Exotic Species and the Shipping Industry:

The Great Lakes-St. Lawrence Ecosystem at Risk

A Special Report to the Governments of the United States and Canada

International Joint Commission
and the Great Lakes Fishery Commission

September 1990

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Exotic species are organisms that are not native to a particular region Or ecosystem. For example, the zebra mussel is an exotic species in North America; in the Caspian Sea, it is a native species. While the term exotic species includes terrestrial and aquatic organisms, this special report focuses on the latter, particularly those species that are shipborne.

Exotic Species and the Shipping Industry:
The Great Lakes-St Lawrence Ecosystem at Risk
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Photo and Illustration Credits: Outside Front Cover, detail of drawing of zebra mussels by Margaret Var *photos page* 2 from U.S. Fish and Wildlife Service; *page 4 zebra mussel illustration* by Margaret Var by Dennis M. Pratt; *illustration page* 5 from Lloyd's Register of Shipping; *photo page 7 (left)* by Bill K *(right)* by Don Schloesser; *inside Back Coverphoto* by Bill Kovalak.

Purpose

The health and integrity of the Great Lakes Basin Ecosystem, including the 40 million humans who live in the basin, are jeopardized by an immediate and growing problem: the rampant colonization by shipborne exotic organisms. It is a problem that can and must be curtailed.

This special report, entitled Exotic Species' and the Shipping Industry: The Great Lakes-St. Lawrence *Ecosystem* at Risk. is a unique endeavor by the International Joint Commission and the Great Lakes Fishery Commission. It reflects our mutual concerns and conveys our joint recommendations for short-term and long-term actions - actions we believe would significantly reduce the immediate and continuing risks to the health and integrity of the Great Lakes Basin Ecosystem and its connected waters.

Context and Background

The international Joint Commission and the Great Lakes Fishery Commission both have substantial interest in the exotic species issue. The invasion of the exotic sea lamprey precipitated the establishment of the Great Lakes Fishery Commission in 1955. In 1977, the dangers of interbasin transfer of aquatic organisms were highlighted in the International Joint Commission's report on the Garrison Diversion Unit.

In separate letters to Governments in 1988, both Commissions outlined their respective concerns regarding shipborne introductions of exotic species (Attachment 1). The International Joint Commission also highlighted the issue in its recent Fifth Biennial Report on *Great lakes* Water Qualify, in which it signalled its intentions to provide additional advice on the matter.

Non-native organisms have already severely disrupted the Great Lakes Basin Ecosystem. In past decades, the sea lamprey devastated lake trout populations in the lakes. The Great Lakes Fishery Commission has led the costly effort to control that menace for years: direct expenditures for lamprey control have amounted to ten million dollars annually. The alewife has degraded the water quality of some of the Great Lakes, and their periodic die-offs have rendered beaches unusable. Exotic species entering this ecosystem more recently, such as the spiny water flea and the zebra mussel, threaten to disrupt the food web on which the Great Lakes fishery depends.

The zebra mussel is illustrative of how one tenacious exotic species can impair a wide variety of human uses of the Great Lakes Basin Ecosystem, including commercial and recreational fishing, power generation, manufacturing, navigation, tourism and beach use, natural area/native species appreciation, and, public water supplies. Drinking water for some 25 million people could be affected by this one exotic species alone.

[1] Exotic species are organisms that are not native to a particular region or ecosystem. For example, the zebra mussel is an exotic species in North America: in the Caspian Sea. it is a native species. While the term exotic species includes terrestrial and aquatic organisms, this special report focuses on the latter, particularly those species that are shipborne.

All indications are that the costs of managing the zebra mussel invasion will increase to hundreds of millions of dollars per year.

At a workshop jointly sponsored by the two Commissions in March 1990 (Attachment 2), participants concluded that much more effort is needed to prevent the introduction of exotic species. Experience with the sea lamprey and the zebra mussel shows that such organisms cannot be eradicated once they become established, and that reactionary actions are costly and largely ineffective.

Preliminary research indicates that approximately one-half of the 100 or more exotic species reported in the Great Lakes system were introduced via ballast water from oceangoing ships, which was taken on in ports on other continents. An estimated two-thirds of those species that have appeared since the St. Lawrence Seaway opened in 1959 were introduced through the uncontrolled discharge of ballast waters. Hundreds of millions of gallons of ballast water are discharged into the Great Lakes system by oceangoing ships each year.

In too many instances, an exotic species in a new ecosystem is like a square peg in a round hole: it just doesn't fit! Because it is free from predators and other constraints found in its original habitat, the species' population often grows without limits. The Commissions conclude that the chemical, physical, and biological integrity of the wafers of the Great Lakes Basin Ecosystem cannot be adequately safeguarded without more effective measures to prevent the introduction of these exotic species.

The specific considerations, conclusions, and recommendations that follow are based on a recognition of the urgent need to address immediately the ballast water aspects of the exotic species issue. At the same time, they encourage a long-term perspective that will lead to a more effective and comprehensive strategy for managing the introduction of exotic species into the Great Lakes Basin Ecosystem.

As few as one in seven lake trout will survive a sea lamprey attack.

Fatal wound caused by sea lamprey's many-toothed mouth.

Legislation and Regulation

The Commissions conclude that immediate action is required by Governments to reduce the risk of unwanted exotic species being introduced to the Great Lakes ecosystem through the discharge of ballast waters from oceangoing ships. Given the risks associated with the introduction of exotic species, the discharge of ballast water in the Great Lakes and connected fresh and brackish waters must become a privilege granted only to those ships that have taken reasonable and acceptable precautions to prevent ballast-borne introductions.

The Commissions recognize and appreciate the recent legislative and regulatory efforts made in the United States and Canada and encourage the development of further necessary legislation. Title 1 of the Non-Indigenous Aquatic Nuisance Act (S2244/H.R. 4214), now before Congress, has been endorsed by the Great Lakes Fishery Commission, which also recommended that this initiative be coordinated with Canadian efforts.

Legislative and regulatory efforts should ensure that any ballast waters discharged in the Great Lakes and connected fresh and brackish waters have been exchanged or adequately treated so as to be free from undesirable exotic species. Satisfactory evidence of compliance with this provision should be provided prior to a ship's entry into these waters, and noncompliance should result in the forfeiture of a ship's right to enter the Great Lakes and connected fresh and brackish waters.

Exotic species, once established, are as enduring as-the most persistent synthetic chemical pollutant. The ultimate objective of legislative and regulatory initiatives should be to eliminate introductions of unwanted exotic organisms capable of surviving and reproducing in the Great Lakes and connected waters. Thus, the principle of zero discharge should be applicable to exotic organisms in ballast water.

The Commissions submit to the Governments of Canada and the United States that the most effective initial measure available to prevent the discharge of unwanted exotic organisms is to mandate the mid-ocean exchange of ballast water in oceangoing vessels prior to their entry into the Great Lakes system and connected waters.

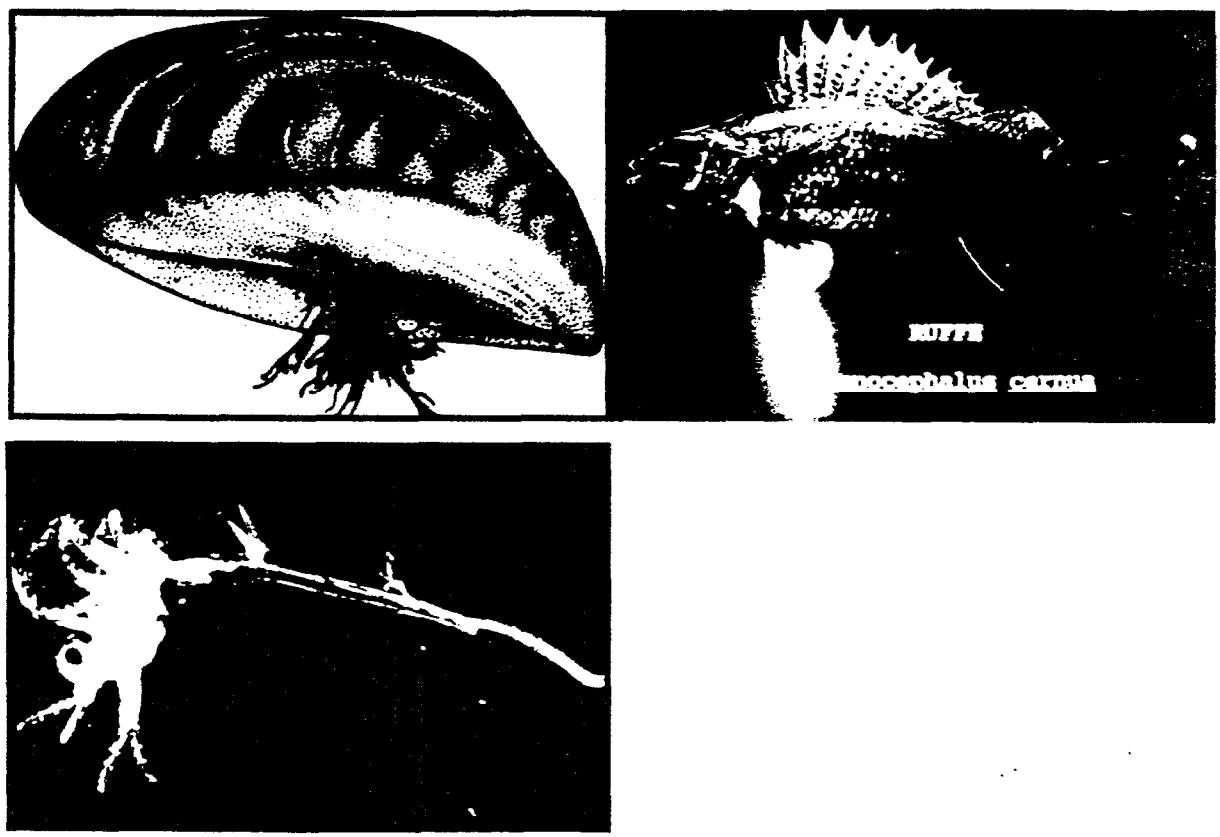
Backup options are required for ships that are unable, due to special circumstances such as severe storms, to exchange ballast in mid-ocean. For such cases, onshore facilities for the exchange of ballast water could be provided; and the discharged ballast water, itself, would then require environmentally safe treatment before it is further released or discharged. The onshore oily water separator used by Sarnia, Ontario, oil refineries to prevent discharge of oil residues with discharged ballast waters from oil tankers might serve as a potential model for an onshore ballast water disinfection facility. Such facilities might be located in the St. Lawrence and Hudson River estuaries.

