ANS
Aquatic Nuisance Species
Volume 2, No. 2 August 1997
DIGEST
FRESHWATER FOUNDATION
Providing current information on monitoring and controlling the spread of harmful nonindigenous species.

Nonindigenous Species and Upcoming Guidelines for Prevention

by William (Jay) Rendall

The topic of regulations and guidelines to prevent the introduction and spread of nonindigenous aquatic nuisance species (ANS) is large and complicated. Therefore, this article will not cover the topic in detail, but rather will provide a broad overview of past, current, and upcoming ANS regulations and guidelines, and will try to answer the question of whether regulations, alone or together with other activities, are an essential part of ANS management. By way of definition, "guidelines" means activities that someone is recommended to follow; "regulations" means what someone is required by law to follow.

Lessons from the Past and Visions for the Future

Several lessons from the past provide the context for discussing the importance of guidelines and regulations:

- There are many pathways of introduction and spread for ANS, most of which are related to human activities, both accidental and intentional. New species continue to be introduced and spread within North America through these pathways.
- Introductions have many costs associated with them: control and management costs; long-term ecosystem changes; and loss of recreational opportunities.
- Often there are no acceptable controls available for use in natural waterbodies once ANS become established.
- Once species are successfully introduced, any control efforts will be very expensive and eradication very unlikely.

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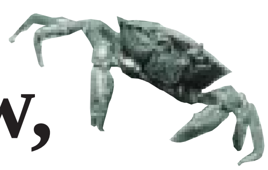
Have Claw, Will Travel



by Andrew N. Cohen

The common green crab *Carcinus maenas*, a marine species native to Europe, has spread to many parts of the world, where its appetite for commercially valuable clams and crabs has distressed some important fisheries. Originally restricted to Europe and possibly northwest Africa, it invaded eastern North America by 1817, southern Australia by 1900, and California by 1989 or 1990. Recent genetic studies have also revealed the presence of the Mediterranean green crab *Carcinus aestuarii* alongside common green crabs in South Africa and Japan (where green crabs have been reported since 1983 and 1984, respectively)(Geller et al. in press). Additional records of the European green crab from Hawaii, Panama, Brazil, and at several sites in the Indian Ocean represent introductions that never "took," probably because the crab cannot reproduce successfully in these warmer waters (Carlton and Cohen in press).

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Aquatic Nuisance Species Spread into Classrooms

by Douglas A. Jensen and Nancy Riggs

Students learn how zebra mussels clog water pipes in the trunk activity "All Clogged Up"

The learning process starts early. School children learn about important events in American history, from the contributions of George Washington during the Revolutionary War to John Glenn's space exploration. However, little attention or resources have been devoted to teach youth about aquatic nuisance species (ANS). While several federal and state agencies and organizations are responding to the need for public education—a critical component in the control and management of ANS—nearly all programs are aimed at adults. Recognizing this unmet need, two Great Lakes Sea Grant offices are helping spread the war against ANS into the classroom.

Education programs are a key to thwarting the spread of ANS and to protecting the environmental integrity of our nation's waters. Two "traveling trunk" programs have been developed to educate our future environmental stewards about ANS. The Sea Grant-sponsored trunks seek to extend ANS education programs to schools so children can learn about ANS and learn to be good environmental stewards.

Zebra Mussel Mania Traveling Trunk

Zebra Mussel Mania Traveling Trunk, developed by Illinois-Indiana Sea Grant in cooperation with the Illinois Rivers Project of the Illinois Department of Natural Resources, is helping educators teach young minds to think critically about important events that affect the ecosystems in which they live. The trunk has become an important teaching resource in the southern Lake Michigan region.

Designed to be used in fifth- and sixth-grade classrooms, the "trunk" is a plastic tub full of fact cards, posters, brochures, videos, and zebra mussels shells, with a curriculum guide to lead teachers and students through easily completed experiments. The experiments help students relate complex problems to their own environments. Experiments

Classroom *continued on next page*

Aquatic Nuisance Species Digest

Direct questions and comments about *ANS Digest* to: Freshwater Foundation, Gray Freshwater Center, 2500 Shadywood Road, Navarre, MN 55331; (612) 471-9773; e-mail: freshwater@freshwater.org.

Aquatic Nuisance Species Digest (ISSN 1083-8864) is produced by the Freshwater Foundation, a public nonprofit foundation whose mission is to pursue the sustainable use of freshwater resources through education, conferences, publications and research. *ANS Digest* is published quarterly in cooperation with the U.S. Fish and Wildlife Service and the national Task Force on Aquatic Nuisance Species.

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***Classroom** continued from previous page*
include measuring reduced water flow in pipes clogged with mussels and examining zebra mussel clusters that can damage boat motors and hulls.

Illinois-Indiana Sea Grant, with the Illinois Cooperative Extension Service, has made the trunks available at more than 30 lending centers, including the Shedd Aquarium in Chicago, the Bell Museum in Minneapolis, the Indianapolis Zoo, as well as various educational and Cooperative Extension locations throughout the United States. Trunks are also available for purchase.

The trunk earned several awards, including the 1996 Gold Award in Distance Education and Instructional Design, the 1996 Instructional Design Outstanding Professional Skill Award from the Agricultural Communicators in Education, and the Great Lakes Sea Grant Network's 1996 Superior Program Award.

