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Research Project Report
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Habitat Complexity and Shoaling Behavior in Fathead Minnows *(Pimephales Promelas)*

Abstract: Fathead minnows were placed in either a complex environment with a predator, complex environment without a predator, simple environment with a predator, or simple environment without a predator in order to determine the shoaling behavior in these specific situations. Videos were taken of each trial to analyze and collect data. The results showed no significant effect on either the distance between the individuals or shoal diameter. In this particular experiment, this result demonstrates shoaling behavior is neither based on the complexity of environment nor whether or not a predator is present.

Introduction: Grouping behavior occurs in the vast majority of the animal world ranging from shrimp to locusts to kangaroo to animals of all other sizes. By using grouping behavior, animals are reducing the chance of becoming prey and therefore increasing the chance of reproduction. Shoaling in fish is mainly the response to predator avoidance as it decreases the risk for a single attack, increases vigilance, and confuses predators (Gonda et al., 2009.) One shoaling theory specifically states that gregarious behavior is a strategy by which individuals seek cover behind other group members to reduce the risk of predation (Armstrong et al., 2008.) Because of this idea, known as Hamilton's theory, it can be predicted that fish will shoal less in a more complex environment that provides natural cover from predators than in a simple environment where the protection is not there. In our study, we were interested in the shoaling behavior of fathead minnows when they were introduced to a predator in a complex environment versus a simple, open environment. We predicted in a simple environment minnows will move in tighter groups and will shoal more frequently than in complex environments.

Materials and Methods: To make the complex environment, polypropylene ropes were cut and tied to test tubes filled with sand, in order to mimic wild rice. The ropes were then placed in the bottom of a fish tank measuring 61x31x39 cm and filled with water 33 cm deep. A fish tank filled with 33 cm of water was used for the simple environment. After constructing the environments, fathead minnows were purchased from a local bait shop, and the predator, a perch, was caught from Lake Itasca. Each trial used four minnows, which were rotated throughout the experiment so as not to get accustomed to a particular environment. 40 different trials were completed with ten each of complex environment with a predator, complex environment without a predator, simple environment with a predator, and simple environment without a predator. A 5 min video was taken of each trial and later analyzed by stopping the video every 10 sec and recording the body length distance between each of the fish as well as a total shoal diameter. After collecting the data, a 2 factor ANOVA was completed.

Results: The results of the data conclude there is no significant effect on either the distance between individuals or total shoal diameter. For distance between individuals, habitat complexity ($F_{1,36}$=0.357, p=0.72,) predator absence or presence ($F_{1,36}$=6.753, p=0.157,) and interaction ($F_{1,36}$=5.671, p=0.194) show no significance. The results of shoal diameter also show no significance, habitat complexity ($F_{1,36}$=1.400, p=0.713,) predator absence or presence ($F_{1,36}$=9.045, p=0.353,) and interaction ($F_{1,36}$=20.308, p=0.167.) As seen in **Figure 1** and **2**, the averages of the different treatments do not differ considerably.

Discussion: In simple and complex environments and with or without predators, the results suggest shoaling distance remains the same. These findings are not in agreement

with the hypothesis being tested and do not agree with similar research. One comparable study states, shoal size differed significantly between the treatments of a complex and simple environment. (Armstrong et al., 2008.) The study also concluded the propensity of minnows to move around the test arena was affected by predation risk; the presence of a predator slowed down the movement of the minnow. Because the findings do not support related research, new questions arise. The study should be redone in a broader scale in a larger, more natural environment to get a solid conclusion on shoaling behavior. This would allow the experiment to be more accurate and really look at shoaling in fish.

References:

Armstrong, J., Griffiths, S., Magurran, A., Orpwood, J. 2008. Minnows and the selfish herd: effects of predation risk on shoaling behavior are dependent on habitat complexity, *Animal Behaviour* 76. pp. 143-152.