In addition, the Governments need to provide their Coast Guards with adequate resources to develop, implement, monitor, and enforce measures required to prevent ballast-borne exotic organisms from entering the Great Lakes Basin Ecosystem and its connected waters.

The Commissions specifically recommend that:

1. the United States and Canada require all oceangoing ships to exchange their ballast waters in mid-ocean - before entering the Great Lakes or connected fresh and brackish waters. In those instances when mid-ocean exchange proves inappropriate for safety or other reasons, ballast water must not be discharged unless there has been previous environmentally safe exchange or treatment to remove or destroy all organisms capable of surviving in the waters of the Great Lakes ecosystem; and

2. the United States and Canada, through their Coast Guards and other responsible agencies, coordinate their ballast water exchange and treatment programs as fully as possible for purposes of standardization, monitoring, and enforcement.



Three of the *unwelcome intruders, recently arrived* in the Great Lakes via ballast water - *the zebra mussel, the ruffe, and the spiny water flea.*

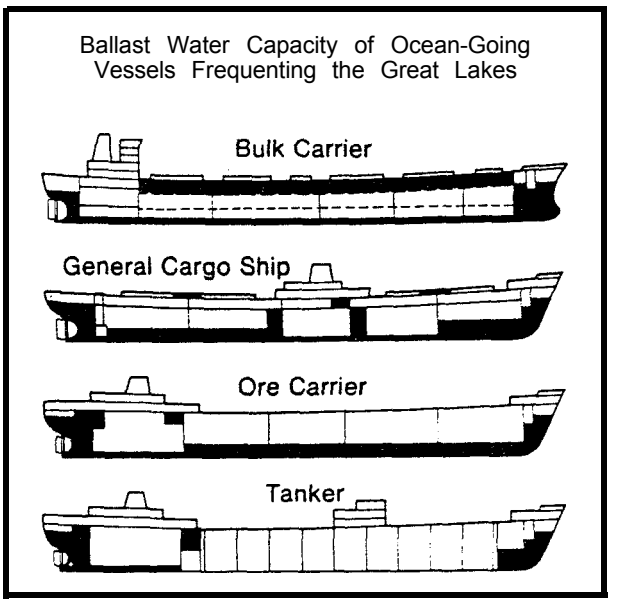
Applied Research and Development

Ballast water exchange in mid-ocean is a practical means of substantially reducing the risk of ballast-borne introductions of exotic species. Results of the monitoring program to determine the levels of compliance and effectiveness of Canada's ballast water exchange guidelines will, we expect, provide substantial confirmation of the potential of mid-ocean exchange. Nonetheless, we must assume that ballast water exchange - even in mid-ocean -will not be completely effective in eliminating all life stages of all organisms found in ballast tanks. It is also assumed that mid-ocean exchange of ballast may not always be practical or possible.

A concerted effort is needed to develop safer, more effective, and less expensive measures to virtually eliminate the risk of ballast-borne introductions. In the past, for example, oceangoing vessels heated their oil and ballast using "waste" heat from their engines. The use of heat to pasteurize and sterilize ballast waters is an attractive treatment from an ecological perspective; and the feasibility of designing and retrofitting ocean-going ships to accomplish such treatment could be assessed. Such design and retrofit could be adopted quickly, if found successful. This option and others are listed for consideration in Attachment 3.

The Commissions recommend that:

3. the United States and Canada ensure, in cooperation with shipping and other interests, that a major applied research and development program for devising and testing of improved measures for the exchange and/or treatment of ballast water is established and coordinated.



One oceangoing ship may carry more than a million gallons of ballast water- most frequently in dedicated ballast ranks, but also in available cargo ranks.

Once new, improved measures have been developed and tested, they can be incorporated into comprehensive strategies to prevent unwanted introductions. Perhaps a multiple barrier approach may be warranted, whereby individual ships select appropriate options from a menu of treatments proven safe and effective.

Strategic Research

The above recommendations reflect the conclusion that significant actions must be taken immediately to reduce the risk of unplanned introductions Of exotic species into the waters of the Great Lakes Basin Ecosystem. At the same time, limited understanding of how exotic species establish themselves in a new environment hinders both countries' abilities to develop a fully effective and comprehensive strategy. New and continuing investigations of vectors and prevention strategies need to be undertaken concurrently with actions that address more immediate concerns.

In the statement of purpose in Article II of the Great Lakes Water Quality Agreement, the Parties agreed "to make a maximum effort to develop the programs, practices, and technology necessary for a better understanding of the Great Lakes Basin Ecosystem." While that agreement focuses on water quality and chemical pollutants, a better understanding of biological pollutants and their relationship to water quality, human health, and other aspects of the integrity of the Great Lakes Basin Ecosystem is also emphasized.

The Great Lakes are directly and indirectly connected to major tributaries in both countries (e.g., the Hudson River via the Erie Canal, the Ottawa River via the Rideau Canal, and the Mississippi River via the Chicago Sanitary and Shipping Canal). Thus the implications of an exotic species invasion may be far reaching, and could include competition for food with native species, spread of disease, contamination of drinking water sources, and bioconcentration of pollutants. These are just a few of the many threats posed by exotic species.

While effective ballast water management is important, other measuresare required. Potentially colonizing organisms can survive oceanic crossings in various locations aboard ships: in the sediments of ballast tanks, in ship's chain lockers, on decks, on anchors, and on hulls. Once introduced to the continent, many aquatic organisms can survive short trips in anglers' bait buckets and on the hulls of recreational boats, which may move between the Great Lakes and other lakes rivers. Coordinated, long-term strategic research is needed to develop a more compr. nsive understanding of how exotic species become established in, and spread throu new ecosystems.

Therefore, the Commissions recommend that:

4. the Governments of the United States and Canada work together to foster and encourage long-term strategic research on all dimensions of the exotic species problem.

International, Intercontinental, and Global Considerations

Shipborne introductions of exotic species are an international problem. Fragmented strategies to prevent these transfers are not likely to be effective and could be counterproductive. The Governments of the United States and Canada are encouraged to participate actively in efforts initiated through the International Maritime Organization of the United Nations regarding exotic species. Ecologists, oceanographers, water treatment specialists, naval architects, and experts from other disciplines serving on national delegations need to address ship-mediated introductions of exotic organisms.

The Commissions recommend that:

5. Canada and the United States instruct their national delegations to the International Maritime Organization of the United Nations to augment and strengthen existing conventions, codes, and processes [Attachment 4] In order to:

- establish the significance of the global - though largely unrecognized - problem of shipborne introductions;
- assist in the development of standardized policies to address ballast transfers; and
- provide leadership and expertise for a coordinated exploration of opportunities to design new vessels and retrofit existing vessels to maximize effectiveness, ecological acceptability, occupational safety, and cost-effectiveness of ballast water exchange and treatment practice.

A Great Lakes clam fatally *encrusted by* zebra mussels.

A Great Lakes crayfish partially immobilized by zebra mussels.

Conclusion

The Great Lakes Fishery Commission and the International Joint Commission see a window of opportunity for Canada and the United States to adopt measures that prevent the introduction of unwanted exotic species. Many people perceive the threat, and the serious consequences of the spread of exotic species are widely understood. Unfortunately, funding for cooperative solutions to prevent the introduction and spread of exotics is in meagre supply.

While virtually eliminating the risk of new, human-induced biological invasions to the Great Lakes Basin Ecosystem will be expensive, the costs will almost certainly be less than the costs incurred to control species after they have invaded an ecosystem. The total cost of mitigating the zebra mussel's adverse impacts to the Great Lakes would be more than sufficient to bring biological invasions attributable to oceangoing shipping to a virtual halt.

The preventive approach also obviates some of the unanticipated consequences of after-the-fact control measures. For example, as a result of the zebra mussel invasion, government regulators are under pressure to lessen controls on the use of biocides. It is imperative that the full consequences of today's difficult choices be carefully considered before any actions are taken. For the Great Lakes Basin Ecosystem, the cumulative effect of chemical control on zebra mussels at multiple facilities may have serious and long lasting consequences.

The United States and Canada have an opportunity to take timely action. Working together, the two nations can develop prevention strategies and undertake the research and monitoring that are essential to assess and improve programs and practices that prevent the introduction of unwanted exotic organisms. Commitment and resources are necessary to virtually eliminate the risk of new biological invasions. If these are not applied in a timely fashion, the continued introduction of new exotic species will remain inevitable. We expect the zebra mussel could prove to be the forerunner of additional massive and calamitous invasions.

The Great Lakes Fishery Commission and the International Joint Commission offer their services to the Parties, and the affected international community, to assist in finding proactive solutions to the shared problem of exotic species.

Summary of Recommendations

The Commissions recommend that:

1. the United States and Canada require all oceangoing ships to exchange their ballast waters in mid-ocean - before entering the Great Lakes or connected fresh and brackish waters. in those instances when mid-ocean exchange proves inappropriate for safety or other reasons, ballast water must not be discharged unless there has been previous environmentally safe exchange or treatment to remove or destroy ail organisms capable of surviving in the waters of the Great Lakes ecosystem;

2. the United States and Canada, through their Coast Guards and other responsible agencies, coordinate their ballast water exchange and treatment programs as fully as possible for purposes of standardization, monitoring, and enforcement;

3. the United States and Canada ensure, in cooperation with shipping and other interests, that a major applied research and development program is established and coordinated that devises and tests improved measures for the exchange and/or treatment of ballast water;

4. the Governments of the United States and Canada work together to foster and encourage long-term strategic research on ail dimensions of the exotic species problem; and

5. Canada and the United States instruct their national delegations to the international Maritime Organization of the United Nations to augment and strengthen existing conventions, codes, and processes in order to:

- establish the significance of the global -though largely unrecognized - problem of shipborne introductions;
- assist in the development of standardized policies to address ballast transfers; and
- provide leadership and expertise for a coordinated exploration of opportunities to design new vessels and retrofit existing vessels to maximize effectiveness, ecological acceptability, occupational safety, and cost-effectiveness of ballast water exchange and treatment practices.

