

## Chapter 3

# Toward Biological Integrity: The Challenge of Alien Invasive Species

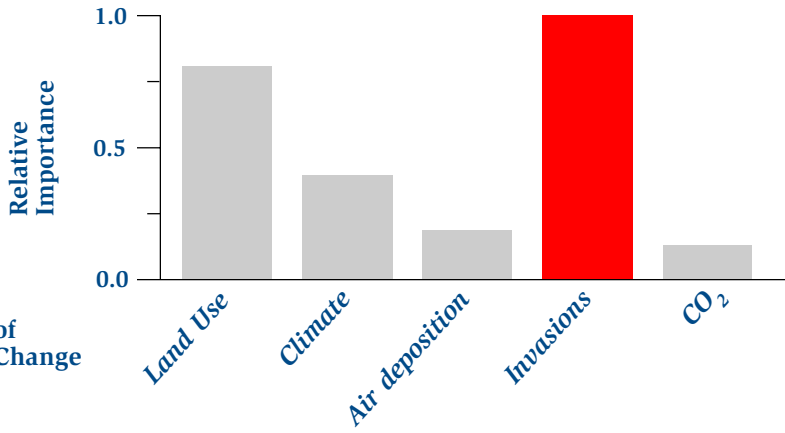
*Despite more than a decade of national attention and regional action, the introduction and spread of aquatic alien invasive species continue to impair the biological integrity of the Great Lakes-St. Lawrence River basin ecosystem.*

*Immediate federal action to mandate improved ballast water management procedures can reduce but not eliminate the biological and economic threat to the Great Lakes-St. Lawrence River basin ecosystem from the further introduction and spread of alien invasive species.*

### Introduction: An Ecologically Damaging and Economically Costly Problem

Since the 1980s, the International Joint Commission has issued alerts about the threat of aquatic alien invasive species to the Great Lakes-St. Lawrence River basin ecosystem and economy.<sup>1</sup> Yet despite more than a decade of international attention and regional action, this “biological pollution” continues at both great ecological and economic cost.

Most citizens of Canada and the United States are probably familiar with the havoc some alien invasive species have wreaked. The chestnut blight and Dutch Elm disease, gypsy moths, Norway rats and kudzu, and, in the Great Lakes basin, purple loosestrife, sea lampreys and zebra mussels are well known examples of ecologically and economically harmful species



**Drivers of Species Change in Lakes**

**Causes of Biodiversity Change in the Great Lakes during the 21st Century**

*The introduction and spread of aquatic invasive species is expected to be one of the leading causes of biotic change in lake ecosystems during the 21st century. All of the Great Lakes are experiencing such impacts from zebra mussels, sea lamprey, round goby, and the spiny waterflea. Sala et al., 2000.*

imported either accidentally or purposely from other continents to North America. In each of these cases, damage occurred because native species and ecosystems were not capable of resisting infection, infestation, predation or competition from the alien species. In some cases, damage has been extraordinarily severe. The chestnut blight, for instance, eventually wiped out virtually all American chestnut trees across nine million acres; sea lampreys devastated populations of lake trout and other fish species in the Great Lakes.<sup>2</sup>



**Invasive Species**

*Examples of invasive species: sea lamprey, asian carp, zebra mussel, purple loosestrife.*

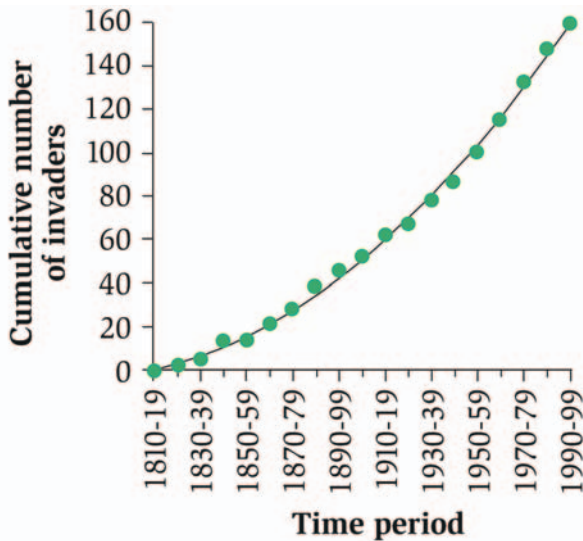
Researchers widely believe that the costs of biological pollution from alien invasive species are both massive and rising, with costs to native ecosystems, natural resources, fisheries and agriculture estimated in one study to reach \$137 billion per year in the United States alone, including but not restricted to aquatic species.<sup>3</sup> In contrast, 1992's Hurricane Andrew, the single most expensive natural disaster in United States history, cost insurers only a small fraction of that amount, about \$16 billion (or \$20 billion in 2002 dollars).<sup>4</sup> This suggests the true costs of biological pollution in the U.S. alone equal multiple Hurricane Andrews every year.

