The Effect of Salinity on the Round Goby (*Neogobius melanostomus*)

Sydnie Mauch, Biology and Spanish, University of Minnesota Duluth
Dr. Allen Mensinger, Biology Department, University of Minnesota Duluth

Abstract

The Eurasian round goby (*Neogobius melanostomus*) is an invasive species of the Laurentian Great Lakes that entered through the medium of ballast water in 1990. Native to the Caspian and Black seas, round gobies are acclimated to different salinity levels. Since the effect of changing salinity levels on the round goby is scarcely understood and a greater understanding of gobies spread is needed. We evaluated the environmental relationships between salinity water and goby survival.

We used 40 subjects from the Duluth-Superior Harbor caught via minnow traps. Gobies were acclimated to laboratory settings and measurements taken included weight and length weekly for 4 weeks. Round gobies can survive efficiently in pond water (0.10%) and saltwater (3.5%). The average weight lost after the conclusion of four weeks for gobies in pond water was 0.267 g and 0.09 g for gobies housed in salt water. Methods to help slow the invasion of gobies are already in place such as exchange of ballast water at sea before entering the great lakes. Our results suggest that this exchange of ballast water may not be enough. Instead, using DI water, which resulted in 100% fatality, during ballast exchange could be an effective way to eradicate the fish. However finding a cost effective approach is key to help prevent further invasions of round goby.

Introduction

The round goby, *Neogobius melanostomus*, an invasive species of fish of the Laurentian Great Lakes, was first discovered in 1990. It is thought they originally were

transported from their native water by ballast water, which is used in ships to provide stability after exchange with new water at their destination. Ballast water is a common culprit of transfer of invasive species. For example, the round goby's Native range is in the Caspian Basin and tolerates a wide range of salinities yet it is found all over (Lynch et al. 2012). However it is not known the effect of salinity on growth and survival.

This species is one of the most wide ranging invasive fish on earth and now makes up a main component of the Laurentian Great Lakes food chain (Kornis et al. 2012). Numerous studies have investigated the impacts of these fish and have concluded that prevention versus eradication is the optimal management approach. To do this, a greater understanding of ballast water conditions in the transportation and spread is needed (Kornis et al. 2013).

Although it has been suggested that round gobies can tolerate a wide range of salinities, the exact range has not been determined. This study focused on identifying the high and low salinity thresholds in which round gobies can survive. It is possible the round goby is unable to tolerate open ocean salinity levels (The Baltic Sea is approximately 20 ppt), therefore transoceanic ships should exchange ballast water at sea to reduce the threat of round goby transport. Alternatively, it may be possible to determine the minimum salt levels needed for survival. As one goes upstream in freshwater streams and rivers, already low salt concentrations will probably be below the minimum amount needed for survival. If that minimum can be identified, then management will be able to focus on areas where round gobies can survive. If it is determined that round gobies thrive in low contents of salt, there is deductive reasoning to focus prevention of the invasive species in fresh bodies of water.

Methods

Round gobies (n=80) were collected in the Duluth-Superior harbor with baited minnow traps set out for four days. Fish were sexed and separated and acclimated for one week to laboratory conditions. Fish used for the experiment were selected based on length (10-15cm). Nine 20 gallon tanks were set up with three different salinity treatments. Three tanks contained low salt concentrations of 0.10% salinity to simulate the migration of upstream fish. Three tanks contained high salt concentrations of 3.5% to simulate sea water and the ballast tank exchange. Three tanks contained distilled water for a control. Two males and two females were placed in each of the nine tanks. Tanks contained no bottom substrate but pipes for shelter. Initial weight and length (head to caudal fin) was taken for each fish (Figure 3.) Water temperatures, survival rate, weight, sex and growth rate (assessed by length and weight measurements) were examined at the beginning (Monday) of each week for four weeks Fish were fed a bi-daily amount of dried fish food of 4 pellets at each feeding period.

Results

Following the completion of the experiment, it was determined that round gobies thrive in low contents of salt and high concentrations of salt, which does not fully support the hypothesis, which predicted less survivability in open ocean level salinities. The hypothesis was supported in that the round gobies in the de-ionized (DI) water had the lowest survival rate. This suggests the method of ballast exchange, to prevent further introduction of this invasive may not be sufficient. Instead, using DI water during ballast exchange could be a good eradicator to the fish. However, finding a cost effective approach is key to help prevent further invasions of round goby.

Although it has been suggested that round gobies can tolerate a wide range of salinities, the exact range has not been determined. This study focused on the salinity levels round gobies can survive. It was determined that they are able to survive efficiently in pond water (0.10%) and saltwater (3.5%). The average weight lost after the conclusion of four weeks for gobies in pond water was 0.267 g and 0.09 g gobies housed in salt water.