Great Lakes Fishery Commission

ESTABLISHED BY CONVENTION BETWEEN CANADA AND THE UNITED STATES TO IMPROVE AND PERPETUATE FISHERY RESOURCES

4 August 1988

The Honorable George Schultz
Secretary of State
U.S. Department of state
2201 c street, NW
Washington DC 20520

Dear Mr. Secretary:

The Great Lakes Fishery Commission wishes to alert its parties to a serious threat to the Great Lakes fishery. Scientists are convinced that harmful organisms are being introduced with discharge of ballast water from ocean-going vessels entering the Great Lakes. Three such introductions have - i - n the last few years. A European perch-like fish, the river ruffe (Gymnocephalus cernua), established itself in Duluth Harbor, the most inland port of the St. Lawrence seaway. A predacious planktonic cladoceran, called "B.c." (Bythotrephes cederstroemi) has spread throughout the Great Lakes apparently from th Great Lakes apparently from the port of Sarnia. The third organism, the European zebra mussel (Dressena polymorpha), was discovered a few days ago in Lakes St. Clair and Erie.

Exotic organisms can disrupt native fish through predation, competition, infection, interbreeding, and through their effects on habitat. The three recent arrivals, river ruffe, B.c., and zebra mussel, are expected to degrade the resources of the Great Lakes. The Duluth population of river ruffe is growing and is expected to spread throughout the system, competing with yellow perch and preying on the eggs of whitefish, both economically important species. A reduced - o f cladoceran water "fleas" (Daphnia spp.) has been attributed to B.c. predation. Water fleas are important food items for young fish, and improve water clarity through their own grazing activities on algae. Impacts of the newly arrived zebra mussel on native fish are not yet known. However, the zebra mussel is known to colonize and block water supply pipes and therefore could do great damage in the Great Lakes.

Although it is not possible to eradicate these recent invaders and other exotic species once established, the governments can limit the potential for future introductions via ballast water. In preliminary consultations scientists and shipping experts judged cost-effective a requirement that ocean-going vessels exchange their ballast water at sea before entering the Great Lakes. Thus nearshore water and its biota would be exchanged for open-ocean water and its organisms. (Open-ocean organisms are very unlikely to survive in the Great Lakes, and therefore could not disrupt the Great Lakes ecosystem.) Routine monitoring of ship logs and ballast water would determine whether ships have carried out the Proposed exchange. A backup system of disinfection might be required for saltwater vessels which are unable to exchange their ballast water in the open ocean.

1451 Green Road l Ann Arbor, Michigan 48105-2898 l Telephone (313) 662-3209 / FTS-378-2077

The Great Lakes Fishery Commission has the support of federal, provincial, state, and tribal fishery agencies in the Great Lakes in urging the U.S. and Canadian governments to eliminate this serious threat to the integrity and value of the Great Lakes fishery. In particular we strongly recommend that you consult with the U.S. Coast Guard on this issue. We understand that the Canadian delegation, supported by the United States, will raise this issue at the 5 September 1988 meeting of the International Maritime Organization's Marine Environment Protection Committee. The U.S. and Canadian Coast Guards, lead agencies in their delegations, have the authority to regulate ballasting, and have responsibility under Annex 6 of the amended Canada/United States Great Lakes Water Quality Agreement to address the ballast water introductions issue. For its part, the Great Lakes Fishery Commission offers its services to any groups addressing the ballast water introductions problem. We would appreciate being advised of progress and of opportunities to be of assistance.

A similar letter has been sent to Canadian Secretary of State for External Affairs Joe Clark.

Sincerely,

James M. Ridenour
Chairman

Carlos M. Fetterolf, Jr.
Executive Secretary

cc: Commissioners
Board of Technical Experts Executive
Council of Lake Committees
Habitat Advisory Board
U.S. Advisors
John Waugh, Ontario Fish Producers Association
Rick Morgan, Ontario Federation of Anglers and Hunters
Directors and Ministers of Great Lakes fishery agencies
Mike Donahue, Great Lakes Commission
International Joint Commission - David Chance, David LaRoche, Al Duda
Malcolm Windsor, North Atlantic Salmon Conservation Organization
Basil Parrish, International Council for Exploration of the Sea
U.S. Coast Guard - Paul Yost, Joel Sipes, Dave Pascoe
Canadian Coast Guard - R.A. Quail, Mike Turner
Joe Schormann, Environment Canada
Bonnie Koenig, Council of Great Lakes Governors
U.S. Department of State - Frederick Bernthal, Fred Hall, Rozanne Ridgway, Larry Snead, Sharon Stanley, Stetson Tinkham
Canadian Department of External Affairs - B. Applebaum, R.C Ball, Brian Buckley, D.W. Campbell, Aaron Saarna
Tom Martin, Michigan Department of Natural Resources
St. Lawrence Seaway Development Corporation - James Emery, Irman Cocci

Attachment 1 (b)

International Joint Commission
Commission mixte intemationale

August 9, 1988

The Right Honourable Joe Clark, P.C., M.P.
Secretary of State for External Affairs
Lester B. Pearson Building
125 Sussex Drive
Ottawa, Ontario
K1A 0G1

Dear Mr. Clark:

The Commission has been advised by its Great Lakes Water Quality Board that the introduction of foreign biological species to the Great Lakes via the discharge of ballast water from ships is a matter of concern. Each ballast water discharge has the potential to introduce exotic species to the Great Lakes waters which can negatively impact on the water quality and integrity of the Great Lakes ecosystem. The IJC's Science Advisory Board recently considered the issue and unanimously agreed that it is a matter of concern.

We are aware that the Great Lakes Fishery Commission has raised this issue with the Canadian and U.S. Coast Guards. They have urged the Coast Guards to act under authority of the revised Great Lakes Water Quality Agreement to make firm plans leading to the end of the ongoing introduction of exotic organisms to the Great Lakes via ballast water discharge.

The Commission shares the concern expressed by these groups and encourages governments to take action to prevent further introduction of foreign species to the Great Lakes waters from the discharge of vessel ballast waters. The viability of a large number of foreign species introduced in this manner has been demonstrated and the Commission believes that the introductions negatively impact on the water quality and the integrity of the Great Lakes ecosystem.

Under the terms of Annex 6 of the revised Great Lakes Water Quality Agreement, the Coast Guards have the responsibility to "review ...practices and procedures regarding waste water and their deleterious effect on water quality, including, as required, studies to determine if live fish or invertebrates in ballast water discharges into the Great Lakes System constitute a threat to the System." We believe that sufficient studies have been conducted to confirm the threat posed to the Great Lakes and that action is required.

A similar letter has been sent to the United States Department of State by the Secretary of the United States Section of the Commission.

Yours sincerely,

D.G. Chance
Secretary, Canadian Section

cc: 3 Canadian Commissioners
U.S. Section

Attachment 2 (Original format 8½" x 11")

INTERNATIONAL JOINT COMMISSION

GREAT LAKES FISHERY COMMISSION

WORKSHOP

on

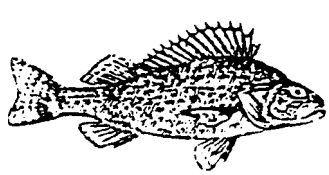
EXOTIC SPECIES AND THE SHIPPING INDUSTRY

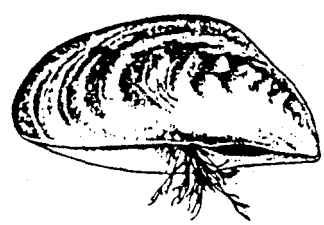
Toronto, Ontario
28 February - 2 March 1990

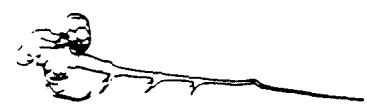
SUMMARY AND RECOMMENDATIONS

prepared by

Margaret A. Dochoda, Great Lakes Fishery Commission
Andrew L Hamilton, International Joint Commission
Bruce L Bandurski, International Joint Commission







EXOTIC SPECIES AND THE SHIPPING INDUSTRY

A workshop held
February 28 - March 2, 1990

Sponsored by

The International Joint Commission of
the United States and Canada
and the
Great Lakes Fishery Commission

Workshop Summary

and

Recommendations

prepared by

Margaret A. Dochoda, Great Lakes Fishery Commission
Andrew L. Hamilton, International Joint Commission
Bruce L. Bandurski, International Joint Commission

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INTRODUCTION: The context and the process

The Governments of Canada and the United States, the parties to the Great Lakes Water Quality Agreement, agreed on the following statement of purpose:

> "The purpose of the Parties is to restore and maintain the chemical, physical and biological integrity of the waters *of* the *Great* Lakes Basin Ecosystem."
> Article II. Great Lakes Water Quality Agreement of 1978.

Article VI and Annexes 4 to 9 of that Agreement all address "Pollution from shipping activities" and assign specific coordinating, enforcement and reporting functions to the U.S. and Canadian Coast Guards.

Exotic species introduced into the Great Lakes Basin Ecosystem have had a major impact on the integrity of the system. The sea lamprey invasion is one such example. The recent establishment of the zebra mussel (Dreissena polymorpha) in the Great Lakes System is another that has resulted in a great deal of public interest and *concern.* This exotic species is *very* prolific and, as an adult, attaches to solid substrates and is an extremely efficient filter feeder. Its capacity to clog water intake pipes has caused a great deal of concern as has its ability to cover spawning reefs, ship hulls, etc. As an abundant and efficient filter feeder it is also likely to have a large effect on the food webs that support valued fish populations.

The zebra mussel has now been found in Lakes St. Clair, Erie and Michigan and in the Welland Canal and the St. Lawrence River. All indications are that it will be permanent and very disruptive feature of all the Great Lakes and that from the Great Lakes it will be able to successfully invade most major watersheds on the North American continent. While most attention has been focussed on the disruption to municipal and industrial water supplies, the long-term effects *on* the fish and fisheries of the Great Lakes could be equally important.

Other recent arrivals-including the European percid ruffe (Gymnocephalus cernuus) and the spiny water flea (Bythotrephes cederstroemi\, a predaceous cladoceran - also clearly have the potential to disrupt the integrity of the waters of the Great Lakes Basin Ecosystem. These unplanned and unwelcome additions must now be considered as permanent parts of the system.

