AQUATIC INVASIVE SPECIES

Potential Impacts of Invading Ruffe (*Gynmocephalus cernuus*) on Benthic and Pelagic Ecosystems of the Grat Lakes

Final Report

Objectives

Our three major objectives are to: (1) determine the potential competitive interactions between exotic Eurasian ruffe and native yellow perch in Lake Michigan and throughout the Great Lakes, through new knowledge of their preferences for prey and habitat, (2) determine how predators (e.g., pike) and another exotic animal, zebra mussels, might affect the success of ruffe and their interactions with yellow perch in the Great Lakes, and (3) determine the current composition of benthic macroinvertebrates in Lake Michigan to generate a baseline prior to the anticipated invasion by ruffe.

Summary of progress

We have completed our 3rd year of research as part of this project, which has been extended for a 4th and final year with a no-cost extension. This project is a collaborative effort among four Sea Grant programs (Minnesota, Michigan, Ohio, and Illinois-Indiana) to assess the potential environmental consequences of the invasion of the Great Lakes by Eurasian ruffe *(Gymnocephalus cernuus*). The Illinois-Indiana component of this integrated project has focused on using laboratory experiments to assess the interactions among ruffe, yellow perch (*Perca flavescens*), potential fish predators, and zebra mussels during an invasion scenario such as might occur in southern Lake Michigan. We have completed the perch-ruffe competition study (objective 1 above), which has resulted in a published manuscript in a special issue of the Journal of Great Lakes Research devoted to ruffe (Fullerton et al. 1998), and we are currently preparing two more manuscripts for submission (see citations below). We have also conducted ancillary work on round gobies in Lake Michigan, and have a paper in press (Benning and Berg, in press). We have addressed objective 2 with laboratory experiments, and a manuscript is being prepared on ruffe – zebra mussel interactions. We are midway through our experiments on predator-prey relationships. A field survey of benthic macroinvertebrates in southern Lake Michigan (objective 3) was repeated in 1998 to establish the baseline prior to ruffe invasion. Results from the 1997 survey were published in Fullerton et al. 1998.

Accomplishments

This project is providing basic information relevant to the management of Eurasian ruffe as they extend their range within Lake Superior and possibly into the other Great Lakes. A paper in a widely read journal (Journal of Great Lakes Research) has been published and several other papers are in varying stages of preparation for publication (2 papers should be submitted before the end of 1998). In 1998, we also presented our results at the annual meeting of the North American Benthological Society (including within the Presidential Address by Gary Lamberti) and at the joint meeting of the Ecological Society of America and American Society of Limnology and Oceanography. An update on our research will be presented at the forthcoming International Conference on Zebra Mussels and Aquatic Nuisance Species in Duluth, Minnesota, in April 1999. Our work was also highlighted in a report by The Science Coalition to the U.S. Congress entitled "Great Advances in Scientific Discovery" as one of the 162 significant scientific breakthroughs of 1998 (see attachment). All of these venues provide important information for management decisions with regard to the ruffe invasion.

Benefits

Many state and federal agencies are responsible for the management of fisheries and water resources within the Great Lakes. Nominally, these include the U.S. Fish and Wildlife Service, U.S. Environmental

Protections Agency, Great Lakes Fishery Commission, U.S. Army Corps of Engineers, and the Departments of Natural Resources or Environmental Management for the various states bordering the Great Lakes. All of these agencies will be able to use our findings to better manage Eurasian ruffe in the Great Lakes and their inflowing rivers. Because our research was highlighted in the report to Congress, this should emphasize the threat of exotic species at the national level while providing visible benefits to Sea Grant. Our research has also been highlighted in local news stories, thereby informing the public of the threats of exotic species. News stories also inform the public of the relevance of our work and the importance of supporting basic research.

Narrative Report

A major issue in the management of the Eurasian ruffe invasion is whether ruffe will compete with native yellow perch, an important commercial and sport fishery in lakes Michigan and Erie and an important forage fish for large predators (e.g., walleye, pike, lake trout). We have found that ruffe will consume similar food as perch, and share habitat with perch, and thus will potentially compete with yellow perch where they coexist. Both species, however, suffer from reduced growth rates when they coexist in laboratory tanks at fairly high densities with limited food. It is also possible that another exotic species, zebra mussels, will modify habitat sufficiently to alter the interaction of ruffe and yellow perch. Zebra mussels provide refuge for invertebrates, thereby making them less accessible to fish. We are also examining whether large predators (e.g., walleye, northern pike) will feed on ruffe, thereby slowing invasion rates or using ruffe as an alternate food source. These experiments are ongoing, but it appears that predators show large individual variation in their predation on ruffe. The baseline study of Lake Michigan invertebrates continues to show that prey items suitable for ruffe are abundant in the western and southern portions of the lake.