Exotic Aquatics Traveling Trunks

The second Sea Grant traveling trunk project, Exotic Aquatics Traveling Trunks, is now being used by teachers and by agency educators in the Great Lakes and beyond to teach middle-school students about the threat exotic plants and animals pose to our nation's water resources. The trunks, developed by the Minnesota Sea Grant Program in cooperation with the University of Minnesota Bell Museum, the National Park Service and National Park Foundation, the US Fish and Wildlife Service, and the Minnesota Department of Natural Resources, are available for loan from the Minnesota Sea Grant office in Duluth and from nine other lending centers throughout the Great Lakes region. Sixty teachers have used the trunks since September 1996, teaching an estimated 3,317 students about exotic aquatics. More trunks are now being assembled for use by natural resource agencies and programs throughout the Great Lakes, and inquiries about purchasing or reserving trunks have come from fourteen states.

The trunks present a broad perspective of ANS issues using many hands-on activities. Each trunk contains preserved specimens of exotic species, books, maps, posters, and a complete curriculum guide. Students learn while having fun seeing and touching preserved specimens of exotics such as zebra mussels, Eurasian ruffe, sea lamprey, Eurasian watermilfoil, purple loosestrife, rusty crayfish, and spiny waterflea. The nine activities integrate disciplines such as biology, ecology, geography, math, art, and composition. The trunks also contain a 22-minute Exotic Aquatics video that uses the Bill Nye the Science Guy approach to teach about ANS, which has won two national Telly awards for children's programming and education.

Although designed to be used with fourth through seventh graders, teachers and educators have adapted the trunks for both younger and older students, and the trunks have been used as stand-alone displays (using the museum-quality preserved specimens and the videotape) at science fairs, libraries, and environmental learning centers.

For more information about the Zebra Mussel Mania Traveling Trunk, contact Robin Goettel at (217) 333-9448, or email: r-goettel@uiuc.edu. For more information about the Exotic Aquatics Traveling Trunks, contact Doug Jensen at Minnesota Sea Grant's Exotic Species Information Center, (218) 726-8712, or email: djensen@mes.umn.edu.

Douglas Jensen is coordinator of the Exotic Aquatics Traveling Trunk project and of the Exotic Species Information Center for the University of Minnesota Sea Grant Program. Nancy Riggs is the Illinois-Indiana Sea Grant Public Information Manager and writer/editor for The HELM at the University of Illinois, Urbana-Champaign

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Have Claw, Will Travel

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Transport Mechanisms

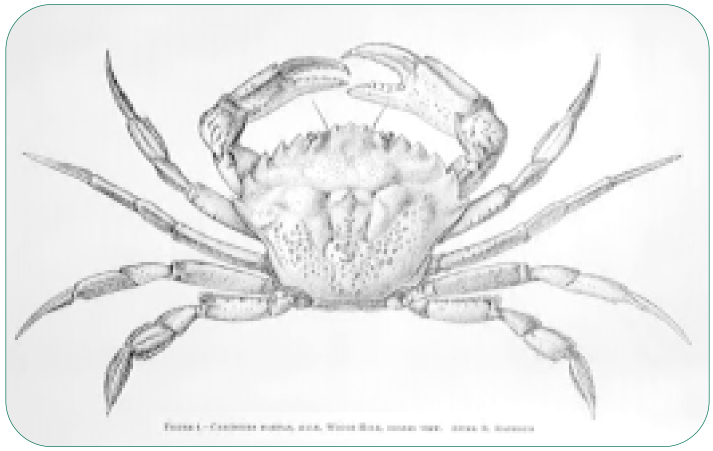
These otherwise hardy crabs are remarkably **polyvectic***, having had access to many modes of transoceanic and interoceanic transportation. In the early days they could be carried among rocks loaded for solid ballast or on the hulls of ships—nestled among dense growths of attached organisms such as barnacles, mussels, sponges, seaweeds, sea squirts, and mussels, or in cavities cut into wooden hulls by wood-boring clams and crustaceans. In recent years they could be transported as larvae or small crabs in ballast water tanks or in other parts of ships' sea-water systems; in accidental association with the burgeoning global shipments of living marine organisms for aquaculture facilities and food markets; or they escaped or were released from aquaria at educational or research institutions (Cohen et al. 1995; Carlton and Cohen in press). Le Roux et al. (1990) suggested that green crabs arrived in South Africa on semi-submersible exploratory drilling vessels, a mechanism that has transported whole communities of organisms across oceans (Benech 1978). However, green crabs most likely reached California in seaweed-packed shipments of marine bait worms from Maine (Cohen, Carlton, and Lau, unpublished data).

Green Crabs in North America

In eastern North America green crabs gradually spread from the New York-New Jersey region north to Canada, where they are now one of the most commonly encountered intertidal and near-shore crabs. In the 1950s they became very abundant in bays and estuaries in northern New England, where they caused massive destruction in the soft-shell clam fishery (Glude 1955; MacPhail et al. 1955), and inspired a variety of control efforts including the use of fences and of bait soaked in pesticide (Smith and Chin 1951; Hanks 1961). Predation by green crabs has also induced evolutionary changes in shell shape in snails in this region (Vermeij 1982).