All indications are that these three exotic species were introduced into the Great Lakes through the discharge of ballast water that was taken on in freshwater or brackish water harbours in Europe. Ocean-going vessels have the capacity to transport very large amounts of water as ballast. Many forms of aquatic organisms

can survive for extended periods of time in these ballast waters. The Great Lakes Fishery Commission, because of its responsibilities for the fish and fisheries of the Great Lakes, has been particularly concerned over the recent unplanned introductions of exotic species to the Great Lakes. These introductions, singly and in combination, clearly have the potential to adversely affect the fish and fisheries of the Great Lakes.

The Great Lakes Fishery Commission formally brought the matter to the attention of governments in a letter dated August 4, 1988. On other occasions it has communicated with the International Joint Commission and with government agencies and has urged that major steps be taken to reduce the risk of future unplanned introductions of exotic species to the Great Lakes Ecosystem. On August 9, 1988 the International Joint Commission, acting on advice from the Great Lakes Water Quality Board, the Great Lakes Science Advisory Board, and the Great Lakes Fishery Commission also expressed its concern to Governments.

The Canadian Coast Guard (following consultation with the United States Coast Guard, the Great Lakes Fishery Commission and others) put in place a set of voluntary guidelines for the control of ballast water discharges from ships proceeding to the St. Lawrence Seaway and Great Lakes. These guidelines went into effect on May 1, 1989, and were in effect for the 1989 shipping season. Current guidelines which will be in effect during the 1990 season are attached (Appendix 4). Legislation to control the release of ballast waters in United States waters was adopted by the United States Congress on November 21, 1989 (Public Law 101-225). The United States Coast Guard has been requested to provide Congress with an assessment, by July 1990, of how this legislation could be implemented.

The International Joint Commission has, in recent months, become more sensitized to the issue of exotic species in the Great Lakes Ecosystem. Both its Water Quality Board and its Science Advisory Board expressed concern in their 1989 biennial reports to the Commission. The Great Lakes Fishery Commission and the American Fishery Society have each requested that the IJC become more involved *in* addressing the issue. Several presenters at the Commission's recent biennial meeting held in October 1989 in Hamilton, Ontario, forcefully outlined the seriousness of the problem and urged that solutions be developed and implemented.

It was in the context of this rapidly evolving international issue that the International Joint Commission and the Great Lakes Fishery Commission concluded that it was in their mutual interest to develop a clearer understanding of the nature, extent and significance of unplanned introductions of organisms to the Great Lakes System. It was also seen as being in the interests of both Commissions to ensure that whatever advice was forwarded to governments was sound and constructive. The significance and

public profile of the problem also make it all the-more important that the two Commissions work together to develop co-ordinated advice and recommendations.

With the above in mind the two Commissions agreed to sponsor a workshop on "Exotic Species and the Shipping Industry". The focus of the workshop, 'which was held from February 28 to March 2 in Toronto, Ontario, was on preventing future unplanned introductions rather than on measures for dealing with unwanted exotic species that have already been established in the Great Lakes System.

Fifty individuals from the United States, Canada and Australia participated in the workshop. They were from a wide variety of agencies and interests. A plenary session was held on March 1, the first full day of the workshop, to give attendees a general sense of the scope, complexity and significance of the problem. Four working groups were then convened to consider the issue and to develop recommendations. The reports of the four working groups were later raised in plenary *session.* Dr. Jim Carlton, of Williams College, provided a succinct summary of the major findings, conclusions and recommendations (Appendix 1). Dr. Carlton's summary together with the work group reports (Appendix 2) provided much of the basis for this workshop summary. The agenda for the workshop together with a list of attendees is attached as Appendix 3.

Events are moving quickly. Following the workshop, Canada and Australia requested at the meeting of the International Maritime Organization held in London, England, during the week of March 12, that the problem of exotic species and the shipping industry be treated as a matter that required urgent attention. At their request an ad hoc discussion group of the Marine Environmental Protection Committee was formed. The discussion group, which was made up of several concerned member states, presented three recommendations to the Committee, viz:

1. To establish a working group at the next session of the Marine Environmental Protection Committee to discuss the ballast water issue, with possible extension of the working group for two additional sessions:

2. To invite member states and non-governmental organizations to provide research information and suggested solutions to the ballast water problem for consideration by the working group: and

3. Pending introduction of an international approach, to request member states and non-governmental organizations to comply with current Australian and Canadian guidelines.

The Committee agreed to include the ballast Water issue in its long-term work plan, for discussion within a working group at the next session of the Committee in November 1990 and for likely completion by 1991 -- i.e., possibly at two additional committee sessions.

The Committee also agreed with the discussion group's recommendation 2, but could not accept recommendation 3 since it was felt that the Committee should not be seen to be encouraging compliance with a possibly risky ballast exchange procedure, prior to approval of such procedures by the Committee.

Notwithstanding the view of the Committee on recommendation 3, the International Chamber of Shipping expressed its willingness to bring the ballast water exchange guidelines to the attention of its members.

THE PROBLEM: Unplanned Great Lakes biological invasions

Exotic aquatic organisms have the potential to transform water quality, existing plant and animal communities, and human uses of the aquatic ecosystems that they invade. This transforming capability is found in otherwise inoffensive minute organisms as well as in top predators when either is introduced into a new ecosystem such as the Great Lakes. Unplanned introductions can sometimes have devastating consequences. A recent example is the zebra mussel which may cost Canadian and American taxpayers an estimated four to five billion dollars over the next 10 years through lost fisheries and blockage of water systems in the Great Lakes watershed alone.

Plants and animals which are transported across oceans where they can invade new ecosystems such as the Great Lakes, also find access to an untested continent. It is expected that the recently arrived zebra mussel (Dreissena **polymorpha**), the European percid ruffe (Gymnocephalus cernuus), and the predaceous cladoceran "BC" (Bythotrephes cederstroemi) will spread from the Great Lakes to other suitable habitat in North America.

Once established in large open aquatic systems exotic organisms have proven impossible to eradicate. A successfully established exotic must be regarded as a permanent addition to an aquatic community. Control of numbers and range may, in specific instances, be attempted, usually at great cost and continuous effort, if warranted by extensive adverse impact and permitted by peculiar physiology or habits. The sea lamprey control program was an example where such extraordinary efforts were possible and

warranted. Society may also elect to spend large amounts of money to control exotic organisms which severely impair use of a resource in a localized area. The control of zebra mussels in water intakes is one such example. For the vast majority of exotic introductions, however, very little can be done to minimize adverse ecosystem impacts and resulting losses.

Scientists have concluded that ocean-going ships were the means of introduction for as many as 27 of the 69 exotic organisms reported in the Great Lakes, including the ruffe, the spiny water flea ("BC"), and the zebra mussel. Ship transfer can be effected in many ways including sediments caught in anchor lines, and in the large amounts of water carried as ballast. The relative significance of the ballast water vector is illustrated in Figure 1.

Studies show that many aquatic plants and animals survive overseas voyages in ballast water. In recent years the Great Lakes have typically received ballast water discharge from about 1000 ocean-going vessels. In one voyage, each ship may discharge a million plus gallons of water in the Great Lakes, and each is capable of initiating an unplanned biological invasion when conditions in the receiving environment are conducive to the survival and reproduction of the introduced organism.

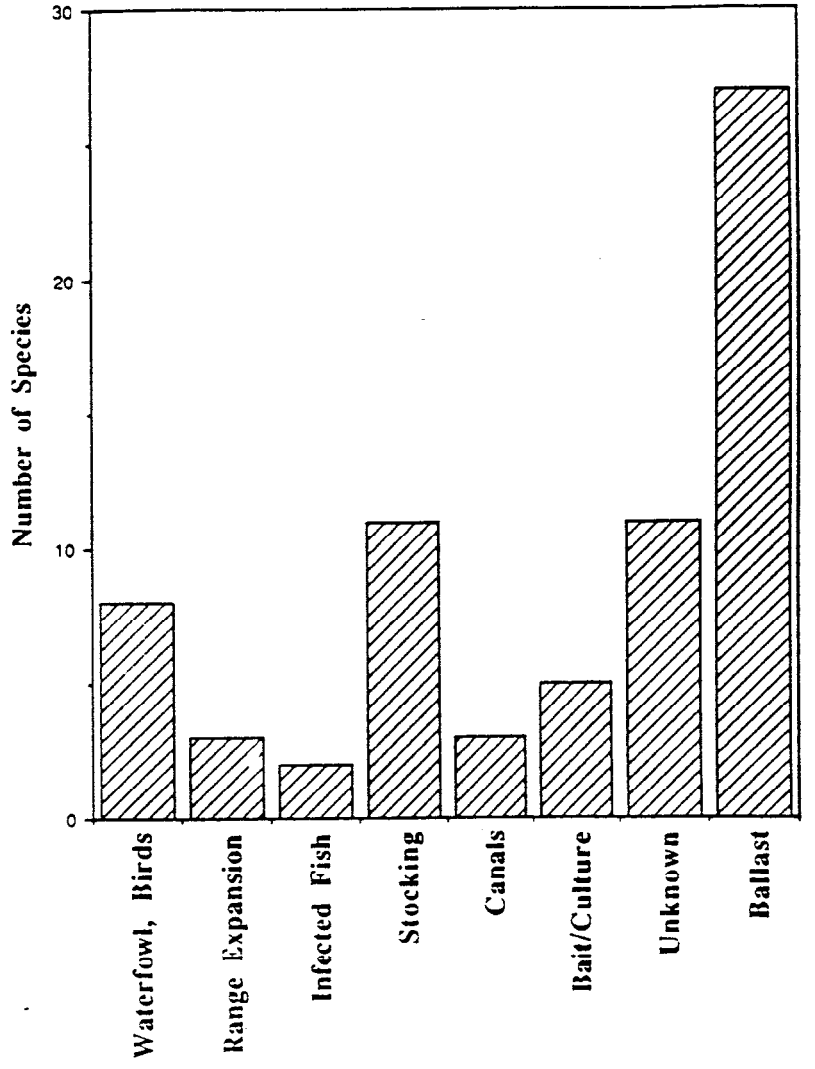
In order to prevent additional disruption of the Great Lakes and its human users, immediate and continuing efforts are required. The urgent need for preventive measures is demonstrated by the uncertainty associated with undocumented stowaways arriving daily, as well as by the problems caused by recent introductions to the Great Lakes Basin Ecosystem.

ADDRESSING THE PROBLEM

Strategic considerations: preventing unplanned biological invasions.