In the Great Lakes, costs for treatment and control of zebra mussels alone reach several billion dollars annually.<sup>5</sup> The Great Lakes Fishery Commission reports that sea lamprey control, assessment and research cost \$13.5 million in 2001.

The damage is at least as much environmental as economic. Since biological pollution's effects are often irreversible, any future introductions of alien invasive species could permanently harm the biological and ecological diversity of the Great Lakes, the world's largest surface freshwater ecosystem. Yet, despite some efforts to reduce the potential for future introductions of harmful alien species, the threat remains. This serious problem continues at least in part because individuals or businesses responsible for introducing alien invasive species have never borne any significant part of the often extremely high costs. The high costs instead have been transferred to government resource agencies and the taxpayers who support them, to private and public utilities, and to industrial and private users of natural resources.

### **Current rules and practices are not solving the problem**

Today, the Great Lakes - St. Lawrence River basin ecosystem is home to more than 160 non-indigenous fish, invertebrates, plants, parasites, algae and pathogens.<sup>6</sup> Additionally, many introduced species have likely gone unnoticed.<sup>7</sup> The number of recorded introductions of alien invasive species increased throughout the 20<sup>th</sup> century, from 40 in the first half to 76 during the latter half. And despite increasing awareness of the risks, the 1990s saw no discernable improvement. In the 1990s, 15 alien species found their way into the ecosystem, a number of introductions essentially unchanged from the 1980s (15), the 1970s (17), and the 1960s (15).<sup>8</sup>



## Great Lakes Invasions

The number of recorded introductions of alien invasive species from all sources continued to increase through the 20th century. Riccardi 2001.

## Nonindigenous Animals Established in the Great Lakes Drainage Basin Since the mid-1980s

Common Name	Year of Discovery	Endemic Region	Mode of Transfer	Probable Donor Region
Ruffe	1986	Ponto-Caspian	Ballast water	Danube River
Zebra mussel	1988	Ponto-Caspian	Ballast water	Baltic Sea
Quagga mussel	1989	Ponto-Caspian	Ballast water	Black Sea
Rudd	1989	Eurasia	Bait release	---
Round goby	1990	Ponto-Caspian	Ballast water	Black Sea
Tubenose goby	1990	Ponto-Caspian	Ballast water	Black Sea
New Zealand mudsnail	1991	New Zealand	Ballast water	Baltic Sea
Blueback herring	1995	Atlantic N.A.	Canal	Atlantic N.A.
Echinogammarus (amphipod)	1994	Ponto-Caspian	Ballast water	Baltic Sea
Acineta noticae (ciliate)	1997	Eurasia	Ballast water	Black Sea
Cercopagis (waterflea)	1998	Ponto-Caspian	Ballast water	Baltic Sea
Daphnia lumholtzi	1999	Africa, Asia, Aust	Boat?	Ohio Reservoirs
Schizopera borutzkyi	1999	Ponto-Caspian	Ballast water	Danube River
Heterosyllus nr. nunni	1999	Atlantic N.A.	?	Atlantic N.A.

Riccardi and MacIsaac 2000.

A number of sources, or vectors, can transmit alien invasive species into the ecosystem including aquaculture, canals and diversions, baitfish disposal, intentional introductions, recreational boating, and ship fouling.<sup>9</sup> The most significant vector is ballast water – the water, entrained solids and sediment and, all too often, living species, taken in and discharged by ocean-going ships.<sup>10</sup> Some regulations and guidelines are now in place to attempt to control alien species introduction from ballast water exchange from ships moving into the Great Lakes through the St. Lawrence. Yet, as we achieve better control of ballast water, other vectors must be seriously addressed to stop the invasion of species such as the Asian carp.