Green crabs were first collected in California in 1989 or 1990, with a population discovered in an artificial lagoon in southern San Francisco Bay where bait trappers sometimes found their traps packed with hundreds of green crabs. A single adult crab was also caught near Bodega Bay, about 50 miles north of San Francisco, in 1989. By 1995 green crabs had been collected in seven bays from Elkhorn Slough north of Monterey to Humboldt Bay near Eureka, a distance of 320 miles (Cohen et al. 1995; Grosholz and Ruiz 1995; Miller 1996); and in April 1997 green crabs were discovered in Coos Bay, Oregon, another 200 miles farther north (N. Richmond pers. comm.). The crab's physiology and **biogeography** suggest that its expansion will ultimately be limited in the north by winter water-surface temperatures averaging about -1° to 0°C, and in the south by average summer water-surface temperatures of about 22°C, which are warm enough to inhibit reproduction; this corresponds to a potential range from north of the Aleutians in Alaska south to central Baja, California (Cohen et al. 1995; Carlton and Cohen in press).

words in* **bold *type are defined in the glossary on page 23.*



The common green crab *Carcinus maenas*

In California, green crabs are found in bays in intertidal and shallow subtidal waters and in nontidal lagoons, mainly on sand and mud but also on riprap and under rocks in the intertidal zone at low tide. In Europe and eastern North America green crabs are common in sheltered marine and estuarine waters, and present in all but the highest-energy, outer coast environments. Its habitat in these parts of the world includes mud, sand, and rock bottoms, eelgrass beds, and salt marshes. Although green crabs typically live in water less than 20 feet deep, they have been collected down to at least 180 feet (Cohen et al. 1995). With time green crabs may occupy a similar range of habitats on the Pacific coast.

Adult green crabs can tolerate salinities from 4 parts per thousand (ppt) (nearly fresh) to 54 ppt (saltier than the ocean), and have successfully reproduced in salinities as low as 13 ppt. In winter the crabs, especially the females that are carrying eggs, often move into deeper and typically saltier water, perhaps because at colder temperatures the eggs are less tolerant of low salinities. A mature females can produce up to 200,000 eggs a year, so a population of green crabs can increase rapidly if conditions are right (Cohen et al. 1995).

Effects of Green Crabs

Green crabs have the potential to damage the commercially important Dungeness crab, oyster, and clam fisheries, and to seriously affect many other species. The greatest concerns stem mainly from the green crab's feeding activities—this is a crab that will eat nearly anything. Scientists have recorded an enormous variety of organisms consumed by green crabs, including species from at least 104 families and 158 **genera** in 14 animal and five plant and protozoan **phyla**, although the crab doesn't seem to like echinoderms (the phylum that includes starfish and sea urchins).

Analyses of stomach contents have revealed wide variations in the green crab's main prey: mussels, clams, snails, worms, barnacles, seaweeds (algae), or isopods and other crustaceans. This variety is partly because different organisms are common in different areas, but also seems partly due to crabs selecting different prey. There is also evidence that crabs change their diet with the season, and that large and small crabs, male and female crabs, and crabs in different molt stages may also prefer different foods (Cohen et al. 1995).

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Green crabs locate their food mainly by smell and touch. They readily dig up clams and other prey buried a few inches deep, and occasionally dig as deep as six inches to extract large clams. In the laboratory they have been observed eating mussels and soft-shell clams that are as long or even longer than their **carapace** width, and hard shelled clams and snails that are over half their carapace width. On the Pacific coast, green crabs might reduce production in oyster farms and clam fisheries by preying on young oysters and clams as well as on adult clams (Cohen et al. 1995).

The potential predation on and competition with the commercially and recreationally harvested Dungeness crabs are of particular concern. While green crabs often spend their entire lives in bays and estuaries, Dungeness crabs use these sheltered waters primarily as nursery areas; typically entering when very young and returning to the ocean a year or so later as subadults. Since adult green crabs will mainly encounter smaller juvenile Dungeness crabs, and since green crabs in the laboratory have eaten Dungeness crabs up to their own size (Grosholz and Ruiz 1995), the situation does not bode well for the Pacific coast crab

Photograph by Caroline Kopp

The common green crab *Carcinus maenas*

fishery. Green crabs only grow to about three inches in width and despite their abundance in Europe and eastern North America are rarely harvested for food, so losses in the Dungeness crab fishery are unlikely to be offset by the development of a fishery for green crabs.

Andrew N. Cohen is a researcher at the San Francisco Estuary Institute in Richmond, CA.

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Upcoming Meetings

American Fisheries Society Meeting
24-28 August
Web Page: www.esd.ornl.gov/societies/AFS

Zebra Mussels: Lessons Learned in the Great Lakes
10 September, A Nationwide Videoconference, sponsored by Illinois-Indiana Sea Grant Program, in cooperation with the Great Lakes Sea Grant Network and Purdue University Cooperative Extension Service.
POC: Patrice Charlebois, 847-872-0140/
Tom Luba, 765-494-8414. Read details on the Web
http://www.aes.purdue.edu/acs/zm/regis.html

The Midwest Fish & Wildlife Conference
7-10 December, Milwaukee, WI
Session: Invasive Species:
Impacts on Terrestrial Communities
Contact: Bill Swenson, University of Wisconsin
(712) 394-8410 email: wswenson@staff.uwsuper.edu

Eighth International Zebra Mussel and other Aquatic Nuisance Species Conference
16-19 March 1998, Sacramento, CA
Contact: Elizabeth Muckle-Jeffs
(800) 868-8776 email: profedge@renc.igs.net

63rd North American Wildlife and Natural Resources Conference
20-24 March 1998, Orlando, FL
Session: Nonindigenous Species: Methods of Introduction and Impacts
Contact: Richard E. McCabe,
Wildlife Management Institute (202) 371-1808

Send meeting announcements to: Editor, ANS Digest
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Deadline for the next issue is 25 September 1997

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Interrupting Pathways of Introduction and of Spread

History has taught us that prevention is the best course of action. Regulations, guidelines, and education programs are strategies that can help in the area of prevention. But which are the most effective? The numerous recent introductions of harmful nonindigenous species suggest that existing laws, policies, and guidelines are inadequate (Miller 1995). Likewise, Schmitz (1988) and Kurdilla (1988) believe that a typical approach to ANS regulations and the process of listing harmful species are often reactive, too late, and ineffective. Effective and comprehensive regulations and guidelines that prevent introduction and spread of ANS in the first place are needed, rather than responding after ANS have arrived and become widely distributed. Additionally, Baskin (1996) reports from the United Nations Conference on Alien Species in Trondheim, Norway, that a large part of any effort to limit introductions and spread of ANS and other harmful nonindigenous species needs to be education and rigorous new methods to assess environmental and economic tradeoffs.