Figure 1 represents the survivability percentages of round gobies in pond, DI, and salt water. All of the fish survived all five weeks in pond water. For the salt water,100% of gobies survived the first 3 weeks and 2 fish died the fourth week. All DI gobies died within the five weeks. Figure 2 shows the weight changes between pond and DI gobies in the 5 weeks. Gobies living in pond water lost an average of 0.267 g and the fish in DI lost an average of 0.09 g in 5 weeks.

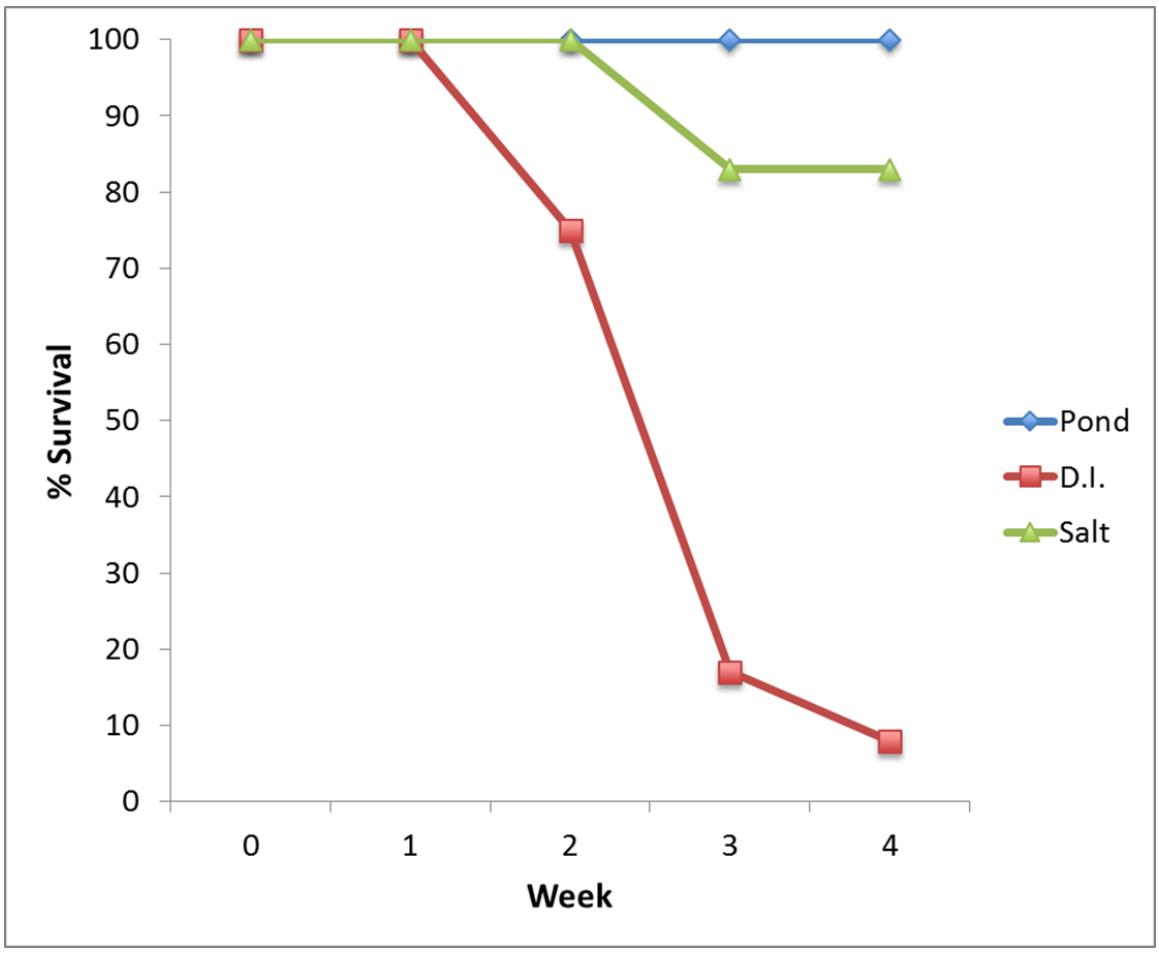

Figure 1. Round goby survivability in pond, D.I. and salt water. All of the gobies survived in the pond water while none survived in D.I. water.