*Both the Canadian Auditor General's Office and the U.S. General Accounting Office will be releasing in the fall of 2002 their analysis of the governments' action to address the ongoing and destructive invasions of aliens species. In developing its findings, the Commission has worked closely with the two organizations.*

### **Discharge of Ship Ballast Water**

*Ballast water is used to stabilize ships and maintain trim. Some transoceanic ships may carry up to 150 million liters of ballast water. Biota can be loaded with ballast water and discharged during routine ballast operations.*

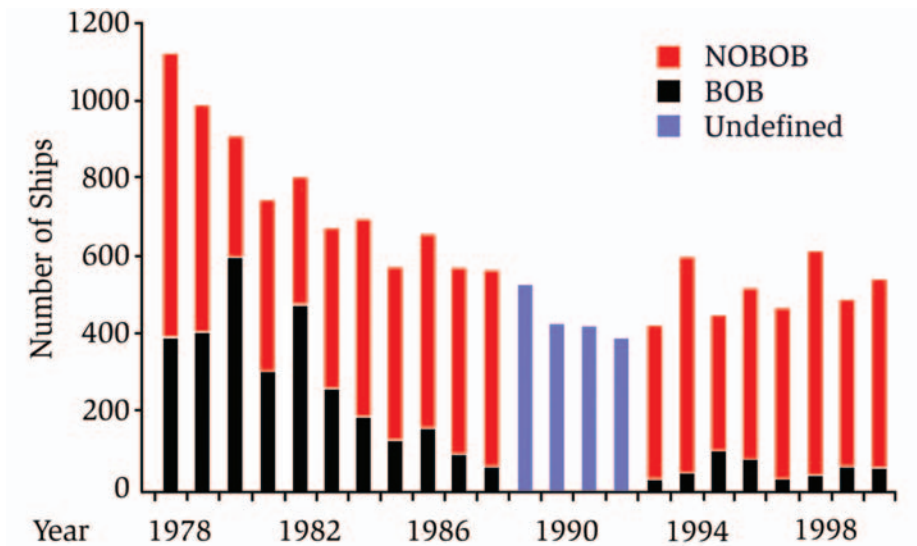
In 1993 the U.S. Coast Guard issued regulations requiring ships bound for the Great Lakes from beyond 200 miles off the U.S. coast to take steps to reduce risks from alien invasive species in ballast water. Ships now are required to exchange ballast water on the high seas, retain the water on board, discharge to an



approved reception facility, use an environmentally sound alternative (which could include such steps as treating the water), or under extraordinary conditions, exchange ballast water within an alternate area. Canada is currently drafting regulations.

Compliance with these regulations and guidelines has been nearly 100 percent.<sup>11</sup> Yet this high level of compliance alone is far from 100 percent effective. Research published in 1999 showed that a population of at least one alien invasive species, *Ceropagis pengoi* (a waterflea), found its way into Lake Ontario, apparently transferred by ballast water, even after the ballast water exchange regulations were put in place.

One major flaw in the process appears to be that ships declaring “no ballast on board” (NOBOBs) are exempt from the regulations, even though these ships can harbor alien invasive species in residues of previously discharged ballast water and therefore represent a serious, continuing biological pollution risk to the ecosystem.



### Great Lakes Inbound Ships

*NOBOB ships, currently exempt from regulations requiring ballast water exchange at sea, make up about 70 percent of the ships entering the Great Lakes system.*

*Colautti et al 2002.*

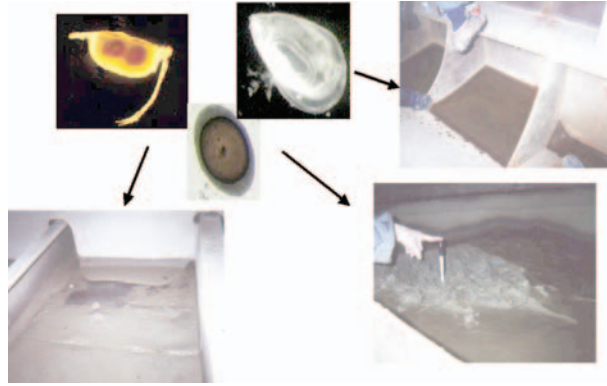
## ***Ballast Water Exchange: A Complex Problem***