Federal Regulations

Current federal regulations do not comprehensively address ANS dispersal. Federal regulations, including the Lacey Act and the Federal Noxious Weed Act, attempt to address some areas of ANS dispersal. However, a recent federal report on harmful nonindigenous species (US Congress 1993) states, “The current federal framework is a largely uncoordinated patchwork of laws, regulations, policies and programs. Some focus on narrowly drawn problems. Many others peripherally address nonindigenous species. In general, present federal efforts only partially match the problems at hand.”

Congress took important steps to establish new guidelines and regulations under the National Invasive Species Act of 1996, which reauthorizes and broadens NANPCA of 1990. This new authority is intended to focus more broadly on the pathways of ANS introduction and spread. One of the primary pathways—ballast water from ships—will now be addressed nationally. The US Coast Guard’s authority to regulate ballast water in the Great Lakes was expanded to apply to any vessel with ballast tanks (this change was important because under the previous act many ships operating on the Great Lakes without pumpable ballast water were exempt from the regulations). Additionally, the US Coast Guard is required to develop national guidelines to prevent the introduction and spread of nonindigenous species into any US waters via ballast water of commercial vessels. These national ballast guidelines are important because more than 54,000 vessels enter US waters each year, dumping more than 21 billion gallons of ballast water.

Also under the Act, the national ANS Task Force is required to develop guidelines to control the spread of zebra mussels and other ANS via recreational activities, such as boating and fishing. The Secretary of Transportation will issue the guidelines through the Coast Guard’s Boating Safety Program. These guidelines are to be completed within one year and could be used as recommended actions by any state or federal agency.

Although the Act represents important progress in addressing introductions from ballast water, other gaps in federal ANS regulations remain. The entry into the US of some categories of harmful ANS are not yet regulated (US Congress 1993), and the Lacey Act does not prohibit interstate transport of injurious fish and wildlife, such as zebra mussels (US Congress 1993).

Rather than dividing nonindigenous species regulations into various problem categories such as agricultural pests, nuisance aquatic plants, or injurious wildlife, a broad regulatory approach for all types of pest species is needed. By rewriting federal laws that classify and regulate nonindigenous pest species into one new comprehensive law, the existing patchwork would be more understandable, enforceable, and more effective.

Regional Guidelines

At the regional level, there are also new guidelines emerging. The Great Lakes Panel on ANS has recognized the need to develop regional guidelines for interrupting pathways of introduction. The Panel has adopted recommended guidelines for boaters and seaplanes that travel between water bodies. At their meeting in December 1996, the Panel agreed to develop additional guidelines for waterfowl hunters, scuba divers, construction barges, and other known ANS transport pathways. In a separate effort to minimize the spread of ruffe in the Great Lakes, the Lake Carriers Association, the US Coast Guard, the Canadian Coast Guard, and others jointly developed voluntary guidelines for ballast exchange in the Great Lakes.

Additional regional panels, such as the Western Regional Panel, are being established by the national ANS Task Force. It is likely that additional regional guidelines, specific to pathways and species in those regions, will be emerging across North America.

State Laws

Similar to the situation at the federal level, most states do not have comprehensive regulations specific to ANS (Hawaii and a few other states are exceptions). The report to Congress (1993) concluded that state laws vary from being lax to exacting and use varied legal approaches. Another finding in the federal report was that “State laws governing agricultural pests are relatively comprehensive. However, for nonindigenous invertebrates and plants that do not affect agriculture, state laws provide only spotty coverage.”

State regulations of nonindigenous species are evolving rapidly both in scope and geographical coverage (ANS Task Force 1994). A recent informal survey found that 17 states have adopted laws prohibiting zebra mussel importation and four states have laws that address zebra mussels in a general way (Doug Jensen pers.comm. 1997). Many states are now recognizing the potential harm of some ANS and are trying to prevent their introduction. However, perhaps the most significant regulatory gap is the failure of most states to prohibit transport of zebra mussels and other ANS within their borders. Regulating transportation, in addition to importation, could be a crucial tool to limit the spread of ANS through well known pathways to and among inland waters.

Guidelines and Regulations *continued on next page*

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Model State/Provincial Regulations

In recent years, several committees, reports, and individuals have attempted to identify the components that model state or provincial regulations should contain. Key components for general regulations include:

- Provide adequate authority for state agencies to regulate importation, transportation, possession, and introduction of ANS (ANSTF 1994).
- Establish "lists" (ANSTF 1994). Many types of lists exist such as clean, dirty, gray, approved, restricted, and prohibited lists (Kurdilla 1988, Miller 1995). Florida, for example, has a prohibited aquatic plant list with species from 18 different **genera**, and Minnesota has several categories of nonindigenous species which incorporates the clean list and dirty list, as well as unlisted species.
- Require permits for regulated actions (ANSTF 1994).
- Make regulatory authority applicable to interstate and intrastate transfers and to both state and private waters (ANSTF 1994).