Abstracts of Papers in Preparation (see citation below):

"Influence of Habitat and Food on Interactions of Eurasian Ruffe and Yellow Perch"

The exotic Eurasian ruffe (*Gymnocephalus cernuus*) is invading areas of the Great Lakes currently occupied by native yellow perch (*Perca flavescens*) where they may compete interspecifically for habitat or food resources. The likelihood of competition for food depends, in part, on whether these fishes overlap spatially and temporally and on their relative abilities to consume the food types associated with given habitats. We conducted two sets of laboratory experiments to quantify habitat (mud, cobble, macrophytes) and food (benthic invertebrates) use. The first set of experiments examined ruffe and yellow perch habitat preferences, the influence of fish density and the presence of food on these preferences, and if fishes competed for habitat space. Ruffe and yellow perch both preferred macrophytes to cobble and cobble to mud in the light; ruffe increased their use of mud in the dark. Neither fish density nor the presence of food affected habitat choice, and competition for habitat was not evident. In the second set of experiments, we quantified the relative abilities of each fish species to consume invertebrate taxa (chironomids, oligochaetes, and amphipods) in each of the three habitats. For both fishes, feeding rates were marginally lower in macrophytes than in cobble and mud. Feeding rates did not differ significantly between fish species. Although ruffe and yellow perch apparently occupy different habitats in nature, our experiments suggest that if they are forced to occupy the same habitat (e.g., during invasion or because of predation risk), competition for space will be weak, if it occurs at all. However, competition for food may occur within a shared habitat when resources are limiting because neither species has a clear advantage in its ability to consume food taxa in any habitat.

"Resource Competition between Eurasian Ruffe and Yellow Perch"

The Eurasian ruffe (*Gymnocephalus cernuus*), an exotic percid fish now established in the Great Lakes, is invading areas currently occupied by native yellow perch (*Perca flavescens*). We conducted two laboratory experiments to test whether competition for benthic macroinvertebrate food (the oligochaete Lumbriculus) may occur, thus resulting in reduced growth of either or both species. In the first experiment, we compared

short-term growth of ruffe and yellow perch among 6 treatments (1 ruffe or 1 yellow perch alone, 2 ruffe or 2 yellow perch alone, 1 fish of each species together, and 2 fish of each species together, each replicated 9 times) at 21 °C over 7 d in 40-L aquaria with mud substrate. Growth was measured both as change in mass and as RNA levels in white muscle tissue of fish (an index of short-term growth). We conducted a second, longer-term experiment in 1-m2 tanks at 17 °C for 58 d, using 4 treatments (2 ruffe or 2 yellow perch alone, 1 fish of each species together, and 2 fish of each species together, each replicated 3 times). Growth rates of ruffe did not differ from those of yellow perch within a treatment in either experiment. In both experiments, however, growth of both species was reduced by about 70% in the high-density treatment (2 ruffe + 2 yellow perch) as compared to low-density (# 2 fish) treatments. Results of RNA analyses were consistent with change in mass and represent an alternative approach to assessing growth responses. In ruffe-yellow perch interactions in nature, fish density may be more important than species composition in determining growth rates when food is limiting. Thus, invasions that increase overall fish density may be detrimental to the growth of both fishes.

International Implications

Range expansions by ruffe, and their ecological and economic effects, are an international problem. For example, Canadian provincial and federal agencies, such as the Ministries of Natural Resources, are involved in addressing and managing the ruffe invasion of the Great Lakes. The U.S.-Canadian Joint Commission addresses regulatory issues involving shared lakes and resources. Furthermore, ruffe have invaded most of continental Europe, Scandinavia, and the British Isles from their origin in the Baltic Sea area, with various ecological and economic impacts. Thus, ruffe invasions are a global problem and research on ruffe has global application.

Media coverage

Our research has been highlighted in a story in the South Bend Tribune, on an internet site of **The Science Coalition (http://www.sciencecoalition.org/)** and in a report to Congress.

Partnerships with other institutions/individuals

This project is a unique collaboration among researchers at four Sea Grant programs (Minnesota, Michigan, Ohio, and Illinois-Indiana) to assess the potential environmental consequences of the invasion of the Great Lakes by Eurasian ruffe. We are working with researchers at the University of Minnesota (Duluth and Twin Cities campuses), University of Michigan, and University of Cincinnati. Other, informal interactions have been developed with various state and federal agencies, including the Wisconsin Sea Grant Program, the Biological Resources Division of the U.S.G.S., and the Indiana Department of Natural Resources.

Publications

Benning, L.A. and M.B. Berg. In press. Benthic invertebrate community responses to round goby (Neogobius melanostomus) and zebra mussel (Dreissena polymorpha) invasion in southern Lake Michigan. Journal of Great Lakes Research.

Fullerton, A.H., G.A. Lamberti, D.M. Lodge, and M.B. Berg. 1998. Prey preferences of Eurasian ruffe and yellow perch: comparison of laboratory results with composition of Great Lakes benthos. Journal of Great Lakes Research 24:319-328.

Fullerton, A.H., G.A. Lamberti, and D.M. Lodge. In preparation. Influence of habitat and food on interactions of Eurasian ruffe and yellow perch. For submission to: Can. J. Fish. Aquat. Sci.

Fullerton, A.H., G.A. Lamberti, D.M. Lodge, and M.B. Berg. In preparation. Resource competition between Eurasian ruffe and yellow perch. For submission to: Trans. Am. Fish. Soc.

