AQUATIC INVASIVE SPECIES

Consequences of Round Goby Invasion for Littoral Zone Communities: Effects on Sculpin and Benthic Invertebrates

Final Report

Dr. Martin Berg is lead investigator on a project (with Dr. John Janssen, Loyola University Chicago, as co-PI) that has implications for native fishes including yellow perch. If the rapidly-expanding populations of round gobies depress benthic invertebrates of the littoral zone more than the native mottled sculpins, then juvenile yellow perch and other fishes, which consume the invertebrates, will be adversely affected. The investigators will use a combination of diet analysis in field-caught fishes and cage experiments to quantify degree of diet overlap and impact on benthic invertebrate populations. The results will be used to predict effects on higher trophic levels, including yellow perch, and to guide management decisions (e.g., whether goby control measures are warranted). The investigators will provide results to the Task Groups working on invasive species in Lake Michigan and to the Yellow Perch Task Group.

Major Goals and Objectives
To determine how the round goby (*Neogobius melanostomus*) will impact littoral zone food webs and whether the round goby is a trophic replacement for the mottled sculpin (*Cottus bairdi*). Because mottled sculpins are a major benthic invertivore in Lake Michigan whose populations have been negatively affected by round gobies, this project will examine whether the impact of round gobies on benthic invertebrates differs from that of mottled sculpins. A consequence of differential effects will be a substantial alteration in littoral zone community structure and potential effects on other Lake Michigan biota.

Our proposed study has three specific objectives that will be addressed using surveys and field experiments: (1) To examine diets of sympatric and allopatric populations of mottled sculpins and round gobies, (2) To determine the relationship between mottled sculpin and round goby feeding on benthic invertebrate communities, and (3) To assess the role of round gobies as trophic replacements for mottled sculpins.

Progress
Data for Year 2 objectives are still being collected and include the collection of round gobies and mottled sculpins for diet analyses and examination of the effects of both species on benthic invertebrate prey behavior.

Accomplishments
Specimens of sympatric and allopatric round gobies and mottled sculpins for diet analyses have been collected and currently are being analyzed. These data supplement collections made in Year 1 of funding by examining fish from locations not previously sampled. The behavior of benthic invertebrate prey when exposed to round gobies or mottled sculpins also is being examined by using both field and laboratory experiments. These experiments are ongoing.

Applications/Benefits
The results of Year 2 experiments will provide information as to whether juvenile round gobies and mottled sculpins have similar diets when in allopatry and whether those diets change when both species co-occur. These results are particularly important because juvenile round gobies and mottled sculpins feed primarily on non-mussel benthic invertebrates and have the greatest potential to alter nearshore food webs. These data will provide valuable insights as to whether juvenile round gobies are trophic replacements for mottled sculpins or whether their impact on food webs differs from those of the native sculpin.

Narrative Report

Three major objectives were examined in Year 2 of the study. Objectives 1 and 2 were continuations of research initiated in Year 1. Objective 1 was to examine round goby and mottled sculpin diets in areas where they co-occur. A total of 100 round gobies and 100 mottled sculpin were collected from sympatric locations in Lake Michigan. Round gobies were collected by either angling or deploying a cast net underwater using SCUBA, whereas mottled sculpin were collected by hand using aquarium nets while SCUBA diving. Specimens were placed into individual containers and preserved. Upon returning to the laboratory, the stomachs of each specimen were dissected and the gut contents identified to the lowest taxonomic level possible, usually genus. An identical approach was used in the examination of diets of allopatric round gobies and mottled sculpins (Objective 2), however fish were collected not only from Lake Michigan but from throughout the Great Lakes. A total of 250 round gobies and 125 mottled sculpins were collected from areas where the two species do not co-occur. All fish for diet analysis in Year 2 of the study have been collected and stomach contents are currently being analyzed. The third objective examined whether the presence of round gobies alters benthic invertebrate prey behavior when compared to prey behavior in the presence of mottled sculpins. These data will be particularly useful in allowing us to elucidate specific mechanisms behind the impact of round gobies on benthic invertebrate community structure that we previously established in cage experiments (from Year 1 funding). Both field and laboratory experiments were used to examine differences in prey behavior. In field studies, sites were selected that have been invaded by round gobies for different periods of time. These time periods included sites that have never been invaded by round gobies (0 years) to those that have been invaded for 1 year, 5 years, and 7 years. At each site, a video camera was deployed underwater for 3 hours (1 hour per site, three replicates per site) to record various aspects of prey behavior including taxa present and amount of time invertebrate prey taxa spent on the tops of rocks. The primary taxon examined was the amphipod Gammarus, however several other taxa occurred in sufficient numbers to be examined at some sites. In the laboratory, the behavior of Gammarus was examined in response to each fish species, however one set of experiments allowed fish to have access to the prey, whereas another set of experiments prevented direct interaction by placing a mesh barrier between between predator and prey. In predator access experiments, 50 amphipods were placed into each half of a 56-l aquarium that was divided by a plexiglass barrier. One half of the aquarium served as a control (no gobies), whereas the other half received 3 juvenile gobies after 30 minutes to allow for prey acclimation. Prey behavior was videotaped from above each aquarium for 30 minutes after fish introduction. The latter set of experiments was conducted to determine whether the mere presence of either fish elicited a change in prey behavior in the absence any direct interaction. These experiments involved dividing the aquarium with a plastic mesh that allowed for water movement but prevented fish passage. Experiments involved placing 50 amphipods in each half of an aquarium, allowing 30 minutes for acclimation, and then introducing three gobies to one side of the aquarium. Whether the presence of gobies altered prey behavior in the absence of direct interactions was determined by comparing prey behavior on both sides of the aquarium.

Brief Summary

The repeated introduction of non-native species represents a series of major disturbances that have affected the integrity of the Great Lakes. These invasions have caused frequent restructuring of lake food webs, the demise of economically important fisheries, and an increase in management costs associated with attempts to control these nonindigenous species. The most recent threat to the Great Lakes is the invasion of a fish, the round goby, and its rapid establishment of populations in all of the Great Lakes. The addition of round gobies to the Lake Michigan nearshore food web combined with the apparent elimination of mottled sculpins raise both faunal concerns about the local extinction of mottled sculpins and ecosystem concerns about changes in energy flow. This study is using cage experiments to assess the differential impacts of round gobies and mottled sculpins on benthic invertebrate community structure in nearshore Lake Michigan. In addition, the diet overlap of round gobies and mottled sculpins and differences in prey behavior will be examined in areas where the two species co-occur and where they occur in isolation from one

another. Observations of prey behavior will be further refined using controlled laboratory experiments. The results of this study will have broad implications for the structure and function of nearshore areas as round gobies continue to spread throughout the Great Lakes. Changes in nearshore communities also can have strong impacts on game and non-game fishes. Because many fish rely on nearshore invertebrates as a major food resource at some time during their life cycle, changes in benthic invertebrate communities could substantially alter fish population dynamics resulting in major changes to fisheries in Lake Michigan and the other Great Lakes.

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- **Completion Date**: February 28, 2002
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