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The Risk to Atlantic Canadian Waters of Unwanted Species Introductions Carried in Ships' Ballast

by

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ABSTRACT

The risk of harmful species introductions, carried by ships' ballast water, to receiving waters in the Laurentian Great Lakes, Australian coastal waters, and other vulnerable parts of the world is well documented. The risks to Atlantic Canada appear comparable. This report reviews existing information and its implications for the aquaculture and capture fisheries of Atlantic Canada. There are cogent reasons to suggest that the productive potential of Canadian Atlantic fisheries, and those of the Pacific Coast of Canada, are at risk. The potential for enduring harm needs to be assessed: first, for the Gulf of St. Lawrence backup exchange zone designated for Seaway traffic, and second, for Canadian east coast waters generally. Appropriate and affordable approaches to evaluating the risks are identified as guides to further action. It appears that the most economical, effective course may be to extend current voluntary guidelines for high-seas ballast exchange, now applicable to shipping destined for the Great Lakes, to include all shipping entering Canadian waters.

RESUME

Le risque d'introduction d'espèces dangereuses, provenant de l'eau de ballast, dans les eaux réceptrices des Grands Lacs, dans les eaux de la côte australienne et dans d'autres zones vulnérables est un fait attesté. Ce risque semble comparable dans la région canadienne de l'Atlantique. Dans le présent rapport, on examine l'information dont on dispose sur cette situation et ses conséquences sur l'aquiculture et la pêche dans le Canada atlantique. On a de bonnes raison de croire que le potentiel de productivité des pêches canadiennes dans la région de l'Atlantique, tout comme celui de la région canadienne du Pacifique, est menacé. Il convient d'évaluer les dangers; d'abord dans la zone de transfert du golfe du Saint-Laurent conçue pour le trafic de la voie navigable et, en second lieu, dans l'ensemble des eaux de la côte est du Canada. On présente ici des moyens raisonnables et adéquats d'évaluer les risques pour décider des mesures à prendre. Il semble que la solution la plus économique et la plus raisonnable réside dans l'élargissement de la ligne de conduite volontaire actuelle sur le transfert des eaux de ballast en haute mer. Il s'agirait d'étendre cette ligne de conduite, s'appliquant maintenant au trafic des Grands Lacs, à tous les navires qui pénètrent dans les eaux canadiennes.

Background

Inadvertent introduction of harmful species of organisms into Canadian waters is not a new phenomenon, but it continues to cause serious problems. Resource management agencies are currently concerned about three species, evidently carried in ships' ballast water, which have very recently become established in the Laurentian Great Lakes. One, first detected in 1988, the zebra mussel (Dreissena polymorpha), is already causing substantial economic losses in the lower lakes by fouling water intakes not designed to cope with its prolific habits. The ecological jury is still out on the other two species. The river ruffe (Gymneocephalus cernua), a small European species of coarse fish, is now well established in the vicinity of Duluth Harbour, with an outpost recently detected as far east as the Apostle Islands, and a predatory species of cladoceran (Bythotrephes cederstroemi) has spread throughout the Great Lakes, apparently from its introduction to the port of Sarnia. Watersheds throughout much of Canada and the U.S.A. are thought to be threatened, and the first invasions of inland lakes have already been reported.

Ballast water introductions of unwelcome species may be thought to be an old problem, and readers can be forgiven for thinking that everything harmful that could be introduced by this route, already has. In fact, global shipping technology and traffic patterns have changed dramatically in recent years, and correspondingly, so has the associated risk of unwanted species introductions. Ships are faster, larger, follow tightly scheduled patterns, more frequently enter Canadian waters in ballast, and new routings increasingly feature trans-equatorial and far-eastern origins, as well as ballast water sources of an increasingly unsavoury nature, such as the Baltic and Adriatic Seas. The Great Lakes are not the only areas to experience such problems; Australian marine ports, west coast ports in the U.S.A., and other localities around the world have also experienced numerous introductions in recent years, some of them harmful (Carlton 1985, 1989) . It is not at all unlikely that similarly unwelcome introductions may have occurred recently on either the east or west coasts of Canada; detection is unlikely because few qualified observers are in position to notice such changes, unless the effects become severe.