Overall cost effectiveness dictates that the strategic emphasis should be on prevention of intercontinental transfers rather than on attempting after-the-fact control of range extensions of exotic organisms. Unplanned introductions of exotic plants and animals have proved so problematic that the ultimate objective of any preventive program should be zero discharge and transfer of exotic organisms capable of surviving and reproducing in the Great Lakes-St. Lawrence River System. This is in keeping with the commitments made by the governments of the United States

Figure 1. Entry Vectors of Exotic Species Introduced Into the Great Lakes Since the Late 1800s.



and Canada who have agreed under the Great Lakes Water Quality Agreement to maintain- the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem.

A long term objective of zero discharge and transfer of viable exotic species reflects the conclusion that the overall risks, costs, and trade-offs of such introductions would make a less stringent objective unacceptable from a societal perspective. The potential costs to society, which in some instances could never be fully compensated, make it imperative that all reasonable steps be taken to prevent the unplanned introduction of exotics to the Great Lakes Ecosystem. Clearly this is an instance where it is inappropriate for one sector of society (i.e., shipping and related interests) to treat the risks and potential costs to the rest of society as "externalities". The shipping industry has both an opportunity and a responsibility to help develop short-term and long-term solutions that are practical, effective and acceptable to society at large.

It is desirable that any preventive program be as simple and as comprehensive as possible. A patchwork of contingencies and special cases will only impair stakeholder organizations, groups, and individuals in their endeavours to understand the effort and to cooperate in making it effective.

In dealing with the threat of exotics, preventive measures must be ecologically sound. This means that they must be environmentally-acceptable and occupationally-safe as well as cost-effective and practical over both the short term and the long term. Continuation of effectiveness must be ensured by building monitoring and feedback provisions into preventive procedures. Short term risk reduction can play an important part in overall strategies, but short term approaches should not be palliatives serving to postpone essential solutions for the long term. The seriousness of the problem *warrants* immediate (not sequential) institution of both short term and long term measures. And the long term measures need to aim at full solutions, not just reductions in the scale of the problem. It only takes one incident to "inoculate" the Great Lakes Basin Ecosystem with an irreversible invasion.

The risk of transfers of shipborne exotic organisms can be immediately reduced by the implementation of mid-ocean ballast exchange. Such exchange would replace freshwater and coastal plants and animals with mid-ocean organisms which are less likely to survive and reproduce in the Great Lakes Basin Ecosystem. If for safety reasons a ship is unable to exchange ballast at sea, measures such as nearshore (saltwater) exchange or chemical disinfection need to be provided as a backup form of protection. Such backup measures are not, however, free of drawbacks. Nearshore (saltwater) exchange poses risks for North America's

marine coasts. Handling and discharge of chemical disinfectants pose risks to individuals and to their environs. Ballast water exchange is *not,* in itself, a complete solution and the auxiliary treatments associated with it bring their own problems. Accordingly, more dependable measures than ballast exchange must eventually be developed and instituted.

Long term strategies for effectively eliminating the risk of intercontinental transfers of exotic organisms by shipping will require a coordinated approach -- possibly a global one. Examination of ships and their discharges, new and continued research and development, and implementation of existing and anticipated measures will necessitate coordination worldwide if programs are to be as effective as they could be at preventing introductions of exotic organisms. There is reason to hope and to expect that the present fleet can eventually by replaced with ships designed to facilitate the carrying out of effective preventive measures with safety and with reasonable ease. In fact, there are ships in today's fleet that with relatively minor retrofitting might be capable of bringing their ballast water to temperatures sufficiently high to ensure that no ballast-borne organisms survive trans-Atlantic voyages. Relatively self-contained solutions such as this -- requiring no handling of chemicals which themselves *are* problematic for other ecosystems which ultimately receive them -- should be most resolutely sought.

Though problematic for the time it would add to voyages, a long term backup alternative to mid-ocean flushings and shipboard treatments might be onshore facilities for treatments and disposal or re-use of ballast water. Alternatively, entry could be banned or tanks sealed before ships with untreated ballast water are allowed to proceed up the St. Lawrence River. The problems brought on by exotic species introduced by shipping are sufficiently serious to justify consideration of such measures.

Some "long term" alternatives (such as heating ballast, using biocidal paints, chemical disinfectants, ozone, deoxygenation, ultrasound, electricity, microwaves, rapid pressure changes, or even screens and filters in combination with other treatments) may have feasibility in the immediate future for some portion of the fleet. They should be instituted (and monitored) as opportunity provides, so that their long term promise might be assessed systematically. The significance of the issue of exotics' introduction via shipping is sufficient to warrant the immediate pursuit of each and every opportunity that would serve prevention strategies.

Implementation: enhancing the probability of *success.*

'International cooperation and coordination is an essential component of an effective and practical program to

prevent ship transfers of aquatic organisms. International consultation via such organizations as the International Maritime Organization is an essential complement to national initiatives. International coordination and cooperation should be sought for both overall strategy and related technology research and development. The need for international cooperation does not, however, preclude the need for individual nations to devise *regional* strategies based upon their own specific concerns and circumstances.

Similarly the cooperation of shippers and ships' crews should be actively courted wherever possible in order to maximize the effectiveness of preventive programs. Keys to shipping industry cooperation are an understanding of the problem, reasonable-cost preventive procedures, and positive feedback to cooperators. Brochures explaining ecological concerns - simply, in appropriate languages - would be useful. Preventive programs with built-in directed monitoring and feedback mechanisms would also be helpful as would cooperative research and development initiatives.

Preventive programs should be as effective and (environmentally and occupationally) safe as possible. How the shipping industry achieves the desired goal should then be a matter of consultation internationally, and among concerned disciplines including naval architects, environmental regulators, shipping regulators, marine engineers, etc. One suggestion that received a great deal of support at the workshop was that every ship leaving port should have a "ship environment management plan" which would include planned treatment of potentially problematic waters and sediments.

Although regulations *may or may not* be necessary or desirable in the short term or in certain circumstances, regulators should seek legislative authority which would permit rapid action as necessary. Comprehensive regulations will almost certainly be needed eventually in order to implement long term solutions and to help ensure responses that are consistent with the magnitude of the problem.

INFORMATION NEEDS

There is a clear need to implement specific measures to reduce the potential for unplanned introductions of exotic species to the Great Lakes System. Ballast waters carried in ocean-going vessels are considered to be the most likely vector for the introduction of exotic species, and ballast water exchange guidelines and/or regulations are clearly necessary.

At the same time it is also clear that additional information is required to help: (a) assess the risks of further

introductions, (b) assess the effectiveness of short-term measures, (c) assess the feasibility of potential long-term measures, and (d) reveal and define monitoring needs. Under no circumstances should the current information needs be used as a rationale for delaying the near-term measures that are required immediately.

- Assessing the risks

  Thefollowing initiatives would help to clarify and scope some of the risks associated with the transfer of aquatic organisms via ocean-going ships:

  1) an assessment of risks from a public health perspective:

  2) a review of the foreign literature for insights: on potential invaders that are likely to cause major problems if established in the Great Lakes System:

  3) a study of life forms typically carried in the sediments found in ship ballast tanks, anchor holds etc.

- Developing short-term measures and assessing their effectiveness

  The following initiatives would help in developing and assessing short-term preventive strategies:

  4) the development of charts illustrating the regions of the world's oceans that contain few, if any, life forms that are likely to be able to live and reproduce in freshwater (and coastal waters):

  5) an assessment of the potential for active and passive transport to the Great Lakes of exotic organisms released by ships in the St. Lawrence River downriver of the Seaway, in the Hudson River/Erie Canal/Lake Champlain system, and in other contiguous waters which may pose a threat;

  6) an assessment of the feasibility of using chlorine disinfection (or other chemical disinfectants) as a backup to other preventive strategies such as open-sea exchange of ballast water.

- Assessing the feasibility of potential long-term measures

  Implementation of long-term preventive strategies will be largely dependent on the SUCCESS of research programs such as:

7) research and development on the design of ships that are capable of safely exchanging ballast water under rough sea conditions, that are intended to provide onboard treatment of affected waters and sediments, and that are equipped so that sediments can be easily flushed from anchor lines:

8) research and development on the feasibility and design of shore facilities for the treatment, disposal and/or re-use of affected water and sediment, as a backup to ballast water exchange and other onboard procedures and treatments:

9) research and development to develop safe and environmentally acceptable measures for treating and/or filtering ballast waters so that they do not serve as vectors for the transfer of aquatic organisms.

· Monitoring

The effectiveness of all strategies should be determined in field studies, and monitoring should be an ongoing component of any preventive program, particularly:

10) monitoring to assess the compliance with and effectiveness of voluntary guidelines for the control of ballast water discharges from ships proceeding to the St. Lawrence Seaway and Great Lakes:

11) monitoring to assess the compliance with and effectiveness of future programs and strategies for preventing the unplanned introduction of exotic species to the Great Lakes System.

RECOMMENDATIONS to the International Joint Commission and the Great Lakes Fishery Commission

As outlined in this workshop summary it is clear that the problem of unplanned introductions of exotic species to the Great Lakes Basin Ecosystem is a very complex issue that will require a great deal of cooperation and collaboration. The following recommendations are offered as specific initiatives that could be taken to help catalyze and facilitate regional, continental and global efforts to address the problem.

It is recommended:

1) that on or before August 1, 1990 the International Joint Commission and the Great Lakes Fishery Commission submit a special joint report to the governments of the United States and Canada

addressing the matter of unplanned biological invasions of the Great Lakes Basin Ecosystem and expressing the need for immediate and effective action to prevent future introductions. Such a report could be based, in large part, on this workshop summary which was developed following the IJC/GLFC workshop on exotic species and the shipping industry.

2) that, as an interim measure, the government of Canada, through the Canadian Coast Guard, continue to improve and promote its guidelines for the exchange of ballast Water for ships proceeding to the Great Lakes-St. Lawrence River System.

3) that the governments of the United States and Canada fund, through their responsible regulatory and resource agencies, a research and monitoring program to assess the compliance with, and effectiveness of the current voluntary guidelines for the control of ballast water discharges from ships proceeding to the St. Lawrence Seaway and the Great Lakes.

4) that the governments of the United States and Canada be encouraged to continue and expand on their efforts to reduce the risk of unplanned introductions of exotic organisms to the Great Lakes Basin Ecosystem and to the coastal areas Of the North American Continent.

5) that the governments of the United States and Canada be encouraged to continue to work through the International Maritime Organization, its Marine Environmental Protection Committee and other international institutions to develop international guidelines and/or conventions that, with existing and evolving guidelines and legislation in Canada and the United States, will form the basis for protecting *the Great* Lakes - St. Lawrence River System from biological invasions.

