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A Report for the Ministry of the Environment on the Effects of the Round Goby on the Great Lakes

Introduction

In 1990, the round goby, also known as *Neogobius melanostomus*, from the Black and Caspian Sea regions of Eurasia, started to invade the Great Lakes. The round goby is thought to have reached the Great Lakes by being transported and released accidentally from ballast water from ships travelling from Eurasia. The round goby has made its way to Lake Erie, Lake Michigan, Lake Superior, and to many rivers including the Mississippi watershed. There are many key characteristics to the round goby, which allows others to identify this fish. Along with their key characteristics to the round goby, which allows others to identify this fish. Along with their key characteristics, they have pre-adaptations, which help the round goby adapt to their surroundings. There are many biotic factors at risk when the round goby is introduced into the Great Lakes. The round goby has a great impact on the Great Lakes. However, there is only an impact on the population of other species within the Great Lakes and not on human population. There are many predictions for the round goby for the future and a course of action should take place to deal with the invading species. The round goby harms the Great Lakes and other population of species within these bodies of water.

Key Characteristics

The round goby is a bottom-dwelling fish, which rests on rocks and other substrates. They are distinguished by their large heads, soft bodies, and spineless dorsal fins. The round goby has fused pelvic bottom fins that form a suction disk. This suction disk allows the round goby to secure itself to fish and other substrates

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in flowing water. Adult round gobies can grow up to approximately 250 mm. Their bodies are usually a solid slate grey colour and during spawning males take on an almost solid black colour. Because the round goby can live in shallow water, they may have no predators. However, the round goby is an important food source for cormorants, which are fish-eating birds. They are also preyed upon by several sport fish, such as trout, salmon, and walleye. The female round gobies have a life span of three to four years, while the males can live up to one year longer than the females. The males are also larger than the females in size. Figure 1 is a diagram of the round goby:

Figure 1

There are many pre-adaptations for the round goby. This fish can adapt to many surroundings and will compete with native species for their niche, by eating their food and taking over their habitat. The round goby is an aggressive fish with a

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diverse diet. This allows the round goby to become more abundant within the Great Lakes a lot quicker. It also allows the round goby to easily compete with some of the native species. The round goby is a voracious feeder and is able to hunt through total darkness, due to their superficial neuromasts. This allows the round goby to easily hunt for prey. The round goby feeds on a variety of benthic fauna fish, which includes small fish, fish eggs, and invertebrates. This fish also has robust upper and lower pharyngeal teeth that allow them to eat zebra mussels. The round goby also has a high tolerance of a range of environmental factors and has an effective spawning strategy, in which the female lays the eggs and the male guards the nest. The round gobies are able to spawn more than four times a year, which helps increase their population.

Advantages and Disadvantages

The round goby has many advantages and disadvantages. All of the advantages and disadvantages are biotic factors, as they all deal with interactions between species. An advantage to having the round goby in the Great Lakes is that it eats a large quantity of zebra mussels, which are a highly problematic invader species with a high reproductive capacity. The round goby is able to eat approximately 78 zebra mussels a day. Therefore, the population of the zebra mussels is thought to be controlled by the round goby. However, there are more disadvantages than advantages to having the round goby in the Great Lakes. Fisherman find the round goby to be of an annoyance, as it makes catching sport fish difficult, as they are aggressive and will eat the bait on the hook. The round goby also competes with native fish for their habitat and will change the balance of the ecosystem. The round goby also alters the food chains of other species, which will be explained later. Since the round goby's diet consists of mainly zebra mussels, which contain certain contaminants, and sport fish prey on the round goby, the contaminants may

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transfer to the sport fish and then to humans when they eat the fish. The following is a table of immediate and long-term effects on the environment due to the invasion of the round goby.

Immediate	*Long-term*
- A more diverse population of fish in the lake, as the round goby will be introduced - An increase in biodiversity within the Great Lakes	- The round goby will affect fish habitat, as it is an aggressive fish and will compete with the niches of other species in the Great Lakes by eating their food and taking over their habitat

Through research, it was found that the round goby helped decline the population of the yellow perch by approximately 80% from 1990. This was due to over fishing and a decrease in food supply. Once the round goby entered the Great Lakes, sculpin eggs were part of their diet. This declined the amount of sculpin eggs available, and the yellow perch stopped having enough to support their species. Because the sculpin is a major part of the yellow perch's diet, and when the goby interferes with sculpin spawning, there is a negative impact on sculpin reproduction and on the food supply for the yellow perch. The round goby also consumes lake trout eggs. Figure 2 is a diagram of a food chain in which diporea is the source. Since the round goby feeds on diporea, which are fed on by sculpin, smelt alewife, and bloater, there is a decline in these prey fish. Due to a decline in the population of the prey fish there is also a decline in the population of sport fish. Therefore, there will be changes in the eating habits and distribution of the sport fish. There will also be a decline in the population of whitefish, due to the lack diporea. Where the round goby is abundant, there will be a decrease in prey fish, commercial fish, and fish that prey upon diporea. The eating habits of

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these fish and their distribution will then alter. This is due to the round goby being an aggressive fish that will constantly defend its habitat. By the round goby affecting the population of sport fish, especially lake trout since there is already a drop in production of this type of fish, there could be a potential collapse in fishery.

