

# Analysis of Microhabitat Use of Benthic Fishes in a Southern Appalachian Headwater Stream

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## Introduction

Southern Appalachia contains the greatest fish biodiversity in the U.S., much of which is contained in headwater streams dominated by fishes that utilize benthic areas. Freshwater benthic fishes provide important ecosystem functions, such as nutrient recycling, which influences the nutrient dynamics in a stream ecosystem (Taylor, et al. 2012). Benthic fishes in streams can have differing microhabitat preferences within streams. Specifically, darters and sculpins represent a significant component of fish communities in small creeks (Gray and Stauffer, 1999).

Studies of fish microhabitat are often limited to one taxon, excluding taxonomically different but ecologically similar fishes. Within small headwater streams, multiple taxa exist that utilize benthic habitats, including darters, sculpins, suckers, and some minnows. Of these, darters and sculpins are the most ecologically similar. This study investigated differences among microhabitat preference of three small benthic fishes in a headwater stream of Southern Appalachia. **We hypothesize that microhabitat preferences will differ among sympatric benthic fishes.**

## Objective

To determine microhabitat preferences of Mottled Sculpin *Cottus bairdi*, Redline Darter *Nothonotus rufilineatus*, and Greenside darter *Etheostoma blennioides* and determine differences in microhabitat among these species.



Mottled Sculpin  
*Cottus bairdi*

Greenside Darter  
*Etheostoma blennioides*

Redline Darter  
*Nothonotus rufilineatus*

## Methods

**Study Site:** Sampling was conducted from early Sept to early Nov in Corn Creek, a small second- to third-ordered stream in Towns County, GA on the campus of Young Harris College within the Hiwassee River watershed. Average width is 4-5 m with an average depth <1 m and intact riparian vegetation along the stream.



**Data Collection continued:** Recorded microhabitat parameters included depth, flow at the substrate and 50% stream depth, canopy cover, dominant substrate, distance to nearest bank, and habitat unit (run, riffle, and pool). Microhabitat availability for use was determined by dividing the 40 m site into 9 equidistant transects (i.e. 5 m apart) perpendicular to stream flow and measuring parameters (depth, dominant substrate, and flow at 50% of stream depth) at 3 equidistant points across each transect.

**Data Analysis:** Differences among species for quantitative parameters were determined using ANOVA with a post-hoc Tukey's test. T-tests compared means between habitat use and availability. Frequency analysis via a Chi-squared test determined if occurrence differed among species and microhabitat use and availability for categorical variables. Principle components analysis were conducted to compare and visualize habitat use among species.

