The Effects of Turbidity on Anti-Predator Response of the Bridle Shiner, *Notropis bifrenatus*

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OBJECTIVE

To determine how increased turbidity affects the anti-predator response of the Bridle Shiner when exposed to the chemical cues from the native predator, Yellow Perch.

BACKGROUND

Bridle Shiner
- Lives in shallow, freshwater habitats (Harrington 1948)
- Native range from Quebec, Canada to North Carolina and is rapidly deteriorating from human activity (Granqvist 2004)
- In Connecticut and throughout northeastern United States, the Bridle Shiner is listed as a species of concern

Turbidity
- Turbid water is created through dissolved particles in water and may reduce ability to visually detect a predator, altering schooling behaviors (Ferrari et al. 2010) and activity levels

METHODOLOGY

Test Subjects and Predator Cues
- Bridle Shiners were collected from the Shunnock River, CT
- Native predator (Yellow Perch, *Perca flavescens*) collected from the Shetucket River, CT
- Water from Yellow Perch tank was collected, frozen in 60mL volumes for later use

Experimental Design
- Schools of 3 fish were tested in each treatment (n = 9; Table 1)
- 50mL of predator cue was added to predator cue treatments

Table 1. The four treatments used to test the schooling and activity response of Bridle Shiners (*N. bifrenatus*) to increased turbidity (created by adding bentonite clay).
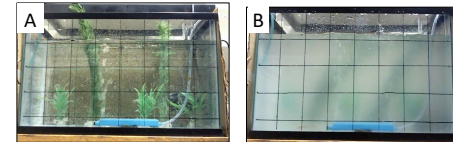
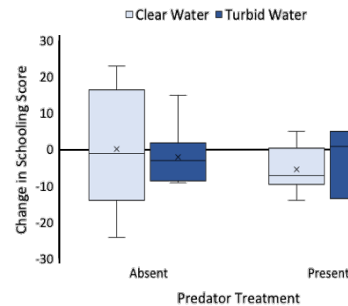|	
Clear Water (0 NTU) Control (No Odor)	Turbid Water (~20 NTU) Control (No Odor)
Clear Water (0 NTU) Perch Odor	Turbid Water (~20 NTU) Perch Odor

DATA COLLECTION & RESULTS

Behavioral Observations
- 10-minute pre- and post-stimulus observations
- **Schooling**: Score based on fish proximity
- **Activity Level**: Number of lines crossed (Fig. 1)

Change in Behavior = Post-stim - Pre-stim

Figure 1. Testing tanks for clear (**A**) and turbid water (**B**) trials.

Figure 2. In pre-stimulus observations, fish schooled less in turbid water (**A**; t_9 = 2.710, p = 0.027) but their activity didn't differ (**B**; t_9 = -1.483, p = 0.177).
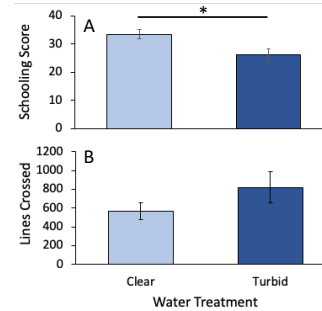

Figure 3. Changes in schooling behavior of Bridle Shiner (*N. bifrenatus*) in response to clear or turbid water with or without predator scent. Schooling behavior was measured using a scoring method.
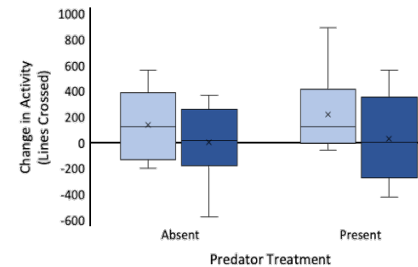

Figure 4. Changes in activity levels of Bridle Shiner (*N. bifrenatus*) in response in clear or turbid water with or without predator scent. Activity levels were measured as lines crossed by all fish.

Table 2. Effects of turbidity and predator presence on schooling behavior

Source of Variation	$F_{1,8}$	p
Predator	0.993	0.348
Turbidity	0.056	0.819
Predator*Turbidity	0.546	0.481

Table 3. Effects of turbidity and predator presence on activity level

Source of Variation	$F_{1,8}$	p
Predator	0.239	0.638
Turbidity	2.248	0.172
Predator*Turbidity	0.071	0.780

*Analyses were 2-Factor Repeated Measures ANOVA. For Changes in activity, data was transformed using a Box Cox transformation analysis.

DISCUSSION AND CONCLUSIONS

Schooling
- Fish schooled less in turbid water when no predators were present (Fig. 2A)
- No significant effect of turbidity or predator scent on schooling responses (Figure 3; Table 2)
  - Schooling is a common antipredator response
  - Fish may gain refuge from visually-oriented predators in turbid conditions

Activity
- There were no significant effects of turbidity or predator scent on activity (Figure 2B, 4; Table 3)
  - Turbidity influenced changes in activity more than predator presence – fish reduced activity more in turbid conditions than clear water
  - Reductions in activity could result from increased activity during pre-stimulus observations under turbid conditions (Figure 2B)
  - Shiner may rely on visual cues to detect predators

Future Directions
- Continue trials to increase sample sizes
- Include the addition of visual predator cues to the established chemical cues

ACKNOWLEDGEMENTS

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