Key regulations to address intentional introductions on nonindigenous species include:

- Some form of evaluation of the potential environmental effects of an introduction should be required with permit applications. Including, at a minimum (ANSTF 1994; Miller 1995):
  - long term effects on native species and ecosystems;
  - purpose and need for the introduction;
  - potential for native species to meet the same purpose; and
  - review of information on the pathogen status of proposed introductions.
- Introducer must be responsible for escapee control or eradication in the event of demonstrated or anticipated harm (ANSTF 1994).
- Monitoring and review programs should be established.

Key regulations to prevent unintentional introduction and transport of ANS include:

- Regulate the transport of harmful species, the transport or diversion of infested water, and other vectors.
- Regulate activities that can be pathways, such as bait harvest and commercial fishing

When developing a regulatory framework at the state level, each jurisdiction must customize the components depending upon its waters, the local pathways of introduction and spread, and commercial and recreational activities within the jurisdiction.

Conclusion

There is evidence that regulations and guidelines can play an important role in minimizing the spread of ANS. The majority of boaters recently surveyed in Minnesota, Ohio, and Wisconsin said that regulations would be "very to moderately effective" at getting them to take steps to prevent spreading ANS (Gunderson 1994; Minnesota DNR 1997) (see "Three-States Exotic Species Boater Survey" in *ANS Digest*, Vol. 1, No. 1). In the same survey only about 10% said they would not be influenced by regulations. The fact that a significant percentage of those surveyed would not respond to guidelines suggests that enforcement, including penalties, is necessary.

Minnesota's experience with the spread of Eurasian watermilfoil is evidence that regulations can be effective. Before state regulations and education efforts targeting boaters were established, 12 to 15 additional infested lakes were identified per year. In subsequent years, the annual rate of discovery of infested lakes dropped to between 2 and 7 per year.

Education of the regulated community is another important way to encourage people to follow guidelines and regulations. When Midwest boaters who did not take precautions to prevent spreading ANS were asked why, they gave two primary reasons: either they were not at infested waters or they did not know what to do (Minnesota Sea Grant 1993). Low public awareness is a key concern; if the target individuals don't know that regulations and guidelines exist, we can't expect them to be followed.

To help prevent the introduction and spread of ANS, guidelines and regulations need these four elements:

- establish prevention guidelines for each type of pathway, so that people know what to do and how to do it;
- use effective educational and outreach efforts that tell those involved with various pathways what the guidelines and regulations are (according to surveys, signs at water accesses are one of the best ways to communicate to boaters);
- establish regulations of potential pathways, especially high-risk pathways; and
- establish penalties and use enforcement of the regulations for those who need the "stick" approach rather than the "carrot."

Each of these four elements will have some beneficial effect independently, but the four combined are likely to be the most effective at protecting our waters for future generations.

William (Jay) Rendall is Exotic Species Program Coordinator at the Minnesota Department of Natural Resources in St. Paul, MN.

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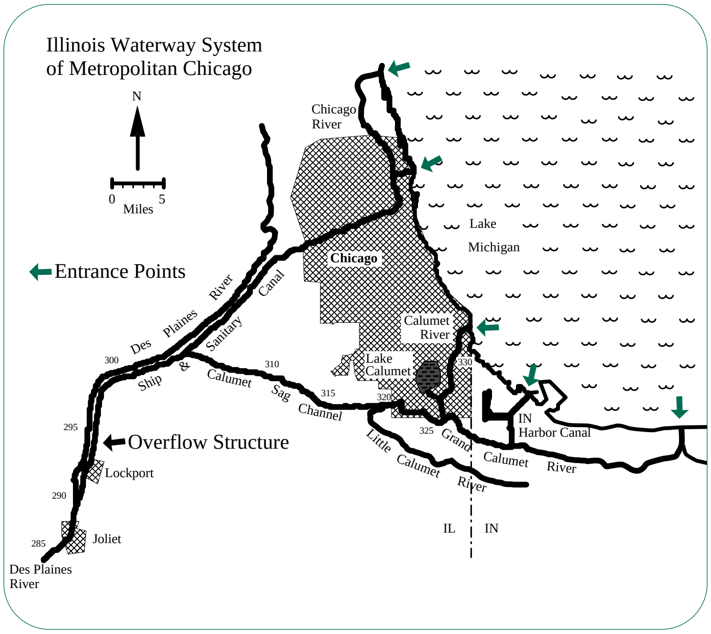
Controlling Round Gobies in the Illinois Waterway System

by Sandra M. Keppner and Edwin A. Theriot



Introduction

The Illinois Waterway System, consisting of human-made interconnecting channels and natural rivers, provides a direct link between the Great Lakes and the Mississippi River basins. The Chicago and Calumet rivers originally flowed into Lake Michigan, however the creation of channels reversed water flows (Changnon and Changnon 1996). Human engineering has created a link that did not exist before; water from Lake Michigan now flows through the Calumet Sag Channel and the Sanitary and Ship Canal to the Des Plaines River, the Illinois River, and finally to the Mississippi River. Although originally designed to advance the transfer of cargo and of people to the Mississippi River and to resolve sewage dilution and removal issues, this link provides a pathway for nonindigenous invasive aquatic species between the two basins. The zebra mussel *Dreissena polymorpha* is one of the more recent and highly publicized invasive species to have used this of dispersal pathway.