Figure 2

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Predictions for the Future

There are many predictions for the round goby and its effect on its surroundings. Figure 3 is an exponential graph, which represents the growth of the round goby. The round goby's population increases, similar to exponential growth. This is because the population of the round goby slowly increases and then starts to dramatically increase, as when the round goby first entered the Great Lakes. It is new to the environment, its population at that time was not great. However, since round gobies are aggressive and the males carefully watch the nests during spawning season, the population of round gobies increases dramatically. This is also due to the round gobies having not many predators in shallow water. In addition, due to the round goby's aggressiveness, it competes with other fish and has an advantage because of this. Due to these facts, it is easy to predict that the round goby's population will continue to increase dramatically, like an exponential graph, and will continue to live in the Great Lakes. Therefore, individuals will have to deal with the round gobies and accept them into the Great Lakes.

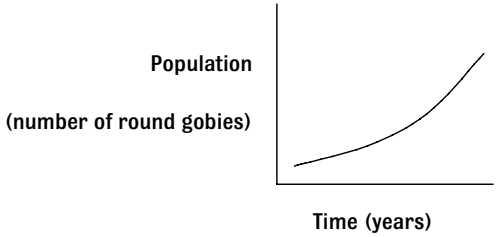

Figure 3

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Recommendations, with justifications, to the Ministry of the Environment for a course of actio

There are many ways to try to prevent round gobies from taking over the Great Lakes. Since round gobies can be picked up and transported on boating equipment, such as boats, trailers, motors, and tackle, precautions should be taken for when an individual transports a boat to another waterway. Before leaving a boat launch, the boating equipment should be inspected, drained, and emptied. Live bait should be left on land and not placed in the water in case one may be an exotic species. When leaving the boat launch, the boating equipment should be washed and dried. One should also learn what the round goby looks like and know what waterways are infested. If any round gobies are found, a report should be made. People could be tested on identifying the round goby as a condition of getting a fishing license.

Being able to identify a round goby is the first step to success in controlling the round goby population in the Great Lakes. Scientists should obtain the round goby samples and preserve them in rubbing alcohol or by freezing when noticed. These samples and other information should then be sent to a fishery management agency or a place that can identify the round goby. Lastly, there are Ballast Water Exchange Laws. These laws restrict and regulate the dumping of ballast water into the Northern American waterways. This law should be enforced and broadcast to individuals, to inform them of how the round gobies are hurting the Great Lakes. This may help stop round gobies from destroying the habitat that was once in the Great Lakes.

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Conclusion

In 1990, the round goby, which originated from the Black and Caspian Sea regions of Eurasia, started to invade the Great Lakes. The round goby has made its way to Lake Erie, Lake Michigan, Lake Superior, and to many rivers including the Mississippi watershed. There are many key characteristics to the round goby, which allows others to identify this fish. The round goby's traits allow it to fight for native species' niches in the Great Lakes, by taking over their habitat. There are many biotic factors at risk when the round goby is introduced into the Great Lakes. There are many predictions for the round goby for the future and a course of action should take place to deal with the invading species. All individuals should be able to identify the round goby to stop the invasion. The round goby harms the Great Lakes and other populations of species within these bodies of water and therefore, must be stopped.

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Bibliography

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Teacher's Notes

Knowledge/Understanding

– The student demonstrates considerable understanding of how the invading species has adapted. He or she links a number of adaptations to the success of the round goby within the environment (e.g., "The round goby has fused pelvic bottom fins that form a suction disk. This suction disk allows the round goby to secure itself to fish and other substrates in flowing water"). However, some of the information appears contradictory (e.g., "they may have no predators. However, the round goby is an important food source for cormorants"; "The round goby feeds on a variety of benthic fauna fish, which includes small fish, fish eggs, and invertebrates").

Inquiry

– The student analyses the actual or potential problem with considerable effectiveness. He or she identifies both advantages and disadvantage of the presence of the round goby in the Great Lakes (e.g., "the population of the zebra mussels is thought to be controlled by the round goby"; "The round goby also consumes lake trout eggs"). However, the student gives no details of the actual or potential economic impact of the round goby.
– The student predicts the future impact of the invading species with considerable effectiveness. He or she predicts the continuing exponential growth of the round goby population in the Great Lakes "since round gobies are aggressive and the males carefully watch the nests during spawning season". The student suggests that "Where the round goby is abundant, there will be a decrease in prey fish, commercial fish, and the fish that prey upon diporea." However, the student does not attempt to quantify the increased environmental or economic impact.

Communication

– The student communicates information in graph/chart/table format with some clarity. The graph has appropriately labelled axes and is correctly described as "an exponential graph", but it is schematic and lacks scientific data. The "food chain" in figure 2 does not include the round goby.

– The student communicates ideas and information with some clarity. The report is organized into logical sections, but there is a good deal of repetition of material. The student generally uses scientific terminology correctly, but there are some terms that require definitions (e.g., neuromasts, benthic).

Making Connections

– The student recommends and justifies a course of action of considerable effectiveness. In addition to recommending the enforcement of "Ballast Water Exchange Laws", the student makes recommendations aimed at boaters and fishers (e.g., "precautions should be taken for when an individual transports a boat to another waterway"; "People could be tested on identifying the round goby as a condition of getting a fishing license"). However, the student offers little justification for the recommendations.

Comments

This work is representative of a low level-3 performance. The student demonstrates a considerable degree of achievement of the expectations in the Knowledge/Understanding, Inquiry, and Application categories of knowledge and skills. However, in the Communication category, the student demonstrates only some degree of achievement – i.e., achievement that is more characteristic of level 2.

Next Steps

In order to improve his or her performance, the student needs to:

- edit and proofread the report to eliminate contradictions and repetition;
- describe the economic effects of the invading species;
- predict quantitatively the future impact of the invading species;
- base the graph on population data;
- define or explain unfamiliar scientific terminology;
- provide additional justification for the recommendations.