

Evolution of Anti-Predator Behavior in Threespine Stickleback Fish In Response to Invasive Northern Pike

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Background

- Invasive predators have dangerous consequences for the native species in an environment.
- Evolution of behavioral responses is abundantly important to native prey species survival.
- Northern pike (*Esox lucius*) have recently invaded several lakes in Alaska in the past 60 years (Haught and von Hippel 2011).



- Pike in particular have a distinct predation ambush strategy from native predators three-spine stickleback (*Gasterosteus aculeatus*) are accustomed to.
 - Pike hide in underwater vegetation and strike at unsuspecting prey
- Evolved behavioral responses fit to avoid predation would include:
 - Lower exploratory behavior
 - Preference for open habitat rather than vegetative one
 - Increased post-attack responses such as darting

Research Objective

Determine whether populations of threespine stickleback in Alaska have evolved specific anti-predator behavior in response to novel pike invasion.

Methods

Exploratory Habitat Choice Pike-Attack



Overview

- F1, lab-reared stickleback from 6 populations (3 with invasive pike, 3 without) underwent 3 behavioral assay trials over 3 days in a testing arena.
- Trials were recorded and subsequently analyzed in J-Watcher a behavioral analysis program.
- Each lane of the testing arena had an acclimation chamber where the fish would stay overnight, and 11 lines on the bottom 9 cm apart to keep track of the stickleback.

Exploratory Assay

- 5 minute long trials
- A PVC pipe was placed for stickleback to hide near, and beyond that a tray of food

Habitat Choice Assay

- 5 minute long trials
- Open habitat on one side an vegetation habitat on the other; each having a tray of food

Pike-Attack Assay

- Stickleback had 10 minutes to approach tray of food to be attacked by pike model
- After attack, trials were 5 minutes and behavioral responses were recorded

Results

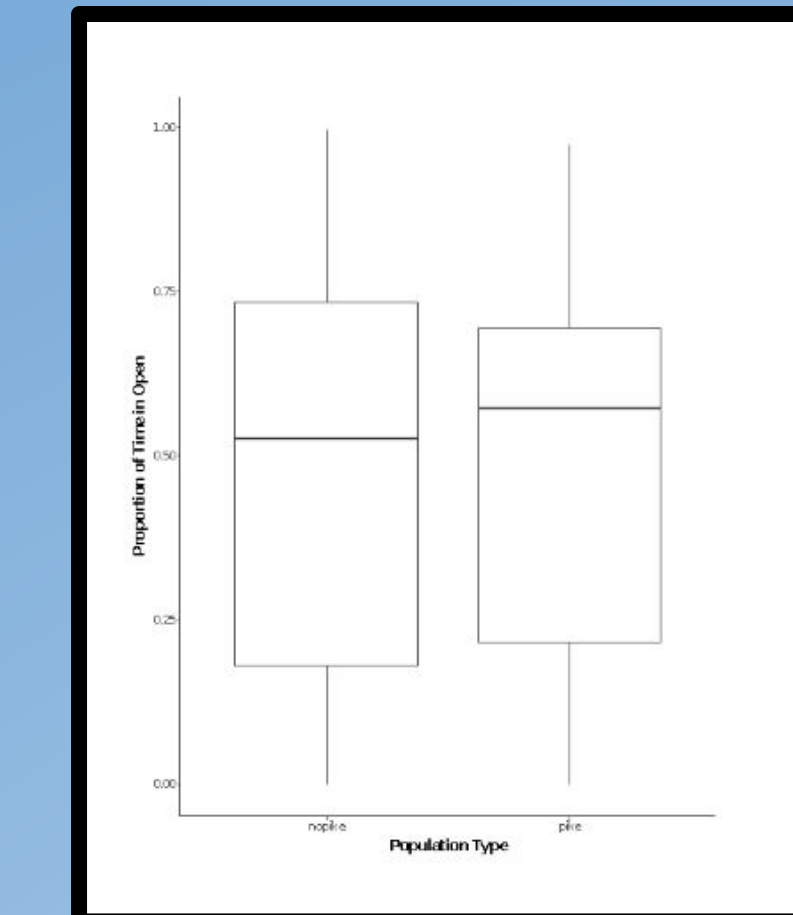


Figure 1: Proportion of time spent outside the acclimation chamber during the exploratory assay trials by the pike and no-pike population types ($P = 0.930$).