The round goby *Neogobius melanostomus*, a small soft-bodied fish first collected in North American waters in 1990 in the St. Clair River (Jude et al. 1992), is now poised within the Calumet Waterway System to advance into the Mississippi River basin via the Calumet Sag Channel and the Sanitary and Ship Canal. The round goby is a **benthic** species, identified by its fused pelvic fins, and noted for its aggressive feeding and defensive behaviors. It is believed to be capable of outcompeting native benthic species for both food and space, especially spawning habitat (Jude et al. 1995). Although capable of feeding on a variety of benthic species, round gobies possess **pharyngeal** teeth that allow for the consumption of mollusks (Ghedotti et al. 1995). Zebra mussels make up a significant portion of their diet in the Great Lakes, raising concerns about round gobies' potential to accumulate toxins and to transfer them to their predators.

In the fall of 1996, the US Fish and Wildlife Service conducted a survey in the Little Calumet River, the Calumet Sag Channel, the Sanitary and Ship Canal, and the Des Plaines River to assess the extent of round goby expansion in the Illinois Waterway System (see "Round Goby Roundup" in *ANS Digest*, Vol. 2, No. 1). A total of 61 round gobies were collected in the Little Calumet River at locations upstream of river mile 321.4, approximately 12 miles inland from Lake Michigan (see map) (Steingraeber et al. 1996). A second survey of the Illinois Waterway System was conducted in June 1997, and it confirmed the findings of the first survey (Pam Thiel pers. com.). Advancement to date has apparently remained relatively slow; the first round gobies were collected in the Calumet River in 1993. The current slow rate of expansion may provide managers with a brief window of opportunity to implement control strategies to prevent the further downstream spread of round gobies.

In a series of meetings beginning in November 1995, a committee of professional and nontechnical advisory members was formed. These meetings focused on identifying nonnegotiable constraints, obstacles which would have to be addressed in developing control alternatives, and acceptable technologies for nonindigenous species control. With the significant players, constraints, obstacles, and technologies identified, a subgroup of the committee was able to focus on which alternatives would be most effective on the round goby and most likely implemented in a short term.

In November 1996, the national Aquatic Nuisance Species Task Force charged the Fish and Wildlife Service and the Army Corps of Engineers to develop control recommendations to prevent the spread of round gobies into the Mississippi River basin through the Illinois Waterway System. Due to the urgency of the circumstances, a brief time-frame was assigned, so implementation could be initiated quickly. The development of a control strategy took advantage of previous discussions and decisions regarding the potential implementation of a dispersal barrier within the waterway system to prevent the exchange of all nonindigenous species between the Great Lakes and the Mississippi River basins.

The recommendations reflect the ideas and discussions of the participants in two meetings held in Chicago, IL, to further develop and refine ideas for potential round goby control alternatives,

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as well as the findings and conclusions of the meetings held in response to the ANS Task Force charge to recommend round goby control alternatives.

Findings and Conclusions of the Report

Constraints and Obstacles

Constraints and obstacles specific to designing control initiatives for the Illinois Waterway System were identified; constraints are defined as unacceptable effects, and obstacles are defined as undesirable effects that may be acceptable under certain conditions. Two constraints were identified; any control program can not cause significant delays in navigation and it can not adversely affect the volume of the Lake Michigan diversion. Several obstacles were identified:

◆ Variable water flow volume. Water flow velocity and volume vary by an order of magnitude, which must be considered if control alternatives include chemical applications.

◆ Degradation of water quality. Water quality within the system has improved significantly and continued improvement should not be hindered by round goby control efforts.

◆ Negative public perception. Successful implementation of a control program requires the support of the public, as well as of decision- or policy-makers. Negative local public perception arising from concerns over control methods may result in management decisions to stop control efforts.

◆ Recreational use. Any control program should not hinder the continued use and growth of a recreational resource.

Control Methods

To design effective control initiatives for a particular species, the biological, ecological, and life history features of the organism must be considered. Discussions referenced European information, current North American studies and findings, as well as further research needs on the round gobies that may affect successful implementation of control alternatives. Developing control initiatives requires an examination of all potential control methods and their effectiveness, cost, and regulatory restrictions.

Control methods are generally divided into three groups; physical, chemical, and biological. Seventeen alternatives were studied; alternatives viewed as short-term methods that could be implemented quickly.

◆ Physical Controls. Seven alternatives were studied: acoustical; active capture through trawling; bubble curtains; electrical fields; habitat alteration; light; and thermal treatments. Electrical fields were identified as the most likely to be effective.

◆ Chemical Controls. Eight alternatives were studied: ammonia; antimycin (fish toxicant); chlorine; dissolved oxygen depletion; nitrogen stripping; ozone; rotenone (fish toxicant); and TFM (fish toxicant). Three, antimycin, chlorine, and rotenone, were identified as the most likely to be effective.

◆ Biological Control. Two alternatives were considered, predation and genetic alteration, but neither would likely be effective or feasible for short-term use.

The control alternatives identified as most likely to be effective were ranked according to effectiveness, cost, and regulatory restrictions. An electrical barrier and the use of the chemical fish toxicant, rotenone, were ranked the highest. Using both of these approaches in an integrated program may provide a mechanism to prevent the spread of round gobies into downstream areas of the Illinois Waterway System.

Recommended Control Strategy

Electrical Barrier

Following the confirmation of the extent of round goby distribution within the waterway, two or more electrical barriers should be located downstream of the farthest extent of the goby's range. Barriers would stretch across the entire width of the channel (bank to bank), extending up from the channel bottom approximately one meter. The first barrier would serve to hinder movement of gobies downstream; the second adds a level of insurance if gobies move beyond the first barrier. The two barriers and the area between them (at least 0.4 km (0.25 mile) in length to allow for trawl sampling), will be referred to as the "barrier zone."