At the urging of the Great Lakes Fishery Commission, the Canadian Coast Guard, with the guidance of the representatives of several regulatory agencies, including DFO representatives from two Regions, devised voluntary interim guidelines for ballast water exchange on the high seas. The basic premise was that exchange with high-salinity water, containing mid-oceanic biota, would minimise the risks of viable introductions to freshwater ecosystems. Hastily established before the start of the 1989 Seaway shipping season, these guidelines reached promising compliance ratings early in the season, after an unavoidable time-lag before the guidelines could become well-known by the global shipping industry. As of Nov. 1989, preliminary Coast Guard data, based on reports from shipping, estimated an overall compliance rating of 83% for the shipping season to date. The Seaway closed in December, so the final compliance rate for 1989 will not differ much from the foregoing estimate.

An October 1989 meeting of essentially the same ad hoc advisory group was held at the Seaway Authority in St. Catherines to establish 1)

independent means to quantify compliance with the guidelines for the 1990 shipping season on the Great Lakes, and 2) to establish the effectiveness of the guidelines, in terms of their efficacy in preventing organisms thought to be potential colonizers from reaching the Great Lakes. Clearly, if voluntary ballast exchange on the high seas is not an adequate measure then more stringent procedures must be implemented. A subsequent meeting in Feb. 1990 explored the detailed requirements, and a further workshop in early March, jointly sponsored by the Great Lakes Fishery Commission and the International Joint Commission, ensured that procedures were established before the April start of the 1990 shipping season on the Great Lakes. Quite obviously, the various agencies involved are determined to resolve the problem, at least as it concerns the Great Lakes.

The Implications for Atlantic Canada

There is no reason to suppose that the ecosystems of Atlantic Canada are immune from similarly unwelcome introductions. There are at least three reasons to suppose Atlantic Canadian waters may be at risk:

1. Most immediately, the voluntary guidelines established for the protection of the Great Lakes entail a secondary ballast exchange zone within the Gulf of St. Lawrence, to be used by shipping which is unable to safely exchange ballast on the high seas. The area, encompassing the Laurentian Channel east of Gaspe, was selected because salinities remain reliably high in that sector, regardless of season, and more importantly, because depths (well in excess of 300 m.) are sufficient that residual transport offshore was supposed adequate to preclude significant settling by smaller organisms. Moreover, the deeper portions of the Gulf, including the Laurentian Channel, comprise a three-layered system, including an intermediate cold layer (Bugden 1981), which is presumed to make the viable colonization of unwelcome species quite unlikely.

The affected Regions of DFO consented to the measure for one year (1989) only, contingent that the associated risks be considered by the MEES subcommittee of CAFSAC. Although preliminary Coast Guard data to the end of Nov. 1989 show that the Gulf area was used for ballast exchange by less than 7% of shipping entering the Seaway in 1989, its availability is an important consideration in ensuring compliance with the voluntary guidelines, in the sense that a) shipping transiting the U.S. Atlantic coast may never reach waters that could be considered "high seas", and b), storm conditions may preclude safe high seas exchange of ballast, especially for ships carrying heavy deck cargo (e.g., many container ships). The apparent usage figure of 7% is a probable overestimate relative to the prior impact of Gulf ballast water exchange, because there is reason to suppose that identification of the Laurentian Channel exchange zone may have diverted ballast exchange in the Gulf from riskier areas, such as the upper estuary.

1.1. Aquaculture is a burgeoning industry in the Atlantic Provinces, and it relies primarily upon the sustained "purity" of inshore waters, which are easily at risk of contamination by parasites, pathogens, toxic dinoflagellates, etc. It is easy to conjecture that the introduction of unwanted species could occasion substantial risk to this new industry, both to the cultured stocks themselves and to their subsequent marketability, in

part because of occasional risks associated with human consumption, and perhaps more pervasively because of media attention that often generalizes beyond localized occurrences.

1.2. As experience in the Baltic Sea, Australian coastal marine systems, the Laurentian Great Lakes and elsewhere has shown, the potential for the introduction of disruptive species to Atlantic Canadian ecosystems by means of ballast water is not trivial. As conditions worsen in the world's coastal and estuarine environments, as they surely will for the foreseeable future, it will become increasingly necessary to ask ourselves what preventative measures we consider necessary.