## Methods Continued

**Underwater observation of benthic fish using an Aquascope.**

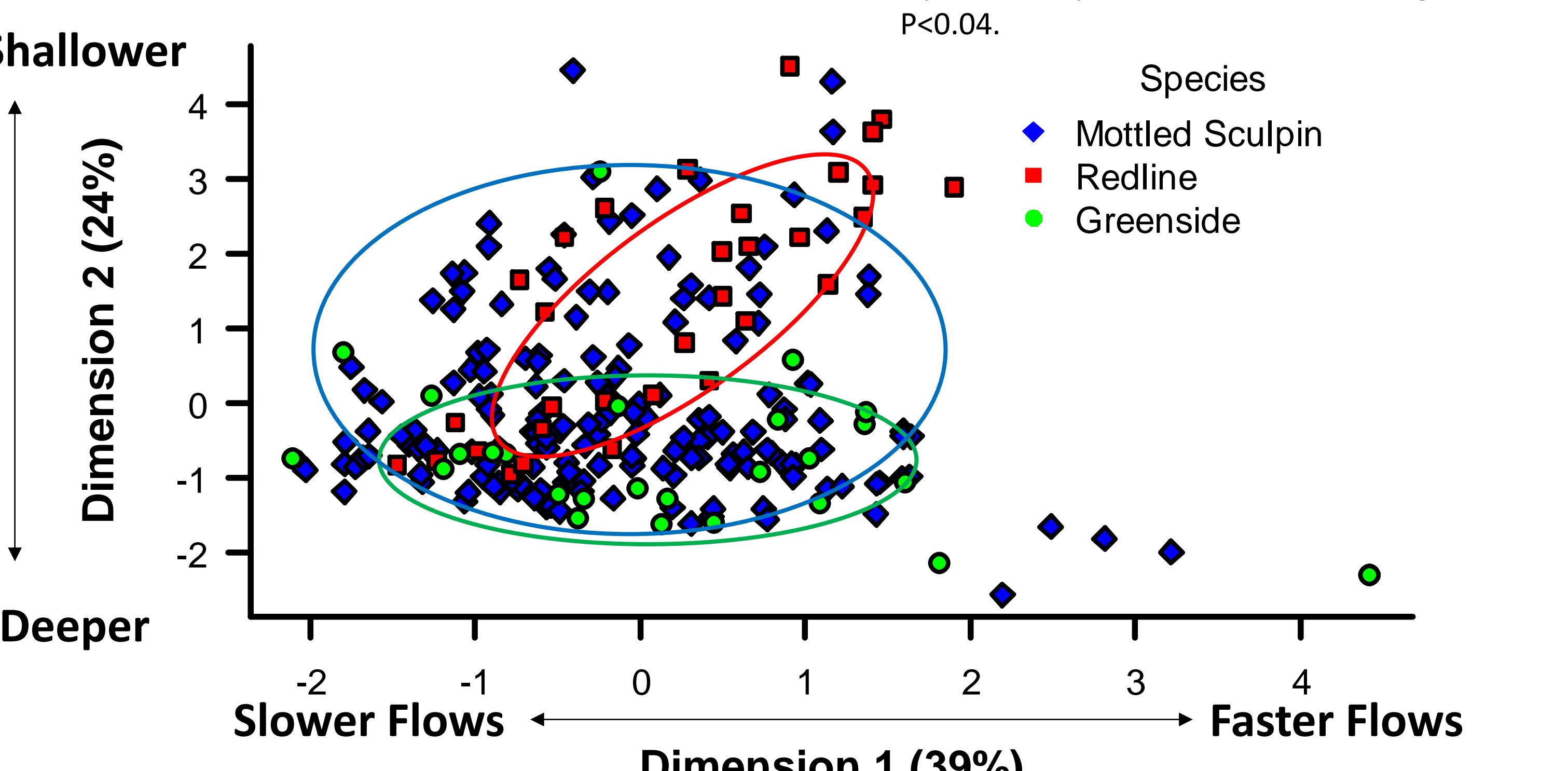


## Results

Observations of *C. bairdi* (n = 188), *E. blennioides* (n = 30), and *E. rufilineatum* (n = 32) varied greatly.

**Table 1.** Mean bottom flow (P<0 .001), flow at 50% depth (P<0.001), distance from bank (P<0.001), and depth (P<0.001) differed among species. Differing letters indicate a significant difference among means between species.

	Mean	SD	N	P Value
Bottom Flow				<.001
<i>C. bairdi</i>	0.32 <sup>A</sup>	0.32	188	
<i>E. blennioides</i>	0.22 <sup>A</sup>	0.21	30	
<i>E. rufilineatum</i>	0.67 <sup>B</sup>	0.49	32	
Flow @ 50%				<.001
<i>C. bairdi</i>	0.50 <sup>A</sup>	0.46	188	
<i>E. blennioides</i>	0.35 <sup>A</sup>	0.29	30	
<i>E. rufilineatum</i>	1.08 <sup>B</sup>	0.62	32	
Distance from Bank				<.001
<i>C. bairdi</i>	1.20 <sup>A</sup>	0.54	188	
<i>E. blennioides</i>	1.78 <sup>B</sup>	1.25	30	
<i>E. rufilineatum</i>	1.22 <sup>AC</sup>	0.52	32	
Canopy Cover				0.106
<i>C. bairdi</i>	52.65	33.56	188	
<i>E. blennioides</i>	58.83	36.24	30	
<i>E. rufilineatum</i>	45.16	30.91	32	
Depth				<.001
<i>C. bairdi</i>	22.44 <sup>A</sup>	10.41	188	
<i>E. blennioides</i>	29.46 <sup>B</sup>	11.62	30	
<i>E. rufilineatum</i>	20.87 <sup>AC</sup>	4.82	32	



**Figure 3.** Principle components analysis of habitat use of three benthic fishes sampled from Corn Creek. Habitat use of mottled sculpins overlaps darter habitat use although darter habitat use differs between redline and greenside darters.

## Discussion

This study compared microhabitat use of ecologically similar but taxonomically different benthic fishes (i.e. sculpins and darters). Significant differences occurred among these taxa with *C. bairdi* exhibiting a more generalist pattern of microhabitat preference whereas as two darters (i.e. *E. blennioides* and *N. rufilineatus*) had much more specific microhabitat preferences, which supported the initial hypothesis.

***C. bairdi*:** Previously described as habitat generalists based on habitat selection (Facey and Grossman, 1992), this study provides supporting evidence that *C. bairdi* occupy a wide range of stream microhabitats. *C. bairdi* in Corn Creek significantly prefer run habitats with cobble and gravel substrates, but also that they exhibit more generalist tendencies of the studied species.

***E. blennioides*:** Described as a habitat and substrate specialist using primarily riffle habitats (Chipp et al., 1994) and large substrates (Hlohowskyj and Wissing, 1986), this study describes *E. blennioides* as more of a habitat generalist compared to redline darters. This included heavy usage of pools and gravel (31% of occurrences) which contradicts previous study (Bunt et al., 1998). Preference for pool habitats may be explained by seasonal changes, using deeper pool habitats during cooler periods (Etnier and Starnes, 2001).

***N. rufilineatus*:** Fast-flowing riffles provide highly oxygenated water. *N. rufilineatus* used high flow habitats more than *C. bairdi* and *E. blennioides* and shallower depths as well (Etnier and Starnes, 2001) with no significant substrate preference, suggesting that habitat selection is strongly tied to flow and oxygen availability (Ultsch et al., 1978). Although the literature is sparse, microhabitat preferences of *N. rufilineatus* from this study supports existing literature.

**Sampling Considerations:** Aquascopes had a limited range of visibility and required both hands to operate, preventing rock turning to uncover hidden fish, as recommended by Gray and Stauffer (1999) and Chipp et al (1994). Therefore, the study may be biased against hidden and cryptic fishes. Double counting and disturbance of fishes from original habitat is a concern also.

**Implications:** Benthic fishes are sensitive to habitat modification, and many benthic stream fishes are disproportionately imperiled in the Appalachian region due to their endemism (Helfman et al., 2009). Microhabitat data is critical to designing conservation measures. Riparian zone removal (Dosskey et al., 2010), increased impervious surface (Pappas et al., 2008), or agriculture (Soulsby et al., 2001) can seriously impact success of benthic fishes that rely on clean substrates. This study also describes habitat use during late summer and fall. Because studies often occur during summer months, study during other times provide a more comprehensive description of habitat use.

## Acknowledgements

We would like to thank the Young Harris College Department of Biology for funding and support and our research advisor, Dr. Johnathan Davis for assistance with this project.

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