While the location of the barrier zone has not yet been determined, important features of the site have been identified.

◆ Site ownership by a federal, state, or local agency would facilitate access.

◆ Smooth or sheer walls in a narrow portion of the channel would provide ideal conditions to prevent gobies from using rocky areas to escape the electrical field.

◆ To avoid interference with navigation, fleeting areas—where barges remain for longer periods of time—should be avoided.

◆ To minimize the potential for damage to the barrier, the shipping industry may be requested to limit the passing of ships through the barrier zone to one ship at a time. Establishing this "one lane only" or "no passing zone" should minimize the risk of barges rubbing against the walls of the channel.

◆ Current channel depth soundings and information on changing water levels should be obtained prior to selecting the location, because water depths may change substantially due to the movement of water by barge traffic, drawdowns, and natural events.

Several locations were identified as potential barrier sites if surveys and channel characteristics were appropriate. If a single barrier zone is to be constructed, the likelihood of round goby expansion into the Illinois Waterway System through other

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entrance points would require the site to be below the confluence of the Calumet Sag Channel and the Chicago Sanitary and Ship Canal (see map). This would help prevent the spread of round gobies into the Des Plaines River, regardless of their entrance or access point into the waterway. Channel walls in this area are perpendicular limestone, the channel is relatively narrow, and the bottom is flat. The construction of more than one barrier zone would otherwise be required to prevent the spread of round gobies within the Calumet Sag Channel and the Sanitary and Ship Canal due to the likelihood that round gobies will enter the system from any one of the five entrance points (see map).

Chemical (Rotenone) Application

If round gobies are detected beyond the first barrier, a chemical application within the barrier zone is recommended to eliminate round gobies at the periphery of their range. Chemicals are not recommended for regular or initial use due to current public perceptions, permit requirements, and effects on non-target organisms.

A secondary use of chemical control recommended to reduce populations on the periphery of their known range, upstream of the barrier zone. This would serve to slow the spread of gobies to the barrier zone.

Education/Outreach Program

Implementation of an aggressive education/outreach program focusing on all potential water users, including federal, state, and local government entities, as well as other potentially affected public and private organizations, is highly recommended. Public awareness and support is critical for effective implementation of this type of program. In many cases of nonindigenous species introductions and range expansions, the public is the first to report new sitings. Through increased awareness, the public may contribute significantly to monitoring efforts and provide the needed support to decision- and policy-makers. Resource managers should be aware of both the potential spread and proposed activities to control that spread, so that information reaching the public is accurate and consistent.

Evaluation

Establishing criteria for program success and a method to evaluate success are essential to any control strategy. To determine the effectiveness of the barrier system and to assess effects on nontarget species, multi-agency, cooperative surveillance and monitoring programs are suggested.

Three evaluation programs are recommended within the Illinois Waterway System. First, to evaluate the effectiveness of the electrical barrier, monitoring is recommended to detect the movement of round gobies into or near the barrier zone. This is a priority because management decisions regarding the continued operation of the barrier as well as the use of similar barriers in other locations will depend on the relative success of this control strategy.

Second, surveillance programs should be conducted in areas likely to be invaded by round gobies. Detection of the movement of round gobies into the Waterway System from any of the other entrance points from Lake Michigan (see map) will be especially important if multiple barriers zones are planned. If possible, installation of multiple barrier zones should not wait until round gobies are detected within the system. However, priorities may be assigned based on range expansions. If a single barrier is installed in a location to prevent expansion from all entrance points, the advance of round gobies toward the barrier zone should be monitored.

Finally, an analysis of the effects associated with implementation of control initiatives is recommended. Analyses should assess the effects of implementing control on nontarget species at all **trophic** levels of the aquatic community. The barrier zone should be specifically monitored, as well as areas immediately upstream and downstream of the barriers.

The window of opportunity available for successful implementation of the round goby dispersal barrier program is likely short. Continuing the refinement and planning of implementation should be dependent on further spread of round gobies. If round gobies become established below the Sanitary and Ship Canal overflow structure at river mile 293.2 (connecting the Sanitary and Ship Canal and the Des Plaines River just above their confluence, see map) this control initiative should be re-evaluated or discontinued.

Current Status

A report including the control recommendation was presented to the ANS Task Force on April 14, 1997. Although well received, several questions and issues were raised at the meeting and Task Force members were asked to submit comments within two weeks and the technical group was asked to revise the report to address those concerns. After an instructive tour of the Chicago River and Chicago Sanitary and Ship Canal on June 18, 1997, the Task Force accepted the revised report at its meeting in Rosemont, IL. The Task Force then agreed to undertake a series of actions aimed at implementing the recommendations of the report. To obtain a copy of the complete report, contact Bob Peoples, Executive Secretary of the ANS Task Force, at (703) 358-2025, or email: robert_peoples@mail.fws.gov.

Sandra M. Keppner is with the US Fish and Wildlife Service Lower Great Lakes Office in Amherst, NY; Edwin A. Theriot PhD is with the US Army Corps of Engineers Waterways Experiment Station in Vicksburg, MS.