Gonda, A., Herczeg, G., Merila, J. 2009. The social cost of shoaling, covaries with predation risk in nine-spined stickleback, Pungitius pungitius populations, *Animal Behaviour* 77. pp 575-580.

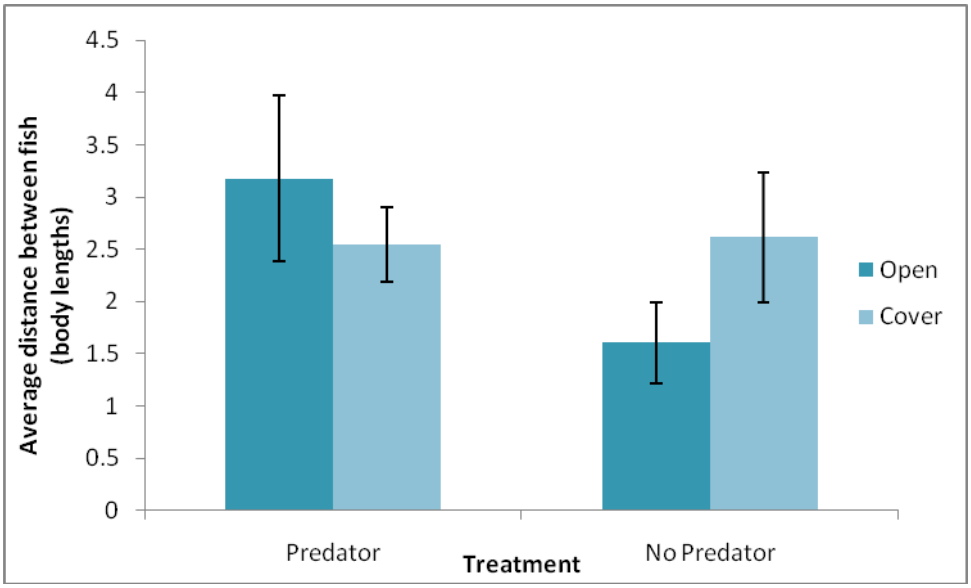

Figure 1. Mean (+/- SE) distance between minnows.

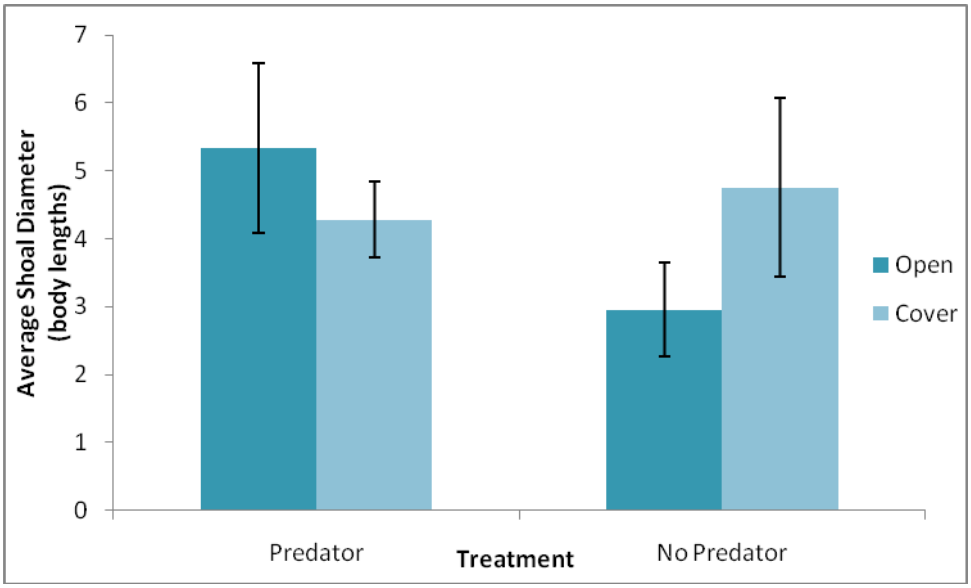

Figure 2. Mean (+/- SE) shoal diameter.