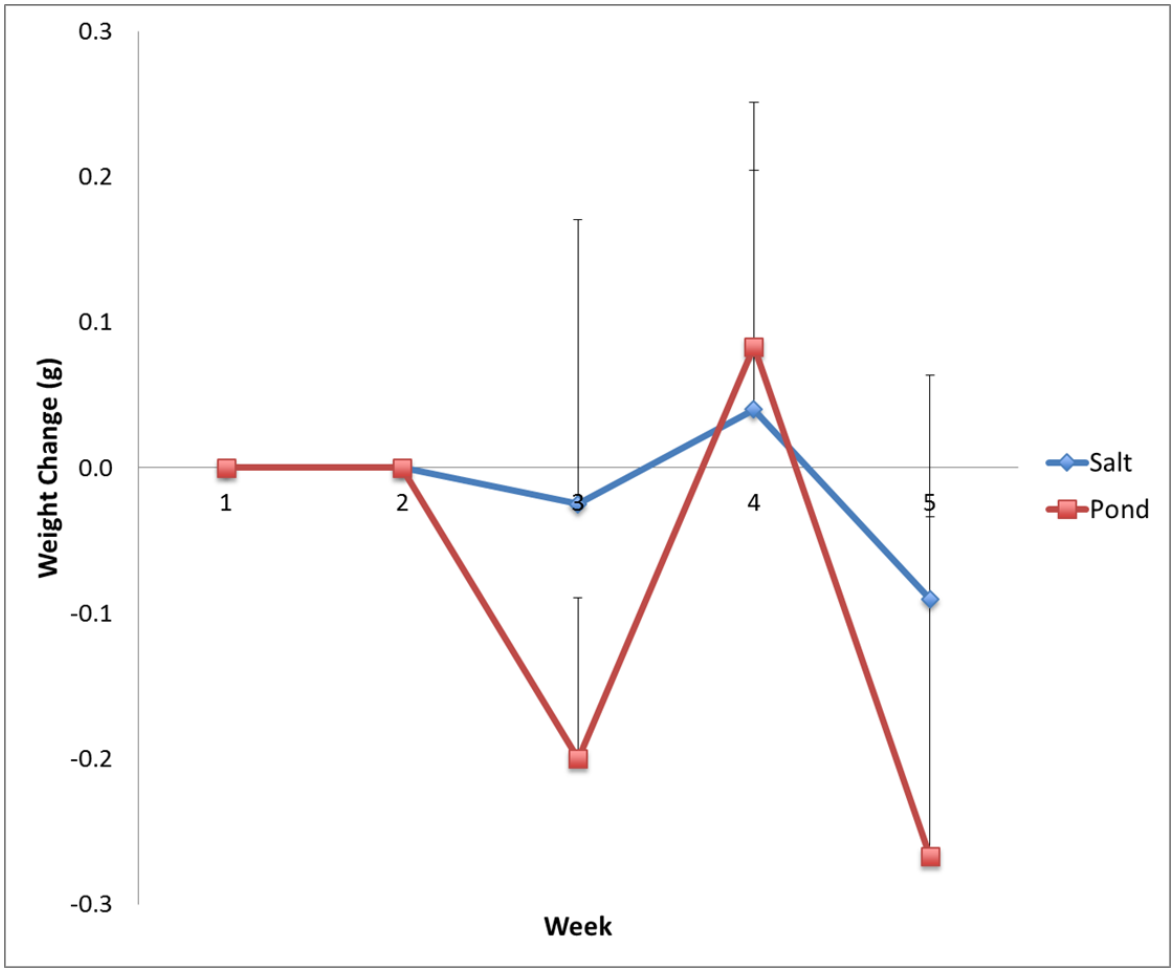

Figure 2. Average weight change of round gobies in salt and pond water. Error bars represent +/- 1 SE


Scout Pro
2000g
ON/ZERO
Off
9.7 g
PRINT
Unit
OHAUS

Figure 3. Measurement technique for length of goby and weight of goby.

Discussion

The objective of the experiment was to understand the physical tolerance of round gobies to changes in salinity in relation to ballast water. Following the completion of the experiment, it was determined that round gobies thrive in low contents of salt and high concentrations of salt, which does not fully support the hypothesis, which predicted less survivability in open ocean level salinities. The hypothesis was supported in that the round gobies in the DI water had the lowest survival rate. This suggests the method of ballast exchange, to prevent further introduction of this invasive may not be sufficient. Instead, using DI water during ballast exchange could be a good eradicator to the fish. DI is an effective method because of the void of minerals and salinity needed for survival and function of life. However, finding a cost effective approach is key to help prevent further invasions of round goby.

Future research includes a second trial to see what concentrations of salt or calcium would be required to eradicate the gobies in the shortest amount of time, simulating the amount of time gobies spend in ballast water.

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