*Ballast water exchange may appear to be a simple matter of filling and emptying a tank, but it is much more complicated and can pose safety and structural risks for the ship and further risks to the crew. The volume of some large ballast tanks could fill a typical high school gymnasium, and the structural loads and effects of ballast water on the operation of a ship are by no means trivial. The weight of huge volumes of cargo, fuel and ballast water, in many different loading conditions must be considered when conducting ballast water exchange. The ship's structural integrity can be damaged if these weights are not properly balanced. Other safety concerns associated with ballasting include ship stability, maneuverability, forward visibility and potential hazards to the crew. In addition, the amount of time necessary to complete a ballast water exchange may be considerable for ocean-going ships – from 15 to 41 hours. Currently, two methods of exchange are recognized, a sequential method of filling and emptying tanks and a flow-through method. However, because the size and structure of ships vary widely, there is no universally acceptable solution. Class Societies, such as Lloyd's Register, Det Norske Veritas and the American Bureau of Shipping, have examined the effects of ballast water exchange on ship structures and maneuverability. These examinations clearly highlight the importance of a ship-specific analysis of structure and operating conditions to ensure that all risks are accounted for in a ballast management plan.*

*Prompted by International Maritime Organization (IMO) actions in 1997 to publish guidelines for ballast water management, Lloyd's Register commenced a two-part study to investigate the effects of ballast water exchange on ship structure and operations and to develop safe approaches for ballast water exchange.<sup>12</sup> This study, carried out by naval architects under the direction of their principal surveyor, used 26 ships of various types, configurations and sizes. The study serves as an important reference or guide for IMO Administrations [the 162 member states of the IMO] who intend to develop ballast water management policies. Regarding the seriousness of the ballast water management issue, they concluded:*

*“The [IMO] Administrations’ inability to multilaterally agree and define clearly the acceptable methods, procedures, and criteria for ballast water management indicates that the problem is not an easy one to solve. However, lack of decision making in the short-term could have long-term consequences for all parties concerned.”*

According to U.S. Coast Guard data, NOBOBs represent over 70 percent (74 percent in 1999, 72.1 percent in 2000 and 68.5 percent in 2001) of incoming ships to the Great Lakes - St. Lawrence River system. These