In short, the question of what unwelcome species can be brought to Atlantic Canada by ships' ballast is a matter for serious consideration. Patterns of ballast import by the shipping industry have changed in recent years, bringing an attendant potential for harm that is already demonstrable in the Great Lakes. It remains to determine if a threat exists to Canada's coastal waters, and if so, what is the best means of prevention. For example, should Canada elect to ensure that all ballasted shipping be required to exchange ballast on the high seas before entering Canadian ports? If so, what measures are to be taken in the instance of shipping that cannot safely comply? There are substantial legal ramifications if that route is pursued. Is the current "backup" zone for ballast exchange in the Laurentian Channel safe, and in what context? What measures are to be taken for shipping which never transits the "high seas" en route to Canadian ports? In a more general context, it should not be overlooked that global transport of organisms via ballast water has implications in the context of global climatic warming. If environmental warming proceeds according to the commonly accepted scenarios, transfer of biota by ballast water promises a speedy and efficient process to accelerate the innoculation of transformed Canadian environments with new species that may prove harmful. At the moment, questions are more easily posed than secure answers ascertained. I address these questions in the remaining sections of this report.

The Issues to be Addressed in Atlantic Canada

In this Section, I consider, first of all, whether the temporarily designated ballast exchange zone in the Laurentian Channel is a reasonable choice. Following those considerations, I then evaluate the associated risks that may be posed to the aquaculture and natural marine fisheries of the Atlantic coast, (and by implication, the Pacific coast of Canada).

2. The Laurentian Channel Exchange Backup Zone.

Several considerations influenced the temporary selection of this portion of the Gulf as an exceptional backup zone for ballast exchange that could not otherwise be accomplished on the high seas. A primary imperative was the wish not to usurp the responsibility of a ship's master for the safety of his vessel. Further imperatives, of at least equal importance, were the requirements that the exchange zone not pose increased risk to the marine ecosystems of the Gulf of St. Lawrence, or of ecosystems downstream from that region. It was also necessary to consider the likelihood of compliance with the guidelines, and their effectiveness should compliance

be secured. Quite obviously, there is little point in establishing procedures that are ineffective, or are not followed, or which at best succeed in transferring a problem from one part of Canada to another (in this instance, from the Great Lakes to the Gulf of St. Lawrence and beyond).

The Gulf is a complex ecological system (e.g., de Lafontaine et al. 1990). As noted earlier, there are physical oceanographic reasons to suggest that the designated ballast exchange zone in the Laurentian Channel of the Gulf of St. Lawrence appears to offer a much safer alternative, as opposed to the transport and exchange of ballast water in the vicinity of the various ports of the Laurentian Great Lakes. Additionally, but to some unknown extent, identification of the Laurentian Channel has presumably directed ballast to that locale which may previously have been discharged in more vulnerable portions of the Gulf, the upper estuary in particular. Unfortunately, I know of no way to quantify or even document this supposition. Indeed, all of the foregoing comments are predicated essentially upon theoretical supposition; hard evidence is lacking.

There is no empirical evidence that would either support or refute the presumed safety of the continued use of the Laurentian Channel as a designated exchange zone. Quite obviously, this question should be addressed with appropriate scientific resources; the attendant financial resources for such a study must therefore be identified. This decision, to determine the effectiveness and safety of the Gulf exchange zone, is the most pressing issue to be decided, and the answer is not a matter to be entertained lightly. Apart from its importance to Gulf ecosystems, the conclusion will impact decisively upon all other measures, both those that are now implemented, and those that are being considered to protect Canadian aquatic resources from the impact of unwanted species introductions carried in ship's ballast water.

2.1 The Risk to Atlantic Canada.

The Great Lakes Fishery Commission and other agencies involved with the ballast water issue are not unmindful of the implications for Atlantic Canada. Understandably however, that is not their first priority. The evidence to date is reassuring; there have been no known recent instances of unwanted species introductions to Atlantic Canadian waters carried by ships' ballast water. The risk, however, appears high; Rao Durvasula, (DFO, Scotia-Fundy Region, personal communication) has for example flagged the unusual occurrence in Atlantic coastal waters of a number of dinoflagellate blooms in 1989, unobserved in earlier years, some of which could possibly be associated with ballast water discharges. There is also, for example, the unexplained failure to become established as yet of two species of barnacle, identified in a 1981 ballast water study commissioned by Environment Canada (Bio-Environmental Services Ltd. 1981) as potential colonizers of Atlantic Canada. There are many other possibilities. Viral Hemmorrhagic Septicemia, for example, thought to have been transported from Amsterdam via ballast water, recently devastated two fish hatcheries in the State of Washington, but there have been no known occurences as yet in Atlantic Canada. Time will tell, for these as for other potential colonizers.