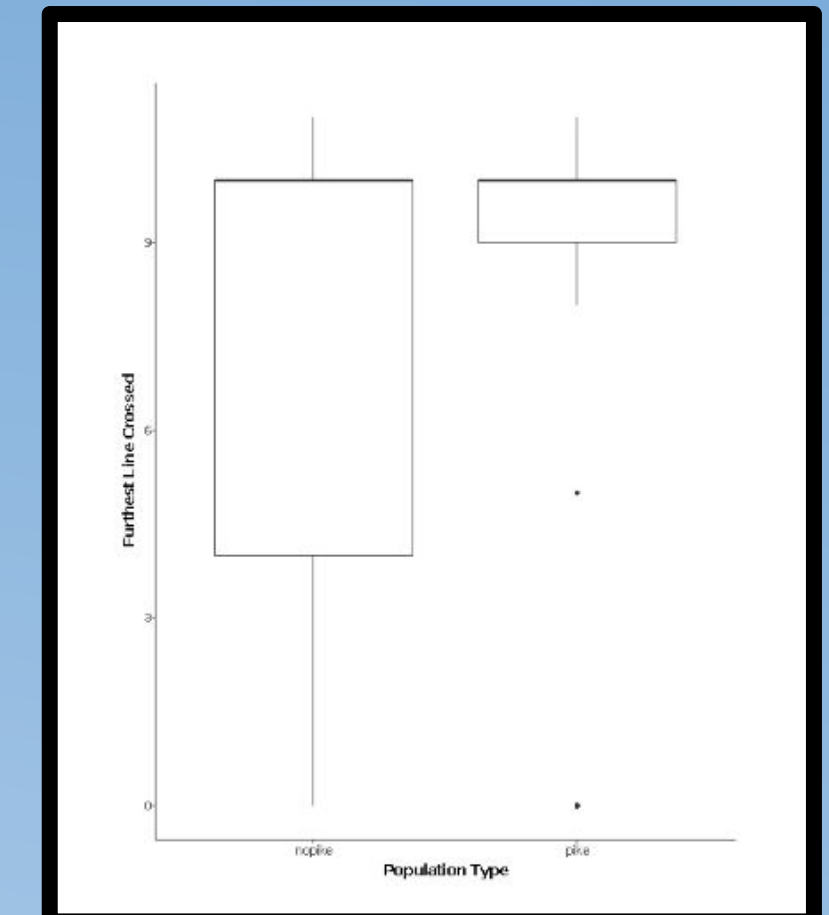


Figure 2: Furthest line crossed by the pike and no-pike population types during the exploratory assay trial. A Kruskal-Wallis ANOVA test was performed here to compare the population types ($P = 0.648$).

