

Virginia Journal of Science
Volume 70, Issue 1 & 2
Spring & Summer 2019
doi: 10.25778/rvvv-j156

Note: This manuscript has been accepted for publication, and is online ahead of print. It will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form.

Microhabitat Comparison of *Percina roanoka* (Roanoke Darter) and *P. nevisense* (Chainback Darter) in the Roanoke River

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ABSTRACT

Snorkel observations of *Percina roanoka* and *P. nevisense* in the Roanoke River during summer months were followed by measuring current velocity, water depth, and substrate diameter at points of occupation. A total of 89 observations of *P. roanoka* and 81 observations of *P. nevisense* were compared using two-sample T-tests. *Percina roanoka* inhabited faster, shallower water than *P. nevisense* with the former found in a mean flow of 0.318 m/s and depth of 31.53 cm and the latter in a mean flow of 0.17 m/s and depth of 55.6 cm. Mean diameter of substrate at points of occupation did not differ significantly between the two species with *P. roanoka* over substrate 10.14 cm diameter, and *P. nevisense* over substrate of 9.7 cm diameter. Differences in habitat among age classes were not detected for either species. These findings suggest habitat partitioning along current velocity and depth help maintain the diverse darter assemblage in the Roanoke River.

INTRODUCTION

Resource partitioning appears to be a key component of maintaining diverse fish assemblages, with habitat and food partitioning cited as especially important in communities containing members of the same family (Ross 1986). Six species of Percidae are native to the Roanoke River upstream of the Blue Ridge (Jenkins and Burkhead 1994). Comparisons of habitat parameters have long suggested habitat partitioning among these species is likely key to their survival in the Roanoke River (Matthews et al. 1982; Matthews 1985; Matthews 1990). However, these early studies were based either on captive observation or collections using seines followed by measuring stream width, gradient, and maximum current velocity within the sampled area. As habitat parameters are rarely uniform within the seined area, a reality discussed in these papers, the data collected are not precise measurements of occupied habitat. Recent studies have described and compared habitat of some darter species based on specimens captured using seines and/or a backpack electrofisher. Following capture, habitat parameters from multiple points within a sampled area were measured within that area and averaged making less precise descriptions of occupied habitat (Vadas and Orth

2000; Roberts and Angermeier 2007). Rosenberger and Angermeier (2003) used snorkel transects to identify microhabitat among age classes of *Percina rex* (Roanoke Logperch) but did not compare these data to other darter microhabitat data. Another recent snorkeling study measured microhabitat of *Percina nevisense* (Chainback Darter) and found they only occupy a portion of available habitat in the Roanoke River but did not compare it to microhabitat data of other darter species (Powers and Whitlow 2018). Collectively, these studies suggest darters have fidelity to specific microhabitats and do partition habitats. However, those studies do not directly compare specific microhabitats of sympatric darters in the Roanoke River. The objective of this study was to test for habitat partitioning among the closely related *Percina roanoka* (Roanoke Darter) and *P. nevisense* using snorkel observation data from precise points of occupation during summer months in the Roanoke River.

MATERIALS AND METHODS

Snorkeling observations were made during summer 2016-2018 in the Roanoke River in Salem, Virginia. At this locality, the river is a fifth order stream, approximately 30m wide with a maximum depth of 1.5 m at base flow. A 5 cm diameter galvanized steel marker numbered and painted fluorescent green was placed at the point of first sighting of an individual of each target species to mark the exact point of observation. Species, number observed, and approximate age class (i.e. juvenile, subadult, adult) were recorded on a diver's underwater writing slate immediately following the placement of each marker. Age classes were determined by estimation of standard length (SL). For *Percina roanoka*, juveniles were less than 25 mm SL, subadults 25-45 mm SL, and adults greater than 45 mm SL. *Percina nevisense* age class estimation followed Powers and Whitlow (2018). Upon completion of snorkel observations each day, we returned to each marker and measured water depth and diameter of five representative rocks within 10 cm of the marker with a meter stick. Current velocity approximately 5 cm above the substrate was also measured with a FloWatch flowmeter. Data for each species were summarized and compared with two-sample T tests. A one-way analysis of variance was used to detect differences in mean values between juveniles, subadults, and adults. Minitab 18 was used to generate 95% confidence interval plots (Figures 1-3) and for all statistical analyses with $\alpha = 0.05$.