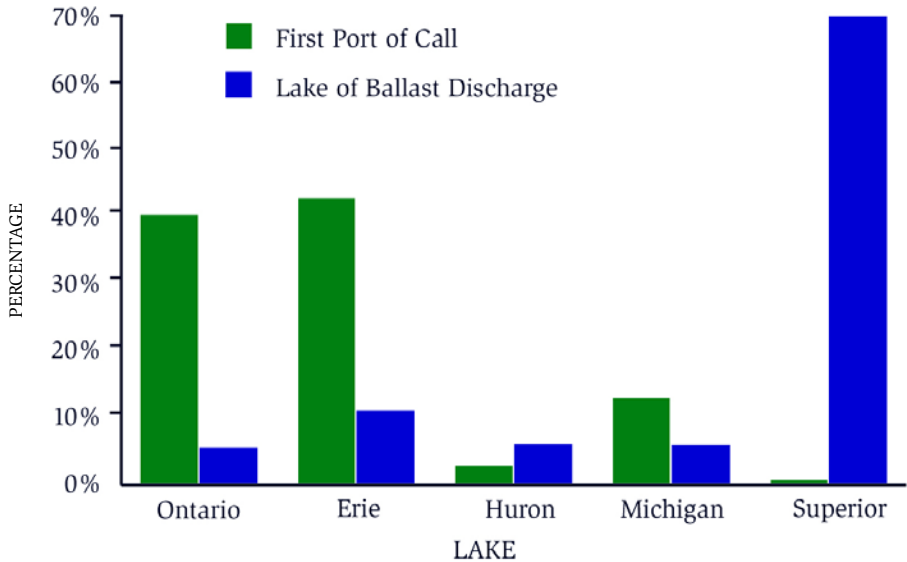


*Invasions via NOBOB Shipping*

NOBOB ships are fully loaded with cargo and as a result their ballast tanks contain minimal (generally less than 3 percent) residual untreated ballast water and sediment. Yet even these small residues can be contaminated with alien invasive species. Both a Transport Canada study and a more recent study presented at the 11<sup>th</sup> International Conference on Aquatic Invasive Species in 2002 reported finding live organisms in virtually all ships that reported as NOBOB.<sup>13</sup> Clearly, current ballast water regulations are not sufficient to eliminate the risk these vessels pose.



**Transit of a NOBOB Steel Carrier** *The yellow arrows indicate the path of a NOBOB ship on an inbound trip, showing points where the ship unloads steel and takes on Great Lakes water as ballast (stability). The blue arrow indicates the final inbound leg of the trip on the Great Lakes. The ship is now empty of cargo and fully loaded with Great Lakes ballast water. Taking on ballast water on the lower lakes provides an environment for cysts or eggs of invasive species remaining in residual ballast water and sediment to hatch.*



### **NOBOB Ships on the Great Lakes**

*The Great Lakes receive ballast water discharged from ships transiting the system. Fully loaded ships carrying only residual ballast water (NOBOBs) unload cargo and take on ballast water for stability and trim. When these ships take on new cargo, they discharge ballast water to attain stability. Lake Superior has increasingly become more important as the initial site of ballast water discharged to the lakes from ships transiting the system.*

In addition to the U.S. regulations requiring ships bound for the Great Lakes to exchange ballast water in the open ocean, Canada and the U.S. also have voluntary guidelines designed to minimize the uptake and release of harmful aquatic organisms, pathogens, and sediment in ballast water.<sup>14</sup> The guidelines suggest precautionary practices to avoid the uptake of ballast water in areas near sewage outfalls, in areas with known outbreaks or infestations, near dredging operations and where tidal flushing is poor, and suggest avoiding shallow water, turbid water, and darkness, when benthic (bottom-dwelling) organisms may be up in the water column. The guidelines provide advice on the timely and routine cleaning of sediment from ballast tanks and include recommendations to avoid unnecessary discharge of ballast water, to retain or minimize release of improperly exchanged ballast and, where applicable, to discharge to appropriate reception facilities. Some guidelines also address anchor-chain washing and removal of hull fouling. The guidelines also recommend maintaining ship ballast water

management records and plans and providing training in ballast water and sediment management for ships' personnel.

Making such ballast water management practices mandatory for all ships capable of carrying ballast water, including NOBOBs, into the Great Lakes - St. Lawrence River basin could greatly reduce, though not eliminate, the threat of introduction of alien invasive species in the Great Lakes. Along these lines, agencies have made some progress. For example, the St. Lawrence Seaway Development Corporation (SLSDC) in the U.S. and the St. Lawrence Seaway Management Corporation (SLSMC) of Canada jointly administer the Seaway Regulations and Rules. The SLSDC, in agreement with the SLSMC, has amended its regulations to require compliance with Great Lakes shipping industry codes for ballast water management practices for a ship to gain permission to transit the seaway.<sup>15</sup> While this step is encouraging, the amendments appear to lack sufficient means to measure compliance and support enforcement. The SLSDC and SLSMC have indicated they will assess the effectiveness of this action after the 2002 seaway navigation season.

Improved mandatory ballast water management practices could use procedures approved by the Coast Guard, or a classification society authorized to act on its behalf, to ensure that the best practices are incorporated for each vessel's particular operational constraints. Owners and operators of ships could also be required to address other possible pathways for unintentional transfer of alien invasive species not connected to ballast systems, such as hull fouling, biofilms and anchor chains. And customers for shipping could be encouraged to contract with owners and operators of shipping lines that apply best management practices.