Fullerton, A.H. 1998. Potential impacts of Eurasian ruffe on yellow perch and benthic macroinvertebrates in the Great Lakes. M.S. thesis. 130 pp. University of Notre Dame.

Kolar, C.S., K.M. Martin, A.H. Fullerton, G.A. Lambert, and D.M. Lodge. In preparation. Influence of zebra mussel-covered substrates on the foraging rates of native yellow perch and exotic Eurasian river ruffe. For submission to: Can. J. Fish. Aquat. Sci.

Undergraduate/graduate students supported by project

A total of 8 graduate and undergraduate students were supported by this project in 1997/98.

Students Supported at the University of Notre Dame (total of 5):

Graduate students: Aimee H. Fullerton - M.S. 1998, Cynthia S. Kolar - Ph.D. candidate.

Undergraduate students: Kristine Martin, Jennifer Mason, Barbara Hinsman

Students Supported at Loyola University of Chicago (total of 3):

Graduate students: Nicole Vidales - M.S. candidate, Nia Haller - M.S. candidate, Jeffrey Coath - M.S. candidate

Back to Research Project List (../../research_ais.php)

Research Information

- **Principal Investigator**: Gary Lamberti
- **Initiation Date**: August 1, 1995
- **Completion Date**: July 31, 1999
- **Affiliation**: University of Notre Dame

- **Principal Investigator**: David Lodge
- **Affiliation**: University of Notre Dame

- **Principal Investigator**: Martin Berg
- **Affiliation**: Loyola University Chicago

Contacts

Tomas Höök (../../staff/hook.html)

Associate Director of Research
765-496-6799
thook@purdue.edu (mailto:thook@purdue.edu)

Carolyn Foley (../../staff/foley.html)
Assistant Research Coordinator
765-494-3601
cfoley@purdue.edu (mailto:cfoley@purdue.edu)

Pat Charlebois (../projects/staff/charlebois.html)
Aquatic Invasive Species Coordinator

847-242-6441
charlebo@illinois.edu (mailto:charlebo@illinois.edu)

Sarah Zack (staff/zack.html)
Aquatic Invasive Species Specialist
847-242-6440
szack@illinois.edu (mailto:szack@illinois.edu)

Danielle Hilbrich (staff/hilbrich.html)
Aquatic Invasive Species Assistant
847-242-6442
hilbrich@illinois.edu (mailto:hilbrich@illinois.edu)

Topics

- **AQUACULTURE (/topic_aquaculture.php)**
- **AQUATIC INVASIVE SPECIES (/topic_ais.php)**
- **CLIMATE CHANGE (/topic_climate.php)**
- **COASTAL RESTORATION (/topic_coastal.php)**
- **GREAT LAKES ECOSYSTEMS (/topic_glecosystems.php)**
- **GREAT LAKES LITERACY (/education.php)**
- **MEDICINE DISPOSAL (http://web.extension.illinois.edu/unusedmeds/)**
- **NATURAL LAWN CARE (/l2l.php)**
- **NUTRIENTS (/topic_nutrients.php)**
- **RECREATION AND FISHERIES (/topic_recreation.php)**
- **RESILIENT COMMUNITIES (/topic_resilient.php)**
- **WATER RESOURCES (/topic_water.php)**

Products

- AQUACULTURE (/products_aquaculture.php)
- AQUATIC INVASIVE SPECIES (/products_ais.php)
- CLIMATE CHANGE (/products_climate.php)
- COASTAL RESTORATION (/products_coastal.php)
- EDUCATION (/products_education.php)
- FISH CONSUMPTION (/products_fishcon.php)
- GREAT LAKES HEALTH (/products_glhealth.php)
- LAND USE PLANNING (/products_landuse.php)
- MEDICINE DISPOSAL (/products_gros.php)
- PROGRAM (/products_program.php)
- NATURAL LAWN CARE (/products_lawncare.php)
- WATER RESOURCES (/products_water.php)

Resources

- ABOUT US (/about.php)
- CHICAGO WATER WALK APP (http://www.chicagowaterwalk.org/)
- FUNDING (/funding.php)
- NEWSROOM (/newsroom)
- OTHER WEBSITES (/other_sites.php)
- PEOPLE (/staff.php)
- PHOTOS (http://iisg.photoshelter.com/)
- SOCIAL SCIENCE (/glssn.php)
- TEACHERS (/education.php)

Careers

- TEACHER TRAINING (/education.php)
- FELLOWSHIPS (/fellowships.php)
- INTERNSHIPS (/internship.php)
- SOCIAL SCIENCE (/glssn.php)

Illinois-Indiana Sea Grant
Purdue University
195 Marsteller Street
West Lafayette, IN 47907-2033
765-496-6009
iisg@purdue.edu (mailto:iisg@purdue.edu?subject=IISG Inquiry)

(http://web.extension.uiuc.edu/state/)

(http://www.seagrant.noaa.gov/)

(http://www.noaa.gov/)

(http://www.purdue.edu/)