RESULTS

Data were collected from a total of 81 observations of *Percina nevisense* from 8 days of observation from June and July, and 89 observations of *P. roanoka* from 9 days of observation from June and July. Age classes of *P. roanoka* (5 juveniles, 11 subadults, 73 adults) were not different for depth, current velocity, or substrate ($P = 0.55, 0.28, 0.82$, respectively), and Powers and Whitlow (2018) similarly found no differences in habitat among age classes for *P. nevisense*. *Percina nevisense* occupied depths ranging from 36 to 97 cm (mean = 55.6 cm, SD = 12.3), current velocities ranging from 0 to 0.4 m/s (mean = 0.17 m/s, SD = 0.094), and substrate diameter ranging from less than 1 to greater than 100 cm (mean = 9.7 cm, SD = 13). *Percina roanoka* occupied depth ranging from 19 to 48 cm (mean = 31.53 cm, SD = 7.93), current velocities ranging from 0 to 0.6 m/s (mean = of 0.318 m/s, SD = 0.114), and substrate diameters ranging from less than 1 to 42 cm (mean = 10.14 cm, SD = 7.74). The two species differed significantly ($P < 0.001$)

in depth and current velocity but not substrate diameter ($P = 0.59$). Mean values and 95% confidence interval plots are presented in Figures 1-3.

DISCUSSION

Powers and Whitlow (2018) found no differences among age classes of *Percina nevisense* for any measured variable. Similarly, we found no differences among age classes of *P. roanoka* for any variable measured. In contrast, habitat partitioning among age classes was found in *P. rex* (Rosenberger and Angermeier 2003). Vadas and Orth (2000) described the microhabitat of *P. roanoka* as 26 to 75 cm/s current velocity over substrate ranging from 6.5 to 16 cm in diameter, but as discussed earlier, their methods did not record habitat at exact points of occupancy. Our mean substrate diameter is largely consistent with the substrate size yielding the greatest number of *P. roanoka* in previous studies (Mathews et al. 1982; Vadas and Orth 2000). While our current velocity data appear similar to that reported by Vadas and Orth (2000), we did find both minimum and maximum current velocity inhabited by *P. roanoka* to be slower. Our data also show much lower current velocities than the riffle habitat (0.79 m/s) reported by Matthews et al. (1982) to have the greatest abundance of *P. roanoka*. The mean current velocity of our study almost perfectly matches the critical current speed (0.3 m/s) for *P. roanoka* in a flow chamber reported by Matthews (1985). This suggests the actual microhabitat occupied by the species is likely different than what has been reported in previous studies and closely matches that for which they are morphologically adapted. Given this finding, it appears snorkeling observation followed by measuring habitat parameters at exact points of observation is more likely to identify accurate habitat parameters than capturing specimens by seine and measuring those same parameters throughout the sampled area. Stauffer et al. (1996) similarly found underwater observation to be most effective at detecting these fine scale differences among microhabitats.

Powers and Whitlow (2018) reported mean values for *P. nevisense* habitat data from throughout the year to be 60.5 cm depth, 0.17 m/s current velocity, and 8.2 cm substrate diameter, but also noted differences among seasons. The mean values for summer months incorporated into this study closely match the mean microhabitat values throughout the year. Direct comparison of data from June and July showed *P. roanoka* occupied shallower ($P < 0.001$) and faster ($P < 0.001$) water than *P. nevisense*. Substrate diameter does not appear to differ between species ($P = 0.585$). The difference in current velocity between these species appears similar to the faster current inhabited by *P. roanoka* compared to *Etheostoma flabellare* (Mathews et al. 1982; Matthews 1985). Matthews et al. (1982) suggested habitat partitioning between *P. roanoka* and *E. flabellare* based on current velocity and stream size with *E. flabellare* inhabiting smaller streams than *P. roanoka*. While *P. nevisense* and *E. flabellare* both inhabit slower water than *P. roanoka*, it appears unlikely these species are competing for habitat in these slower waters of the same streams. The greatest abundance of *E. flabellare* reported by Matthews et al. (1982) occurred in second order streams less than 2 m in width. During data collection for this study, relatively few *E. flabellare* were observed. The mainstem Roanoke River in Salem is a fifth order stream approximately 30 m in width and has little similarity to the second order streams reported as ideal habitat by Matthews et al. (1982). This suggests that just as *P. roanoka* and *E. flabellare* partition habitat partly along

stream size, so do *P. nevisense* and *E. flabellare*. Partitioning among *P. nevisense* and *E. flabellare* is likely stronger than the partitioning among *P. roanoka* and *E. flabellare* as *P. nevisense* and *E. flabellare* occupy similarly slower water than *P. roanoka*.

