THE EFFECT OF VEGETATION UPON PREDATION RATES ON JUVENILE FISH

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Abstract

Current research indicates that the amount of eel grass (*Zostera marina)* coverage along the Eastern Coast of the United States has been decreasing. Many juvenile fish use vegetation as a protective nursery from predators, so this rapid decrease in eelgrass could impact their survival rates. The current study considered the effect plants have on predation rates of juvenile fish. The mummichog (*Fundulus sp.)* was utilized as a model predator, and as model prey juvenile guppies (*Poecilia reticulata*) were chosen, as they often rely on vegetated areas as a nursery. The hypothesis was that if an aquatic ecosystem contains vegetation then it will increase the survival of juvenile fish. The experimental set up consisted of two fish tanks, one with vegetation and one without; each containing the same amount of predators and prey. Survival rates were recorded daily over the course of a week. Although the results were not statistically significant there was a trend indicating more rapid decrease in survival in the absence of vegetation. In conclusion, diminished plant beds could result in decreased populations of juvenile fish in natural habitats. Based on the crucial role of eelgrass beds in juvenile fish development, as indicated in the current study, rehabilitation efforts are recommended to prevent further vegetation loss, and potential impact on fish populations.

Introduction

Seagrasses are common to coastlines around the world (Orth et al 2006). They form a habitat to many organisms, including developing juvenile fish, which use them as nurseries. In the shallow waters, vegetation provides the young fish with protection from predators during a vulnerable stage of their lives. Data indicates that the quantity of seagrasses have been diminishing worldwide over the past years (Short et al 2006). Eelgrass (*Zostera marina*) is one such aquatic plant, which is common to many areas of the world and yet disappearing; in one study at a rate of 80-96% decrease in only a decade (Hauxwell et al 2003). It is not certain whether the current decrease in eelgrass cover is the result of wasting disease, as it was in the large-scale eelgrass decline in the 1930s, where microorganisms attach to eelgrass and leech nutrients from it (Short et al 1987). There are various other factors that could be responsible: such as organismal disturbance by bioturbation of crabs or bird grazing, mechanical factors such as dredging or propeller scaring by boat motors, or physical stress due to changing environmental conditions such as alterations in pH or salinity (Short et al 1996). Regardless of the cause of the disappearance of the eelgrass, it will impact the juvenile fish populations that depend on these plants to function as a protective nursery. The following experiment was conducted to determine how big of an effect decreased vegetation would have on developing fish populations. Although the current study was conducted in a closed system, it should provide an idea of what is occurring on a larger scale in ocean environments, with impacts on commercial and recreational fisheries, and the ecosystem as a whole.

Fig. 1 Left: Top male, bottom female Guppies (*Poecilia reticulata*), Middle: Top male, bottom female Mummichog (*Fundulus sp.*), Right Eelgrass (*Zosteria marina*)

Hypothesis

If an aquatic ecosystem contains vegetation then it will improve the survival rate of juvenile fish against predation.

Materials and Methods

Animals: Both a male and a female Mummichog (*Fundulus species*) were used as the predators in this experiment. The animals were caught at Plumb Beach in the summer of 2011. The prey was juvenile guppies (*Poecilia reticulata*) that were bred at Brooklyn College for several generations.

Experimental Set Up: Two tanks were maintained at 22° C, salinity of 30ppt, and with weekly water quality checks of nitrate levels. It was necessary to establish a mesh partition to prevent the guppies from using the space beneath the filter as protection from predation. A combination of live and plastic eelgrass plants was added to one tank. Preliminary trials were conducted to: 1) establish the control natural mortality rates of the prey *P. reticulata*, and 2) to confirm that predation rates amongst the two *Fundulus sp*. specimens were approximately equal. At the start of the experiment 23 specimens of *P. reticulata* were placed in each tank, and survival was recorded daily over the course of 5 days.

Fig 2. Experimental Setup. Left: Tank without vegetation, Right: Tank with vegetation.

Results

In both the tank with plants and the tank without plants, after 5 days the number of prey decreased, however the tank without plants decreased at a more rapid rate (see figure 3). In the tank without plants, the number of *P. reticulata* dropped to 0 in just one day. In the tank with plants there was a slow decrease in survivors each day, but the population never reached 0. In the control tank mortality decreased on average 4% each day, as compared to the 100% mortality on the first day in the vegetation-less tank, indicating that the high mortality was in fact the result of the presence of a predator. The T-test resulted in a p value of 0.593282, which did not yield statistically significant results. However, behavioral observations (as captured on video) demonstrate that the predator in the tank with the vegetation had difficulty maneuvering when it encountered the eelgrass, and that there were areas of the tank where the predator was entirely incapable of passing. Not surprisingly, the juvenile *P. reticulata* was often seen localized to the area of the tank that contained vegetation.

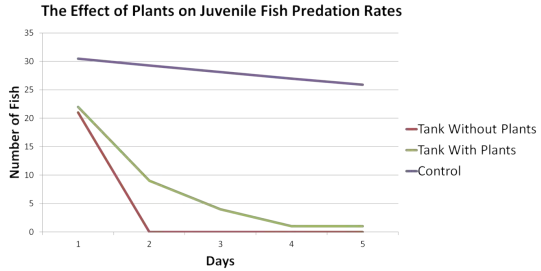

Fig. 3 The predation rate of *Fundulus sp*. on *P. reticulata* over the course of 5 days, with daily recordings of survival in a tank with plants, and without.

Discussion

Based on the results of this experiment, eelgrass could play an important role as a nursery for juvenile fish. The current study demonstrated that vegetation makes it difficult for the predator to reach the smaller prey organisms. Despite the eelgrass being compacted enough to prevent the passage of *Fundulus sp.* from reaching the prey, it had openings to allowing *P.reticulata* to live and swim through. An additional informal trial was conducted where both juvenile and adult *P.reticulata* prey were added to the tanks and in both the tank with and without vegetation the adults were consumed within an hour of addition to the tanks. The larger size of the adult prey prevented them from easily accessing the openings in the eelgrass, and therefore lends further support to the role plants play in preventing predation.

There are real world implications to this experiment because as the areas with eelgrass (as well as other seagrasses) decrease, so too are the nurseries of the ocean diminishing, which could lead to decreased fish populations. More than just juvenile *P.reticulata* use plants as protection in the ocean and the plants could save a lot of different species from dying out. The disappearance of a single species of fish could throw off the balance of an ecosystem. A possible solution for the problem would simply be to plant more eelgrass and other seagrasses so that fish populations can then grow again. But to maintain these newly planted areas, we also we need to cut the toxins that are entering the ocean and damaging the vegetation. These products are cutting off some of the nutrients to the plants, which jeopardize their health.

One thing that could make the results of future trials more convincing would be to increase the sample size by having more than just two tanks and then collecting the data from all the tanks. This would help strengthen the statistical significance and make sure that the plants are the sole factor affecting the predator's feeding behavior.

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