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Bryan Colby
Susquehanna University

Jonathan Niles Dr
Susquehanna University

Matt Wilson
Susquehanna University

Matthew Persons Dr.
Susquehanna University

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Bryan Colby[1], Matthew Wilson[2], Matthew Persons[1], and Jonathan Niles[2]
1 Ecology Program, Susquehanna University, Selinsgrove PA, 17870
2 Freshwater Research Institute, Susquehanna University, Selinsgrove PA, 17870

Introduction

- As climate change continues to raise global temperatures, the temperatures of typically cold headwater streams will rise as well.
- Brook Trout (*Salvelinus fontinalis*) are already being pressured out of their native cold headwater range by Brown Trout, a species with a slightly higher thermal tolerance.
- As stream temperatures continue to rise, Brook Trout are predicted to suffer increased competition with more warm water species such as the Creek Chub (*Semotilus atromaculatus*)[(b)]
- Increased thermal stress can negatively impact feeding behaviors, growth rates, social behaviors, and species phenology.
- Brook Trout will be less capable of competing with warm water species such as Creek Chub within their native range, as they will be subjected to increased stress.
- Conservation efforts acknowledge that temperature is one of the top threats to Brook Trout populations and focus on habitat for sustainable production, and developing populations resistant to environmental variation[(a)]

Figure 1. Pictures of Creek Chub (left) and Brook Trout (right) used in the experiment. Pictured fish are not of equal size, though those used in dyad pairs will be within 5% of each others size.

Hypothesis

- We predict that at higher temperatures Brook Trout will consume less pellets and that Creek Chub will interfere with pellet consumption causing further reduction of pellet consumption
- We also predict that Creek Chub will interfere with Brook Trout, thereby feeding more at higher temperatures and showing increased aggression, intimidation, and spatial displacement of Brook Trout.

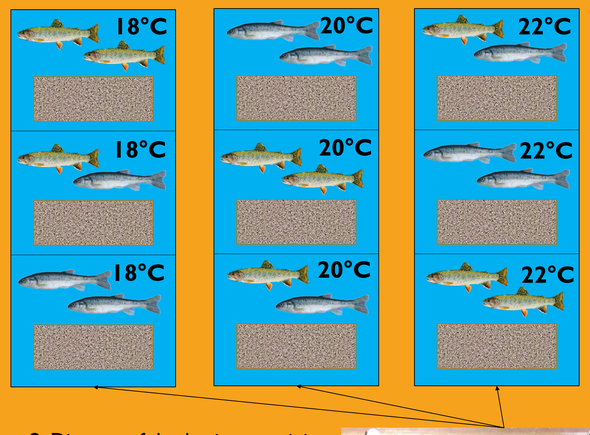

Figure 2. Diagram of dyad pairs containing the three combinations of species pairs, and picture showing a singular dyad with a cinder block in the bottom. Dyad pairs position is varied within each tank to eliminate location bias for each pair grouping. Photo shows actual tank area for testing (22" x 22" x 18" deep)

Methods

- Behaviors of Brook Trout and Creek Chub in dyad pairs for all combinations of species (Brook Trout/Brook Trout, Brook Trout/Creek Chub, Creek Chub/Creek Chub) were measured with a GoPro camera mounted above the dyad. Data recorded was feeding latency, feeding rate, aggressive behaviors, and position within the water column to approximate exploitative or interference competition.
- Ten trials under each temperature (18, 20, 22°C) using similarly sized fish (average ~135 mm) were performed.
- Fish were given a day to acclimate to temperature changes in between measurements.
- Experimental design used is a 3x3 within-between subjects design with three species combinations tested at three temperatures.

Results

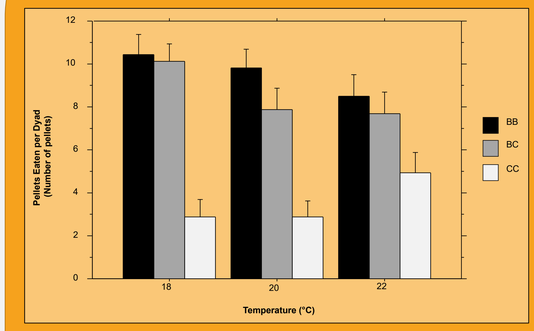

Figure 3. Change in pellets eaten across different dyad pairs at different temperatures. Error Bars ± 1SE

Pair treatment F=23.054, p<0.0001

Pair*Temperature F=3.123, p=0.0158

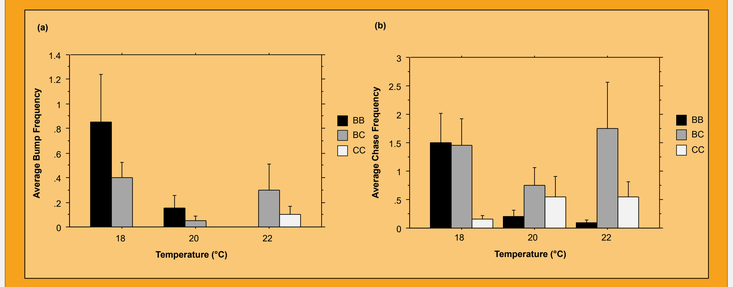

Figure 4. Change in aggressive behaviors including bumps (a, Temperature N=4.476 p=0.0124, Temperature*Pair N=2.761 p=0.0199) and chases (b, Temperature*Pair N=3.253 p=0.127) across different dyad pairs at different temperatures. Error Bars ± 1 SE

Implications

- Trout fishing is a billion dollar industry and a very popular recreational activity in Pennsylvania.
- Invasion of native Brook Trout streams would restrict their ranges and decrease the available habitat for them to live in, thus decreasing fishing opportunities for Brook Trout as well as altering the stream community

Acknowledgements

We thank the Richard King Mellon Foundation and Susquehanna University Biology Department for funding. All Brook Trout were donated by the PFBC's Benner Springs Fish Hatchery.

References

a) Conserving the Eastern Brook Trout: Action Strategies. Eastern Brook Trout Joint Venture (EBTJV). 2011.
b) Taniguchi, Y., F. J. Rahel, D. C. Novinger, and K. G. Gerow. 1998. Temperature mediation of competitive interactions among three fish species that replace each other along longitudinal stream gradients. Canadian Journal of Fisheries and Aquatic Sciences 55(8):1894-1901