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The Western Regional Panel: A Coordinated Response to Nuisance Aquatic Exotics in Western North America

by Linda Drees

The Nonindigenous Aquatic Nuisance Prevention and Contral Act of l990 (16 USC 4701-4741) was reauthorized and amended by the National Invasive Species Act in l996 with broad bipartisan support. The reauthorization process has been instrumental in raising public and private sector awareness of the damage that aquatic nuisance species (ANS) cause to the natural and human-made environment. Zebra mussels are probably the most well known ANS, due to their well-publicized spread through the Great Lakes and Mississippi River basins. Zebra mussels and other ANS now pose a threat to the western United States. Recognizing the need for an organized response to this threat to Western water resources, the Act was amended to call for the formation of a Western Regional Panel (the Panel).

Section 1203 of the Act states that the Panel is to be composed of Western-region representatives from federal, state, and local agencies, and from private environmental and commercial interests. The Act charges the Panel with several tasks:

- identify priorities for the Western region with respect to ANS;
- make recommendations to the national ANS Task Force regarding an education, monitoring (including inspection), prevention, and control program to prevent the spread of the zebra mussel west of the l00th Meridian pursuant to section 1202(l) of the Act;
- coordinate, where possible, other ANS program activities in the Western region that are not conducted pursuant to the Act;
- develop an emergency response strategy for federal, state, and local entities for stemming new invasions of ANS in the region;
- provide advice to public and private individuals and entities concerning methods of preventing and controlling ANS infestations; and
- submit an annual report to the national ANS Task Force describing activities within the Western region related to ANS prevention, research, and control.

At its November l996 meeting, the national ANS Task Force requested that the Western Zebra Mussel Task Force work with the San Francisco Estuary Project, the Prince William Sound Regional Citizens Advisory Council, and the Washington and British Columbia Exotic Species Work Group to develop a proposed membership list, including marine and freshwater interests, for the Panel. Representatives from these groups formed the Panel Work Group and drafted a proposed membership list.

The Panel Work Group presented its proposal at the April l4th meeting of the ANS Task Force Meeting in Silver Springs, Maryland. This proposal described the Panel as being composed of 47 members representing state, federal, tribal, academic, industry, conservation organizations, and freshwater and marine interests. The geographic range of the Panel is very diverse, reaching from Kansas to Hawaii, and from Alaska and to Texas. Prevention and control of ANS by providing a coordinated information network of will be a focus of the Panel. Because ANS introduction pathways respect few boundaries and are relatively easy to identify, the inclusion of freshwater and marine representatives on the Panel will ensure that issues such as introduction and control are dealt with in a comprehensive and coordinated fashion from coastal to interior waters. As needed, work groups may be formed to focus on specific areas, such as coastal issues.

The first forum and organizational meeting of the Panel was held in Portland, Oregon, on July 8th and 9th, l997, at Portland State University. The one day forum provided Panel members with current information on freshwater and marine invasive species issues. The forum was followed by a one day meeting of the Panel to develop a Western Exotic Prevention and Control Work Plan. For more information about the Western Regional Panel or the Western Exotic Prevention and Control Work Plan, contact Linda Drees (913) 539-3474 x20 or email: Linda_Drees@fws.gov

Linda Drees is Nonindigenous Species Coordinator of the Mountain-Prairie Region of the US Fish and Wildlife Service in Denver, CO, and Executive Director of the newly formed. Western Region Panel.

Glossary

Benthic

Organisms that live on or near the bottom of a lake, river, or other body of water.

Biogeography

The geographical distribution of an organism, the habitats in which it occurs, and the ecological relationships involved.

Carapace

The shell covering the back of an animal.

Genera/Genus

In the classification of living organisms, genus is the subdivision of a family (genera is plural).

Pharyngeal

Located near the pharynx,which connects the mouth to the esophagus; that is, the back of the throat.

Phyla/Phylum

In the classification of living organisms, phylum is the subdivision of kingdoms (phyla is plural).

Polyvectic

Having many vectors or means of being transported.

Trophic

Levels in a food chain; for example, an eagle that feeds on a trout is at a higher trophic level than the mayflies eaten by the trout.

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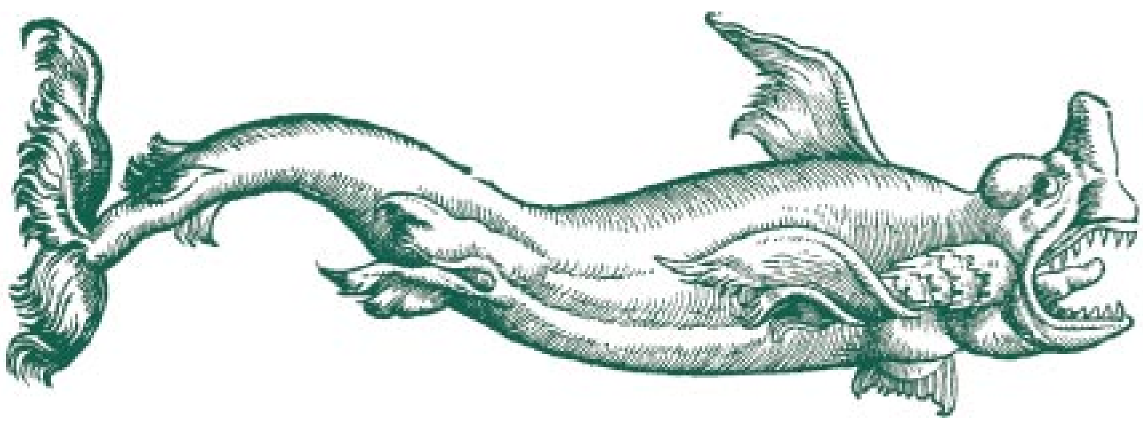

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