6) that the governments of the United States and Canada investigate with the shipping industry and other affected interests a variety of options for encouraging the shipping industry to recognize the seriousness of the problem of unplanned invasion and to enlist its active support and cooperation in finding effective, safe and practical measures for effectively eliminating the risk of ocean-going ships serving as the vector for biological invasions.

APPENDIX 1

RESULTS OF THE JOINT MEETING, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

by

JIM CARLTON

WILLIAMS COLLEGE

March 2, 1990

15

RESULTS OF THE JOINT MEETING

FINDINGS, CONCLUSIONS, RECOMMENDATIONS

(as amended 2 March 1990)

by Jim Carlton, Williams College

1. Exotic species and the control of their spread are international issues.

2. The potential impacts span economic, social, health, and ecological concerns.

3. For the Great lakes specifically, exotic species may enter by a wide variety of routes and mechanisms. The establishment of such exotics are *of* international *concern,* since *exotic* species *can* further spread out from the Lakes across Canada and the U.S. and beyond.

4. Ballast water and sediments are of great concern at this time as a major vector for exotic species. Other vectors include the movements of recreational vessels into and out of the Lakes.

5. A major mechanism to control and reduce the importation of exotics by ballast water is the exchange of water on the high seas. Voluntary guidelines now call for such exchange. Compliance-effectiveness studies are now very much needed. Options may vary for vessel type and source area. Vessels should have ship environmental management plans.

6. The evaluation of additional control measures would be a useful and valuable step at this time, and should be addressed immediately. Field trials should be conducted as part of effectiveness studies. Heat and chlorination have been considered as primary measures among others such as rapid pressure changes.

7. International (multi-country) cooperation is of greatest importance, with rapidly growing *concerns* about the role of ballast water having been expressed not only in Canada and the U.S., but also Europe and Australia. The UN's International Maritime Organization (IMO) should call a conference to find solutions.

8. Immediate effective action to reduce the risk of invasions is now required. All vessels must take steps to insure that continued releases of exotic species into the Great lakes ecosystem will no longer take place or will be vastly reduced. Regulations, laws, and/or agreements will greatly enhance the

realization of this goal. Shippers should also be given positive communications and feedback on their efforts.

(Advice to Commissions and organizers: (1) provide info to Coast Guards prior to 12 March 1990 meeting of IMO's *Marine* Environment Protection Committee: (2) include funding in recommendations to Governments: (3) don't describe introductions as "unintentional"; (4) translate final report to French for distribution in Quebec.)

APPENDIX 2

W O R K G R O U P R E P O R T S

IJC/GLFC WORKSHOP

on

EXOTIC SPECIES AND THE SHIPPING INDUSTRY

February 28 - March 2, 1990

- de-oxygenation

- physical
  - screens/filters
  - hi velocity pumping
  - ultrasound
  - electricity
  - heat
  - microwave'

[ULTIMATE OPTION: ban entry]

*****

PREVENTION STRATEGIES CRITERIA

- environmentally acceptable
- cost effective for society and private sector
- occupationally safe
- long term developed as well as short term strategies
- operationally practicable
- socially acceptable risks and tradeoffs
- addresses water and sediment
- simple and comprehensive
- alternatives available
- can be monitored
- enforceable/enjoys support of private sector

1 ****

SHIP ENVIRONMENT MANAGEMENT PLAN

LANG TERM MAIN OPTION
(INTERNATIONAL)

Ship design
- exchange safely

- sediment

SHORT TERM MAIN OPTION
(GREAT LAKES)

Ballast exchange
protection from
coastal/freshwater organisms
(Australia - organisms
specified)

WORK GROUP A REPORT

MEMBERS: Ted Bailey (IJC), Al Beeton (NOAA), Gary Blundell (CWF), Facilitator Marg Dochoda (GLFC), Tom Fleck (CCG), Phil Knetchel (LPA,Inc.), Walter Lyon (U. of PA), John Merton (AQ&IS), Ed Mills (Cornell U.), Tony Wagner (EC)

*****

PROBLEM STATEMENT

- should mention sediment, including that associated with anchor lines

- don't waffle on impacts!

- impacts all Canada/U.S. taxpayers, consumers etc., not just those in Great Lakes region

- 27 of 69 exotics documented thus far in Great Lakes thought to have been introduced via ballast water of ocean-going vessels

- obtain and insert information on other potential and risky introductions

- current controls are not proportional to risk, compared with those imposed in agriculture

- determine whether Great Lakes ships carry 1.25 or 6 million gallons of ballast water (Australian guideline is maximum of .6 x ship tonnage)

*****

PREVENTION STRATEGIES

- exchange

- treatment facilities

- lengthen voyage

- chemical

    - biocidal paint
    - disinfection
    - ozone

- onboard treatment

LONG TERM BACK-UP OPTION (GREAT LAKES)	SHORT TERM BACK-UP OPTION (GREAT LAKES)
Onshore treatment facilities	Safe harbour exchange
onboard chem. disinfection	Chemical disinfection

1 ****

IMPLEMENTATION ITEMS

- international approach: IMO
- performance-oriented regulations
- education/cooperation
- all North American freshwater a potential source and at risk
- monitoring should be used to provide feedback
- monitoring should address specific questions
- internationally coordinated R&D on technology
- regular review process part of any prevention program
- public health risk assessment needed (parasites, fish disease, bacteria and viruses, toxins)

1 ****

BALLAST EXCHANGE

- "beyond any continental shelf" adequate location for exchange
- should cover ships destined for Seaway ports, with Coast Guard studies on need to include ships destined for Montreal and Quebec City, Hudson River, and Mississippi River

PORT	CURRENT BLOCK	POLLUTION BLOCK	TRAFFIC PROFILE	INTRO HISTORY	STRATEGIC APPROACH	URGENCY
Seaway	-		-1000	27/69	Cdn. Guidelines	#1
Montreal & Quebec	Yes	. Yes	>1000	3+	CCG study	#2
Hudson R.	-		<1000?	few	USCG study	#2
Miss. R.	-	Yes	<1000?	refugia?	USCG study	#3
Hudson Bay	-		<<1000?	none?	None needed	-

- backup options
    - disinfection: chlorine feasibility study
    - safe harbour: no consensus (conflicted with simple/comprehensive and protect-all-freshwater criteria)
- sediment including anchor lines
    - Coast Guard study to see if problem for Great Lakes (if so, arrange for proper dry dock disposal of sediment, and for regular anchor line rinse)

WORK GROUP B REPORT

MEMBERS: Bruce Bandurski (IJC), Jim Carlton (Williams College), Doug Dodge (OMNR), Facilitator Mike Donahue (GLC), Randy Helland (USCG), Dick Kubiak (GLU), Cmr. Claude Lanthier (IJC), Ivan Lantz (SFC), John Lark (DFO), Bob Peoples (USFWS), Charlene Waggoner (U.S. Leg. Asst.)

*****

CAVEATS

- initial reactions based upon group expertise
- R&D needed in all cases
- does not differentiate between different species
- provides guidance for prioritizing action/research needs

*****

PROCESS

- problem statement consensus
- generate additional control alternatives
- evaluate on basis of "control effectiveness" criteria
- evaluate on basis of **political/economic/practical" feasibility criteria
- recommend
  - "immediate application"
  - "immediate R&D"
  - "likely not effective"

*****

PROBLEM STATEMENT

- unplanned introductions are unbalancing
- they spread

- uncertain economic/ecological future unless strong 'steps are taken

- binational/intarnational issue: coordination and cooperation essential

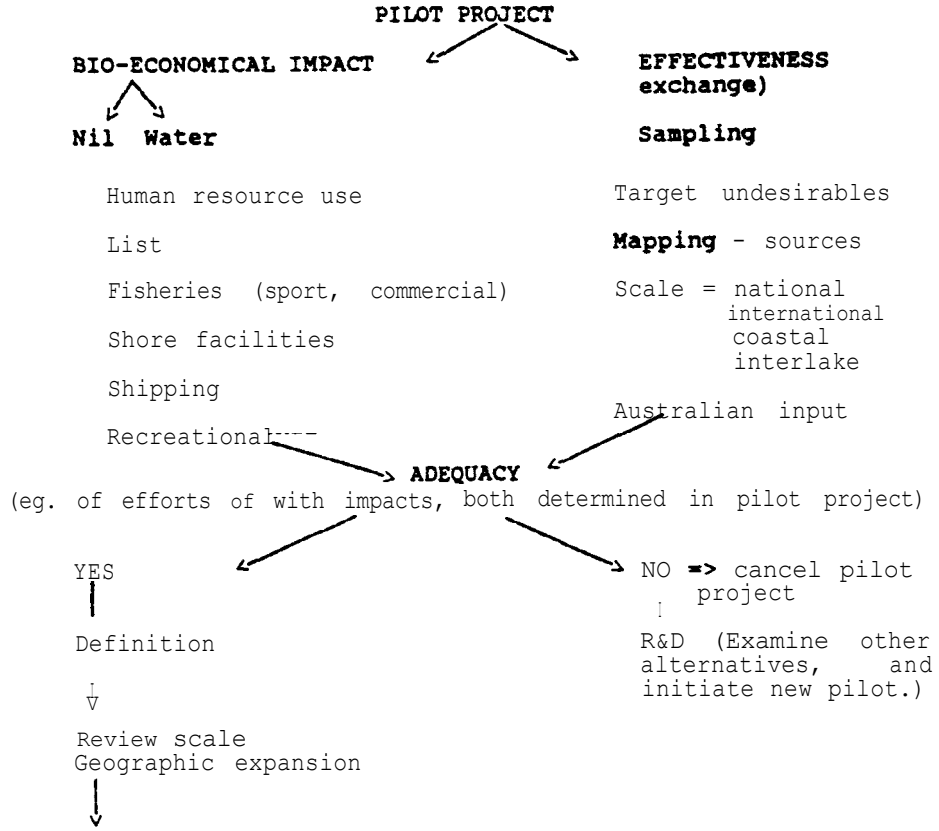
- ballast water is a principal vector

- effective action now is critical

(A substitute problem statement drafted by John ark (DFO) is attached for consideration.)