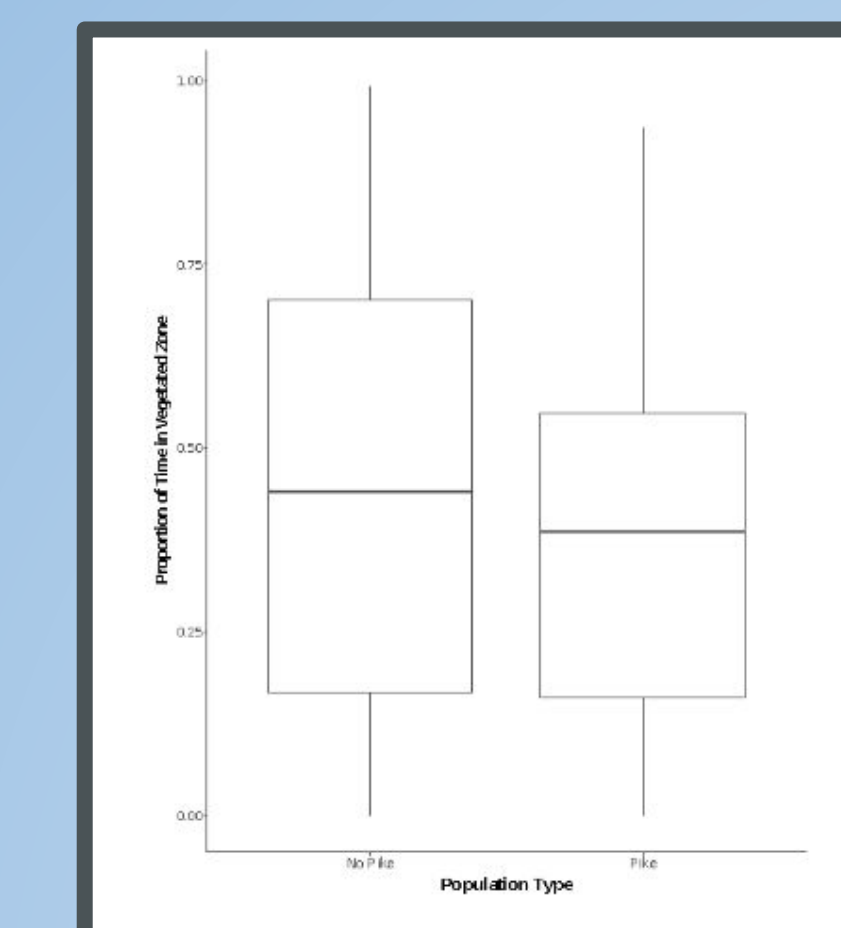


Figure 3: Proportion of time spent in the vegetated zone by pike and no-pike population types ($P = 0.296$).

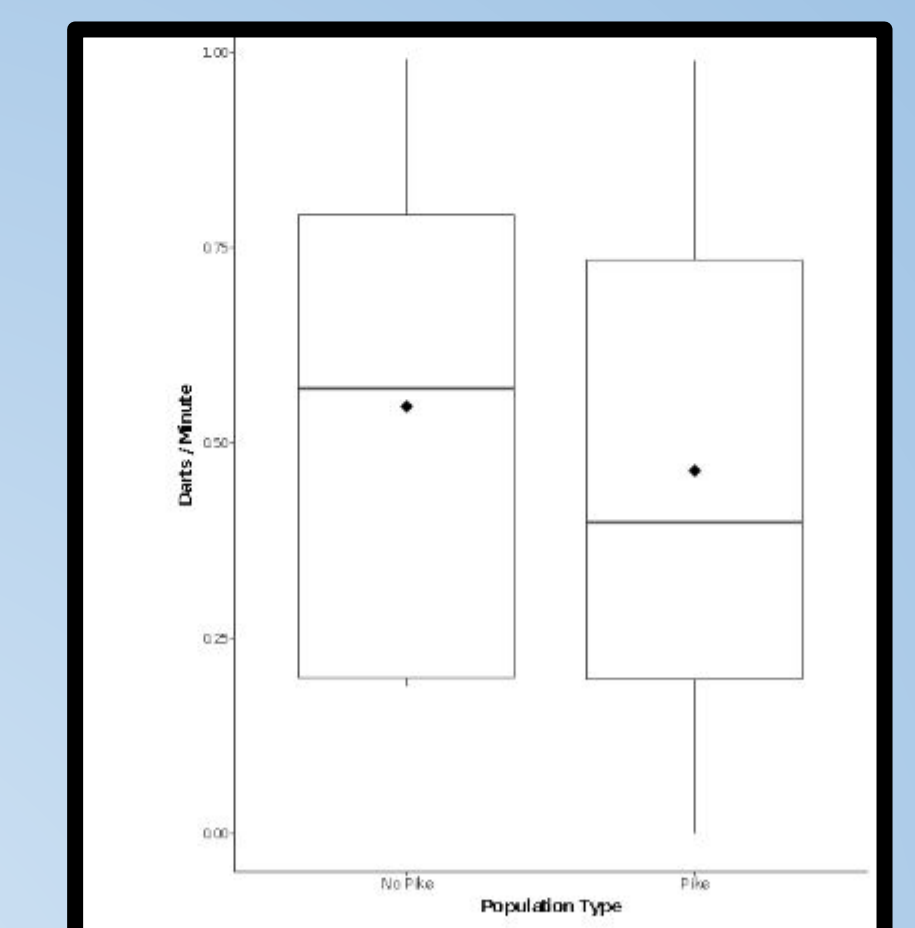


Figure 4: Darts per minute following attack from pike-puppet by pike and no-pike populations types ($P = 0.725$).

Conclusions

Both the pike and no-pike populations types non-significant differences in exploratory behavior, initial habitat choice, and in behavioral responses post-attack.

Possible Explanation:

1. The invasion on pike has only occurred in the past 60 years, more time may be needed in order for genetic and phenotypic behavioral differences.
2. Behavioral responses to pike-attack may need to be socially learned by juveniles, through obtaining social information.

References and Acknowledgement

Haught S, von Hippel FA (2011) Invasive pike establishment in Cook Inlet Basin lakes, Alaska: diet, native fish abundance and lake environment. *Biological Invasions* 13:2103-2114

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