Our finding of habitat partitioning among *Percina* in the Roanoke River is similar to the findings of other studies with different species of *Percina* inhabiting different depths, current velocities, and/or substrate sizes. Welsh and Perry (1998) found *P. caprodes* in faster current over finer substrates than *P. macrocephala* in the Elk River, West Virginia. Stauffer et al. (1996) also noted low niche-breadth values for *P. caprodes* and *P. copelandi* in the Allegheny River system with the latter found mostly in faster current than the former. Habitat partitioning among species of *Percina* utilizing different depths and current velocities has also been documented in tributaries to the Tennessee and Alabama river systems (Weiland 1983; Greenberg 1991). Our findings further suggest habitat partitioning among closely related species is likely important to maintaining diverse fish assemblages, and precise measurements of occupied microhabitat help elucidate fine scale differences among them.

ACKNOWLEDGMENTS

We thank Peyton Whitlow for help collecting data and the Roanoke College Biology Department for financial support of this study. Both authors collaborated on data collection, analyses, and manuscript preparation throughout this project.

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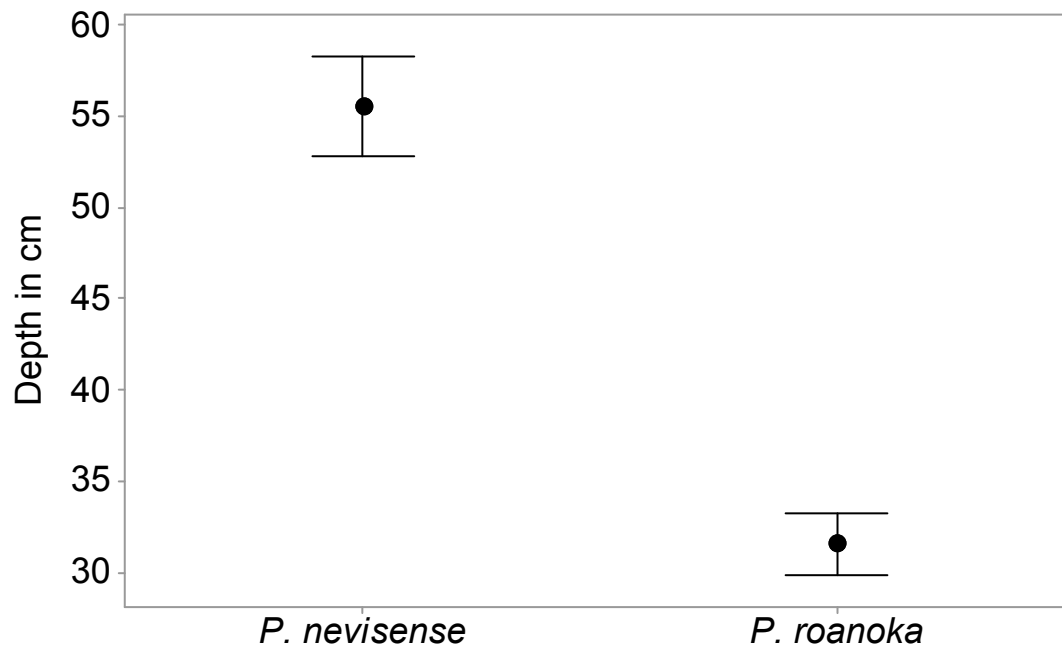


Figure 1: Interval plot showing 95% confidence of mean depth of water occupied by *Percina nevisense* and *P. roanoka* in the Roanoke River.