*****

Work Group B had insufficient time to develop a course of action from the following proposal submitted by *Ivan Lantz (SFC).*



Implementation

International convention

Legislation and regulation

WORK GROUP C REPORT

MEMBERS: Timothy Allen (U. of WI), John Cooley (DFO), Alex Davis (U. of MI), Raymond Fosberg (Smithsonian Institution), Andy Hamilton (IJC), Paul Horvatin (U.S. EPA), Frank Quinn (Env. Can.), Joe Schormann (Nutak), Facilitator Gary Sprules (U. of Toronto)

*****

PROBLEM STATEMENT

- ok, needs minor editing

*****

PURPOSE

- restore and maintain chemical, physical, biological integrity of waters of Great Lakes Basin Ecosystem

*****

CLIENTS

Primary: Great Lakes Basin Ecosystem

Secondary: IJC, *GLFC,* plus stakeholders - shipping industry, resource agencies, resource agencies, resource users, taxpayers, etc.

*****

OBJECTIVE

- work towards zero discharge and transfer of exotic freshwater species into or within the Great Lakes - St. Lawrence River system by vessels

*****

FACTS

- introductions and invasions will occur no matter what

- if do nothing - major problem

- it is feasible and desireable to
    - do something now
    - work toward more effective solutions for future

*****

TACTICS

- focus initially on ballast water and risk reduction, eg.
    - open ocean exchange
    - heating 110 degree F
    - pasteurization 160 degree F
    - salination
- continue use of voluntary guidelines
- monitor compliance and effectiveness with independent verification
- probably need to (must?) move to regulations *in* near future
- move issue to international forum - IJC/GLFC advise parties to convene special meeting of IMO
- *communicate* to shipping federation through simple brochures in many languages
- develop incentives as well as penalties

    eg. reduced tariffs if ship built/refitted appropriately

*****

OPERATIONS

- ballast treatment plan prepared and forwarded before departure
- info reporting (ECAREG radio, Ballast Exchange Report), before entering Great Lakes
- in situ treatment
    - biocides

- heat/pasteurize
- salination

- multiple barriers/filters

*****

RESEARCH AND DEVELOPMENT

- effectiveness of various in situ treatments
- develop new and environmentally appropriate biocides
- new vessel design
- design of retrofits
- effectiveness on sediments/resting stages

WORK GROUP D REPORT

MEMBERS: Ross Alexander (DFO), Joe Craig (SLSA), Tom Frietag (COE), Facilitator Mike Gilbertson (IJC), Reporter Henry Lickers (MCA), Mohi Munawar (DFO), Tom Nalepa (NOAA), Jeff Rigby (BHP, Australia), Bill Spaulding (USFWS), Stacy Taylor (U. *of* MI)

*****

PROBLEM IDENTIFICATION

GENERAL:

- the Seaway

- organisms *from* around the world

=> general recommendation on prevention of introduction of all exotic species via all routes of entry, with shipping (ballast water) identified as major vector into Great lakes and into other *freshwater* locations

SPECIFIC:

- freshwater and estuarine organisms (not marine)

- shipping

- ballast water

- need research on risk areas/locations and potential detrimental effects

*****

IMPACTS

PRIMARY:

1) food web dynamics

2) fisheries

3) replacement of indigenous species

-4) fouling pipes, boats, etc.

5) fouling sunken ships of historical value

6) recycling toxics (concentrating/redistributing in food chain)

SECONDARY:

1) human health - swimmers' itch - also fish & wildlife health

2) fisheries disruption - industry

3) recreation/tourism

4) unsaleability

5) disruption of native way of life and prime users

* * * * *

WAYS AND MEANS

1) Voluntary Guidelines (1989) => effectiveness? Compliance?

2) Modified Guidelines (1990) => IMO, International Chamber of Shipping

3) Regulations - new & existing (slow path)

4) Education via shipping associations

PREMISE:

No techno fix!

* * * * *

WAYS AND MEANS

RECOMMENDATION:

All ships from overseas shall exchange ballast water at sea. (including U.S.)

Requires compliance.

*****

33

WHAT HAPPENS IF NO EXCHANGE!

1) Send back to sea.

2) Treat ballast in place.

3) Seal tanks.

4) Pump ashore and treat.

1 ****

RECOMMENDATION

1) Compliance monitoring criteria shall be based on salinity and picoplankton.

2) Research:

- effectiveness of procedure in predictions

- compliance: salinity or picoplankton or both.

*****

RECOMMENDATION

Coast Guard shall implement necessary procedure to prevent the introduction of new exotic species (Great lakes Water Quality Agreement)

A) Review of legal basis for control

B) Review of new instruments (And authority)

*****

OTHER CONCERNS

- interlakes movement

- river to Lakes

- Gulf problem

- Laurentian Channel

- deep/cold survival of marine organisms => research

- movement/transport (North America) due to recreational vessels

- research => literature review
- research => interlake and intralake transfers
- research => ballast material (water, sediment)

APPENDIX 3

A G E N D A

and

L I S T O F P A R T I C I P A N T S

IJC/GLFC WORKSHOP

on

EXOTIC SPECIES AND THE SHIPPING INDUSTRY

February 28 - March 2, 1990

IJC/GLFC WORKSHOP
on
EXOTIC SPECIES AND THE SHIPPING INDUSTRY

Constellation Hotel
Toronto, Ontario
28 February, 1 & 2 March 1990

Wednesday, 28 February 1990

1900 h 1. Workshop design and desired outcome - Andy Hamilton (IJC)
Marg Dochoda (GLFC)
Carlos Fetterolf (GLFC)

(a) *one* page description of issue ("strawman" handout for work group consideration)

(b) 5-6 page statement on preferred preventive tactics, implementation strategies, and research needs (synthesis of-work group discussions)

(Objective is consensus but minority reports welcome.)

1915 h CASH BAR

Thursday, 1 March 1990

0815 h COFFEE

0845 h 2. Call to order and introductions - Andy Hamilton (IJC)
Carlos Fetterholf (GLFC)

0855 h 3. Welcome - IJC Commissioner Claude Lanthier, GLFC Commissioner Charles Krueger

0915 h 4. An ecological perspective on biological invasions - Jim Carlton (Williams College)

0940 h 5. A global perspective on shipping and the transfer of species - Jim Carlton (Williams College)

1005 h 5. COFFEE

1020 h 6. A Great Lakes perspective on the transfer of species via shipping - Ed Mills (Cornell U.)

1045 h 7. Anatomy of a ship: mechanical designs of water systems aboard ocean-going vessels - Joe Schormann (Environment Canada, retired)

1110 h 8. Operational tactics for preventing transfer of organisms - Jim Carlton (Williams College)

1145 h LUNCH

1300 h "Shipping and ballast water - the Australian experience" - John Murton (Chief quarantine officer, Australian Quarantine and Inspection Service)

1330 h 9. Institutional and regulatory strategies for preventing transfer of organisms - Tom Fleck (Canadian Coast Guard)

1400 h 10. Monitoring compliance and effectiveness - Gary Sprules (U. of Toronto)

1430 h 11. A shipping industry perspective on strategies and tactics for preventing transfer. of organisms - Ivan Lantz (Shipping Federation of Canada)

1500 h COFFEE

1530 h 12. Work group discussions

(i) statement of problem (one page strawman provided)

(ii) elaboration/evaluation of tactics, with associated research needs (agenda item #8)

(iii) strategies for implementation of tactics (agenda item #9)

(iv) monitoring compliance and effectiveness of tactics (agenda item #10)

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Members:
Ted Bailey (IJC)
Al Beeton (NOAA)
Gary Blundell (CWF)
Tom Fleck (CCG)
Phil Knetchel (LPA,Inc)
Walter Lyon (U. of PA)
John Murton **(AQ&IS)**
Ed Mills (Cornell U.)
Tony Wagner (EC)

Work Group B

Facilitator: Mike Donahue (GLC)
Members :
Bruce Bandurski (IJC)
Jim Carlton (Williams College)
Doug Dodge (OMWR)
Randy Helland (USCG)
Dick Kubiak (GLU)
Claude Lanthier (IJC Commr.)
Ivan Lantz (SFC)
John Lark (DFO)
Bob Peoples (USFWS)
Charlene Waggoner (U.S.Leg.Asst)

Work Group C	W o r k .
Facilitator: Gary Sprules (U.of T)	Facilitator: Hike Gilbertson (IJC)
Members :	Members :
Timothy Allen (U. of Wisconsin)	Ross Alexander (DFO)
John Cooley(DFO)	Joe Craig (SLSA)
Alex Davis (U. of Mich.)	Tom Frietag (COE)
Raymond Fosberg (Smithsonian Inst.)	Henry Lickers (MCA)
Andrew Hamilton (IJC)	Mohi Munawar (DFO)
Paul Horvatin (U.S. EPA)	Tom Nelepa (NOAA)
Frank Quinn (EC)	Jeff Rigby (BHP,AUStralia)
Joe Schormann(Nutak)	Bill Spaulding (USFWS)
	Stacy Taylor(U. of Mich.)

. 1700 h ADJOURNMENT

Friday, 2 **March** 1990

0830 h 13. Work Group Sessions

1200 h LUNCH

1300 h 14. Work Group A report

Work Group B report

Work Group C report

Work Group D report

1430 h COFFEE (and group reps meet with Jim Carlton for synthesis)

1500 h 15. Summary - points of consensus, varying points of view and reasoning, final opportunity to reconcile varying points of view - Jim Carlton (Williams College)

1540 h ADJOURNMENT

25 February 1990

IJC/GLFC WORKSHOP ON EXOTIC SPECIES AND THE SHIPPING INDUSTRY

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APPENDIX 4

"VOLUNTARY GUIDELINES FOR THE CONTROL OF BALLAST WATER DISCHARGES FROM SHIPS PROCEEDING VIA THE ST. LAWRENCE SEAWAY TO THE GREAT LAKES"

APPENDIX 4

VOLUNTARY GUIDELINES FOR THE CONTROL OF BALLAST WATER DISCHARGES FROM SHIPS PROCEEDING VIA THE ST. LAWRENCE SEAWAY TO THE GREAT LAKES

1.0 Introduction

1.1 The purpose of these voluntary Guidelines is the protection of Great Lakes waters from non-native fish and other aquatic organisms, that can be harmful to the balance of nature that *now* exists. When a new organism is introduced to a balanced ecosystem, negative changes may result. In the Great Lakes, there have been many aquatic organisms introduced by accident, and several of these have been very harmful. These Guidelines should reduce the additional non-native species being introduced.

