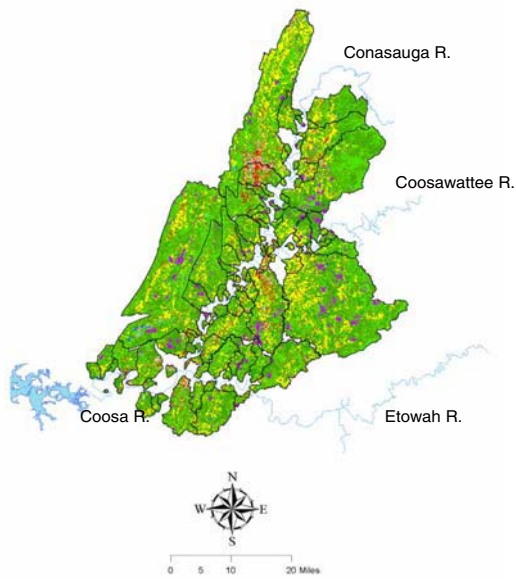
Genetics and Behavior

- Studies in other systems suggest that turbidity (a measure of water clarity) contributes to hybridization by disrupting visual mating cues.
- We will test the hypothesis that turbidity increases hybridization by conducting spawning experiments in artificial stream tanks.
- We will assess the fitness of hybrids relative to parental species to see if they have competitive advantages that accelerate dispersal or the rate of hybridization.

Distribution of Red Shiner



Land cover in the upper Coosa River system. Urban areas are shown in red. Black lines delineate potential study catchments.



Research Questions:

Landscape

- Are urban streams more prone to invasion by red shiner?
- Does the occurrence of black tail shiners slow (via competition) or accelerate (via hybridization) the invasion of red shiners?
- What other environmental characteristics (e.g., stream habitat, water quality) are related to colonization?

Genetics and Behavior

- Does hybridization increase under turbid conditions?
- Do hybrids have competitive advantages over parental species?

Aquarium Experiments

		clear water		turbid water	
		RS ♂	BTS ♂	RS ♂	BTS ♂
Parental crosses	RS ♀	times chosen/total trials	times chosen/total trials	RS ♀	times chosen/total trials
	BTS ♀	times chosen/total trials	times chosen/total trials	BTS ♀	times chosen/total trials

Design of spawning tank experiments. RS = red shiner; BTS = blacktail shiner. This is the design for Year One. We will repeat the experiment in year 2 with all possible backcrosses reared from the year one experiment. The measured variable in the tables represents frequency of mate choice, and can be substituted with other variables such as egg hatch, larval survivorship, and sex ratio to evaluate other aspects of hybridization.

Outcomes

- Identifying the environmental factors underlying the invasion is the first step in identifying management solutions to curb the spread of red shiners.
- These data will also allow us to predict the vulnerability of rivers to invasion and prioritize areas for mitigation.

Collaborators:

Noel Burkhead, Florida Caribbean Science Center, USGS.
 Dr. Byron Freeman, Institute of Ecology and Museum of Natural History, The University of Georgia.
 Dr. Brady Porter, Department of Biological Sciences, Duquesne University

Hybrids have intermediate body shape and caudal spot relative to parental species.

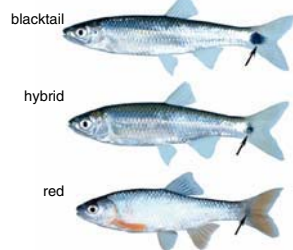


Photo courtesy of Noel Burkhead

Field Study Design

	high urban	low urban
Small Streams	small high urban	small low urban
Large Streams	large high urban	large low urban

The field study will determine the effects of urbanization and the occurrence of blacktail shiner on the spread of red shiner. The study design accounts for the uncommon occurrence of blacktails in small streams.