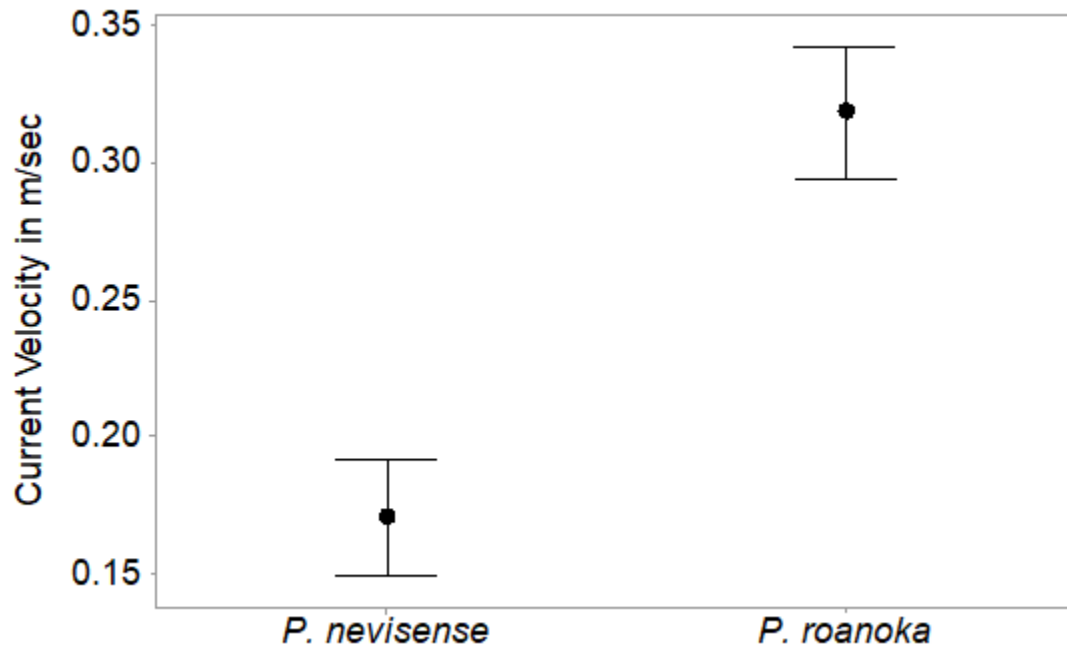


Figure 2: Interval plot showing 95% confidence of mean current velocity occupied by *Percina nevisense* and *P. roanoka* in the Roanoke River.

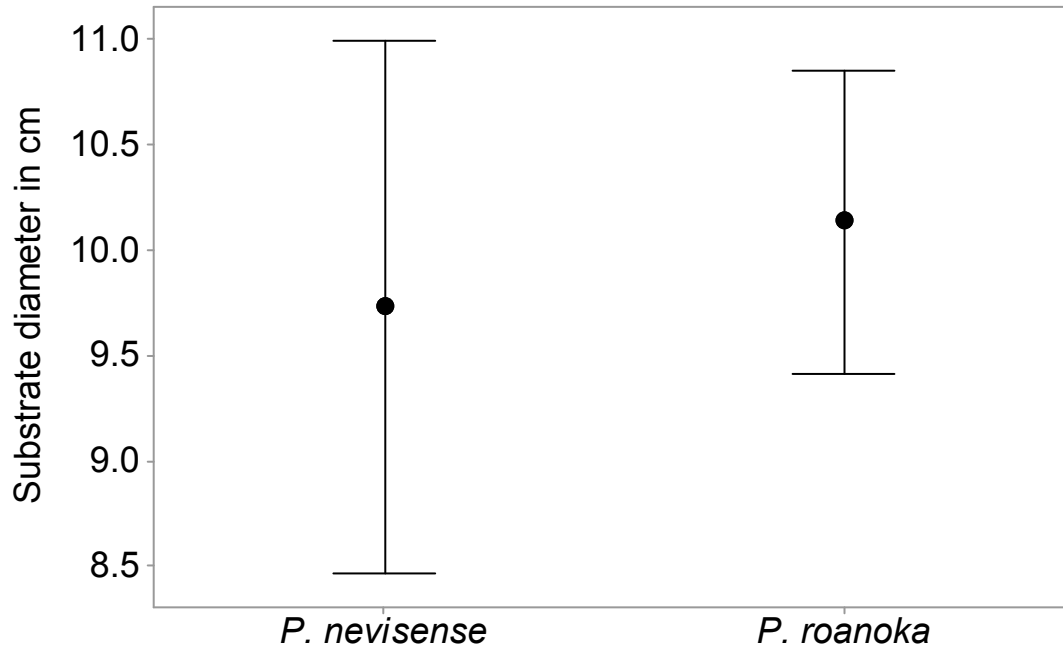


Figure 3: Interval plot showing 95% confidence of mean substrate diameter at points of observation for *Percina nevisense* and *P. roanoka* in the Roanoke River.