1.2 The best method of protecting Great Lakes *waters* from foreign organisms that may exist in ballast water collected in foreign harbours and nearshore areas, is for the ballast water to be exchanged in the open ocean, beyond any continental shelf or fresh water current effect. Harbour and coastal waters are often rich in living organisms that could unbalance the Great Lakes fisheries systems. Water in the open ocean contains comparatively fewer organisms. Those organisms that do exist are adapted to life in open salt water and are less likely to survive if accidentally introduced into the Great Lakes freshwater system.

1.3 The intent of these Guidelines is that all ships, destined for the St. Lawrence Seaway and Great Lakes, exchange their ballast far enough from any coastline so that there will be few *organisms* of any kind in the exchanged ballast water.

1.4 These voluntary Guidelines have been developed by the Canadian Coast Guard, in full consultation with the United States Coast Guard, the Great Lakes Fishery Commission, and representatives of commercial shipping. The Canadian Department of Fisheries and Oceans, and the Canadian Department of the Environment were also involved in their development, and fully support their application.

1.5 These Guidelines should not be seen as adding to or detracting from existing statutory or regulatory requirements, which will prevail in the case of conflict with the Guidelines.

2.0 Short Title

2.1 These Guidelines may be cited by the short title of "Great Lakes Ballast Water Control Guidelines".

3.0 **Application**

3.1 The Great Lakes Ballast Water Control Guidelines apply to all vessels transiting the ECAREG VTS Zone* that are inbound for the St. Lawrence Seaway and Great Lakes.

3.2 The effective date for introduction of these Guidelines is May 1, 1989.

4.0 **Implementation**

4.1 Applicable ships will be requested to provide ECAREG with the following information, as part of the ECAREG interrogative:

(i) Whether ballast water is being carried:

(ii) If the answer to (i) is affirmative, the minimum ocean depth and location where the ballast water was taken *on* or exchanged.

4.2 Vessels, subject to the Guidelines, will be requested by ECAREG to exchange any ballast water that had not been taken on in ocean depths greater than 2000 metres. The exchange should be made, at sea, as far from land as practicable, in a water depth of *not less* than 2000 metres.

4.3 In exceptional circumstances, where it may be impracticable to exchange ballast water as per paragraph 4.2, and for those ships that have not left the North American continental shelf on their inbound voyage, the exchange may be made in internal Canadian waters, within the Laurentian Channel and in water depths exceeding 340 metres. Such internal waters exchanges should be completed prior to the ship passing longitude 64' W and as far east as possible.

*Eastern Canada Vessel Traffic Service5 *Zones.* For detailed information refer to the Annual Edition of Canadian Notice to Mariners, Notice 26.

4.4 Canada's pollution prevention regulations prohibit the discharge of oil or pollutant substances into any waters under Canadian jurisdiction. Where ballast water is being carried in a bunker fuel tank, or in the cargo tank of a tanker, *no* discharge of such ballast water is permissible within Canadian waters and any necessary discharge of such ballast water must only be to a shore reception facility.

4.5 It should be noted that the stability of the ship, and any other safety considerations, remain the responsibility of the ship's master. Nothing in these Guidelines should be construed as an infringement upon that responsibility.

4.6 When pumping out ballast water, preparatory to an exchange in accordance with these Guidelines, the pump should be run until it loses suction, thus assuring that the tank is reasonably empty before commencing to take on the new ballast water.

4.7 A record of the salinity of the ballast water to be discharged in the Great Lakes and the location, date and time of the ballast water exchange should be entered in the ship's log book, or in other suitable documentation.

5.0 Tank Sediment Disposal

5.1 Sediment from the ballast tanks of foreign-going ships is to be disposed of only in land dumpsites.

6.0 **Compliance** Monitoring

6.1 If not already carried on board, ships to which these Guidelines apply will be provided with a copy by the pilot boarding the vessel at Les Escoumins. The Ballast Water Exchange Report Form (Appendix A to the Guidelines) is to be carefully completed by the ships' master. The completed Report Form will be used to verify the information previously provided to ECAREG and as a means of compliance and effectiveness monitoring of the Guidelines. The completed Report *Form* is to be given to the Lockmaster at the St. Lambert Lock. Samples of ballast water may also be taken for the purpose of assessing the effectiveness of the Guidelines.

6.2 These Guidelines are being introduced on a voluntary compliance basis, in the expectation of customary cooperation from the shipping industry. It is in the interests of all parties to work for their success. Evidence of non-compliance may lead to the application of regulatory controls.

6.3 It should be noted that under the Canada Shipping *Act* it is an offence, punishable by a fine of up to $50,000 to refuse to provide information, or to knowingly provide false information to a vessel traffic regulator, where such information is requested for the promotion of environmental protection.

Amendment No. 1
20 Feb 1990

APPENDIX 'A'

BALLAST WATER EXCHANGE REPORT

(To be completed by the Ship's Master and given to the Lockmaster prior to ship clearing St. Lambert Lock)

NAME OF SHIP: _____

PORT OF REGISTRY: _____

OFFICIAL NO. OR CALL SIGN: _____

OWNERS: _____

AGENTS: _____

INFORMATION ON BALLAST WATER BEING CARRIED INTO THE GREAT LAKES									
LOCATION	QUANTITY (tonnes)	WHERE TAKEN ON		SALINITY (specify units)	INTENDED DISCHARGE PORT		IF EXCHANGED, WHERE WAS ORIGINAL BALLAST TAKEN ON		IN COMPLIANCE WITH GUIDELINES Yes OR No
		LONG	LAT		PLACE	DATE	LONG	LAT	
DOUBLE BOTTOMS									
FORE PEAK									
AFT PEAK									
WING TANKS									
SIDE TANKS									
DEEP TANKS									
CARGO HOLDS									

MASTER'S NAME: (Please print) _____ MASTER'S SIGNATURE: _____

DATE: _____ LOCATION: _____

FOR COMPLETION BY ST. LAWRENCE SEAWAY INSPECTOR		
WAS BALLAST WATER SAMPLE TAKEN?	YES	NO

February, 1990

ANNEXE 'A'

RAPPORT DE CHANGEMENT DE LEST LIQUIDE

(À remplir par le capitaine de navire et à remettre au maître éclusier avant que le navire ne quitte l'écluse de Saint-Lambert)

NOM DU NAVIRE: _____

PORT D'IMMATRICULATION: _____

N° OFFICIEL OU INDICATIF D'APPEL: _____

ARRIVÉE: _____

ACCOSTAGE: _____

RENSEIGNEMENTS CONCERNANT LE LEST LIQUIDE TRANSPORTÉ DANS LES GRANDS LACS

EMPLACEMENT	QUANTITÉ (tonnes)	LIEU DU CHARGEMENT		SALINITÉ (précisez unités)	PORT PRÉVU POUR LE DÉCHARGEMENT		SI CHANGÉ, LIEU DU PREMIER CHARGEMENT		CONFORMÉMENT AUX LIGNES DIRECTRICES
		LONG.	LAT.		PORT	DATE	LONG.	LAT.	Oui ou Non
DOUBLE FOND									
BALLAST AVANT									
BALLAST ARRIÈRE									
BALLASTS D'AILE									
BALLASTS LATÉRAUX									
CALES À EAU									
CALES À MARCHANDISES									

NOM DU CAPITAINE (LETTRES MOULÉES) _____ SIGNATURE DU CAPITAINE: _____

DATE: _____ EMPLACEMENT: _____

À REMPLIR PAR L'INSPECTEUR DE LA VOIE MARITIME DU SAINT-LAURENT		
A-T-ON PRÉLEVÉ UN ÉCHANTILLON DE LEST LIQUIDE ?	OUI	NON

Février 1990

Attachment 3

Ballast Water Monitoring Workshop It, Great Lakes Fishery Commission
Toronto, February 8-9, 1990

Checklist of Suggested Alternative Procedures for the Control of the Release of Living Organisms In Ballast Water

(Numerous Contributors)

Before Departure

1. Coat Tank Walls with Biocidal Agent

On Departure

2. Load Pm-treated Water from Onshore (Ballast Water) Supply Facility

During Ballasting

3. Screens and Fitters
4. High Velocity Water Flow (During Pumping)
5. Ultraviolet Light
6. Ultrasound
7. Electrical Current

During or After Ballasting

8. If Seawater Ballast, Simultaneously Pump in Freshwater from Onshore Source
9. Addition of Biocidal Agent (Chemical Disinfection with Toxic Agent)

En Route

10. Increase Length of Voyage
11. If Freshwater Ballast, Pump in Seawater from Ocean
12. Exchange River (Fresh) or Coastal (Harbour, Port, Estuary) Water for High Seas Water
13. Heat Water with Steam Pipes Fitted in Ballast and Cargo Tanks

On Arrival

14. Discharge Untreated Water to Onshore Treatment Facility

(see 2.) Discharge Pre-treated Water back to Onshore (Ballast Water) Supply Facility

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October 23 1989; revised November 27 1989; revised February 9 1990

Attachment 4

INTERNATIONAL CONVENTIONS ON THE CONTROL OF THE INTRODUCTION OF NON-NATIVE MARINE AND FRESHWATER ORGANISMS*

The Revised Code of Practice to Reduce the Risks for Adverse Effects Arising from Introductions and Transfer of Marine Species, by the International Council for the Exploration of the Sea (revised code adopted 1979);

Article 196 of the Convention of the Law of the Sea and Resolutions I-IV, Third United Nations Conference on the Law of the Sea, Eleventh Session (1982);

Recommendation No. R(84) 14 of the Committee of Ministers to Member States Concerning the Introduction of Non-Native Species, by the Council of Europe, Committee of Ministers (1984);

The EIFAC Code of Practice, by the European Inland Fisheries Advisory Commission of the Food and Agriculture Organization of the United Nations (1984); and

The IUCN Position Statement on Translocation of Living Organisms, by the International Union for Conservation of Nature and Natural Resources (1987).

*Excerpted from Table 3 of "Man's Role in Changing the Face of the Ocean: Biological Invasions and Implications for Conservation of Near-Shore Environments" by James T. Carlton in Conservation Biology, Volume 3, No. 3. September 1989: pp. 265-273.

Encrusted condenser tubes in a Monroe, Michigan, powerplant. Annual expenditure for keeping such tubes and intake pipes of drinking water plants free of zebra mussels is estimated to run into hundreds of millions of dollars.