### **Substantial Gaps in Knowledge Remain**

While the salinity of the ballast water is used to determine if it has been exchanged, there is no accepted standard to evaluate how effective current ballast water exchange operations actually are at reducing entrained or accumulated sediment, and its associated organisms. Because ballast tanks containing residual water and sediment have been found to harbor viable organisms,<sup>16</sup> a protocol (a wash out dye study) for testing the effectiveness of ballast water exchange would help ensure that alien

invasive species are not released when a ship mixes ballast water with local water and discharges it during routine operations. Also lacking are agreed-upon discharge standards for ballast water treatment, describing numerical targets for the percent of viable organisms removed, including an acceptable number, type or stage of development for a wide range of organisms. Such standards are necessary to assess the effectiveness of alternative treatment technologies (including biocides) or the effectiveness of any technical modifications for improved ballast water exchange (the installation of ejectors). These protocols and standards would lay the basic foundation for an effective ballast water management program. In support of developing these needed protocols and standards, the U.S. Aquatic Nuisance Species Task Force has recently approved research priorities recommended by its Ballast Water and Shipping Committee. Among its top priorities, the committee pointed to the need for public funding for research to develop methods to measure effectiveness of ballast water exchange procedures and to develop alternative technologies.

Research on developing and testing alternative technologies that could remove or kill alien invasive species, such as filtration, UV radiation, ozonation, biocides, heat and deoxygenation is lagging in the absence of standards and regulations.<sup>17</sup> Paradoxically, the new mandatory ballast exchange requirements in the United States may also be delaying important research into new technologies. To test these new technologies, mandatory ballast water exchange requirements sometimes must be waived, but the current review process for such requests tends to take a long time.

In addition, the lack of assurances that investments to develop, test and implement new technologies will be protected from future rule changes contributes to delays in innovation. Inadequate funding to meet critical research and development needs, identified by numerous national and regional level panels, agencies, task forces and commissions, has delayed progress. Finally, the long-term and slow-moving nature of federal legislation and rulemaking, combined with the need for binational and international harmonization, has further delayed progress in developing and implementing new technologies to prevent immediately the introduction and spread of alien invasive species.

## **Economic Incentives Could Help**

The conspicuous lack of government incentives contributes to the problem. The European port management community has pointed the way toward innovative incentives with its “green ship” awards. These awards offer reduced port fees for ships exceeding established management practices for all ship wastes, emissions, and discharges, including ballast water. Requiring mandatory compliance with existing voluntary guidelines would establish a minimum acceptable level of performance, but a system of awards and economic incentives could encourage shippers to exceed the minimum levels of performance by continuously improving ballast management practices using innovative approaches. (Economic incentives also have been called for by other Great Lakes - St. Lawrence River organizations, such as the binational Great Lakes Panel on Aquatic Nuisance Species in its March 2001 policy statement on ballast water management.)

The future threat of liability for the damages from biological pollution may be a powerful economic incentive. Insurance companies have been slow to recognize that their exposure could be substantial. Because there are a limited number of carriers, customers, and ports of origin and destination, and because such biological analytic techniques such as DNA analysis are advancing rapidly, the prospect of assigning liabilities for damages is increasing. Marine insurers would be wise to consider incorporating the risk of entry of alien invasive species into their insurance policies and premiums.

For governments and regulatory agencies, economic incentives warrant further investigation as to feasibility and enforcement.

## **Progress from Governments**

Governments are making some progress toward addressing the threat of alien invasive species with incremental advances in legislation, rulemaking and international agreements, such as those proposed for the year 2003 by the International Maritime Organization.<sup>18</sup> Recently, the U.S. Coast Guard published an advance notice of proposed rulemaking and a request for comment on the development of a ballast water treatment goal and interim

ballast water treatment standard.<sup>19</sup> Both of these actions are essential to determine whether alternative ballast water management methods are environmentally sound and at least as effective as ballast water exchange. However, such measures are focused on long-term actions and solutions and are developing at a frustratingly slow pace, despite repeated calls for immediate, urgent action from the Great Lakes community.<sup>20</sup>



### **Our Future Hangs in the Ballast**

*Photo of highway billboard developed by citizen group, Protect the Great Lakes, communicates its concerns about aquatic invasive species.*

Reflecting the need to act now, some U.S. states have attempted to pass legislation concerning alien invasive species in the Great Lakes. Only the state of Michigan has successfully enacted such legislation. A private member's bill in Ontario was not passed. These local initiatives, including the recent action by the St. Lawrence Seaway Management and Development Corporations noted previously, illustrate the need for greater federal leadership, particularly between the U.S. and Canada, who control the entrance to the freshwater ecosystem of the Great Lakes.

*Even though the state and provincial jurisdictions are taking or attempting to take unilateral action, the two nations need to take action because this is a matter of inter-state and international commerce and environmental quality.*

Historically, Great Lakes - St. Lawrence River regional concerns have driven the creation of laws and programs to prevent the introduction and spread of biological pollution, including, in the U.S., the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, and the National Invasive Species Act (NISA) of 1996.<sup>21</sup>

The pending re-authorization of NISA is an opportunity to bolster action, strengthen research and improve binational harmonization. Therefore, it is not surprising that the region's sense of the biological and economic urgency of this problem should **again** drive the call for federal action to implement immediate steps to address the continuing threat of alien invasive species in the basin.

The *Tenth Biennial Report* recommended that a reference be given to the Commission to develop binational standards and the most appropriate methods for implementing those standards. Our reasons for requesting that reference persist. Both the Canadian and United States governments responded that progress was being made and that the technical aspects of the issue were best left to existing bodies such as the Ballast Water and Shipping Committee of the Aquatic Nuisance Species Task Force.

The Commission notes the position of the Parties but remains concerned that the pace of progress is much too slow while the risks to the lakes remain high. In recognition that the gateway to the freshwater ecosystem of the Great Lakes is a binational waterway, the coordinating and harmonizing role of the International Joint Commission is particularly relevant. The Commission stands willing to assist the Parties, pursuant to their request. Action must be taken quickly to stop this ongoing threat to the economy and the biological integrity of the Great Lakes.

## Conclusion

The introduction and spread of alien invasive species are continuing to impair the biological integrity and threaten the many water-dependent economic sectors of the Great Lakes basin. The costs for treatment and control are massive, rising, and largely borne by local communities, utilities and industry rather than those who create the problem.

Current regulations, guidelines, and practices in place are not sufficient to prevent further alien invasive species introduction and spread. Specifically, current regulations exempting ships declaring no ballast on board (NOBOB) do nothing to minimize the threat they pose. The Great Lake region's sense of the biological and economic urgency of the problem drives the call for more federal leadership and immediate steps to prevent further introduction and spread of alien invasive species.

Immediate federal action to make mandatory ballast water management practices, including the requirement for NOBOB participation in the program, can reduce the biologic and economic threat from the introduction and spread of alien invasive species. The time to act is *now*.

## Recommendations

**The Governments need to take more aggressive steps to end the invasion of alien species and we urge the following:**

- 1. Immediately make existing voluntary guidelines for ballast water management practices mandatory and provide for measures of enforcement and compliance for all ships capable of carrying ballast water, including those currently not carrying ballast water.**
- 2. Develop uniform protocols for performance testing of ballast water:**
  - develop best practices and any improvements for ballast management operations**
  - establish by the end of 2003 enforceable interim biological standards**

- concurrently, establish biological standards for ballast water discharges from all ships and for new technologies for ballast water treatment.
3. Ensure all ships built after a certain date have a treatment technology incorporated in their construction as a condition for entry into the Great Lakes.
  4. Design and implement economic incentives to encourage shippers to continuously improve (ISO 14000) Ballast Management Practices.
  5. Fund research recommended by expert regional, national and binational panels, task forces and committees, especially focused on:
    - research (including research for biological standards, criteria and indicators) for ballast water treatment necessary to drive technology, product development, and ship design
    - research to develop alternative technologies including biocides to achieve new standards and criteria for the elimination of Alien Invasive Species in ballast water
    - research and technology development to reduce entrained and accumulated sediment in ship ballast water and tanks, and
    - research to develop analytical tools and procedures to permit the identification of new invasive species and to link these species to their possible points of origin and vessels of introduction.
  6. Issue the Commission a reference to coordinate and harmonize binational efforts for action to stop this ongoing threat to the economy and the biological integrity of the Great Lakes.