3. Appraising the Risk.

Many possible approaches could be taken to appraising the risk to Atlantic aquatic ecosystems. Among the possibilities, four complementary lines of investigation seem prudent, potentially effective, and affordable. The following list is ordered with respect to increasing order of cost, information content, and difficulty. All of these are felt to comprise desirable measures.

3.1 Analysis of Eastern Canada Vehicle Traffic Services Zone (ECAREG) data, and compilation of associated shipping data, from an Atlantic perspective. The ECAREG acronym stands for a radio interrogation system maintained by the Canadian Coast Guard, which compiles basic data on ships entering Canadian jurisdiction. It would be a valuable first step to utilize the ECAREG data, together with associated data that should be readily obtainable from ships' agents locally, to compile a comprehensive profile of the types of ships, together with their ballasting sources, discharge patterns etc, for all commercial shipping that visits both east coast and Gulf ports. This much would at least establish the potential dimensions of the problem in Atlantic Canada.

An analysis of this kind could probably be satisfactorily achieved by a relatively senior undergraduate university student, working full-time in the summer months, and part-time through the balance of the year. The result would be a profile of the annual ballast water discharge cycle, focusing primarily on the port of Halifax, but with ancillary data for ports throughout Atlantic Canada.

3.2 A second prudent measure would be to ensure the reanalysis of the ballast water sampling initially conducted by Environment Canada (Bio-Environmental Services Ltd. 1981). This study examined the living biota entering the lower reaches of the Seaway in the ballast water sampled from foreign shipping during a portion of the shipping season. Although limited in scope and seasonal duration, it is the only known data base expressly relevant to ballast water imports to eastern Canada. The reanalysis should be conducted by a marine plankton expert, with the express intention of seeking implications for Atlantic Canada, as opposed to the earlier focus on implications for Seaway discharge ports. The whereabouts of the original samples featured in the report is now being sought by the ad hoc committee noted earlier; if located, the samples would doubtless be available for examination by an expert in marine species. Even if the samples cannot be located, a detailed scrutiny of the printed report by a marine expert might well reveal useful information.

3.3 An active program of ballast-water sampling, addressed to the needs of east coast questions, might be economically associated with the planned sampling program associated with protection of the Great Lakes ecosystems. The parameters for this study have not yet been established, although its formulation will be established by the time this report is written. Costs could therefore vary widely for an associated program. At the time of writing this report, it has yet to be determined where the Great Lakes sampling program will be established, although it appears virtually certain that such a program will be in place for the 1990 Seaway shipping season. If sampling is to begin at the Seaway entrance, it is reasonable to suppose

that some possibility exists for joint cooperation. If not, an alternative is to consider some form of contract with experts at, say, Laval University.

3.4 A further consideration is to recognize the merits of an independent sampling program, addressed explicitly to the perceived needs of Atlantic Canada. Failing the viability of 3.3 above, it may be the only alternative. On the other hand, it may be judged to comprise an essential supplement. A pilot study, perhaps focusing initially upon the Halifax port region, where container ship arrivals are frequent and easily sampled, could be augmented with sampling protocols for Gulf and other Atlantic destinations. Apart from active life forms such as would be liable to be pumped with normal ballast discharge, the study should also examine the presence of viable resting stages (cysts, spores, etc.) contained in the sediments of ballast tanks, which are most likely to be dumped, and available for sampling, when ballast tanks are opened at refit, (i.e., in drydock).

All of the foregoing suggestions, or some affordable mix of these as resources warrant, are strongly recommended for action. The problem will not wait; neither will it go away. The prudent alternative is to formulate an appropriate response to a well-defined problem. Additional dollar resources of approximately $100K will be required to cover the cost of the preliminary investigations identified above; this assumes that part of the work will be undertaken by contract and/or student assistance, and also that project planning, management, etc. will be covered in house. A detailed budget is contingent upon consultations with others, both within DFO and with external agencies.

4. The Responses of Other Jurisdictions.

By way of providing useful context, it may be helpful to set the Canadian response to ballast water introductions into a global context. Given that a general problem prevails that is not unique to Canada, there might be reason to suppose that the responses of other national jurisdictions could provide useful guidance. In fact, only two nations have made legislative responses, to my knowledge.

Australia, smarting under the impact of unwanted introductions of Gymnodinium, which severely damaged the associated aquaculture industry, enacted some very tough regulations governing ballast discharge. In essence, shipping would not be allowed to enter Australian waters without having exchanged ballast on the high seas. The alternative was to make it incumbent on the ship (which had not made a high seas ballast exchange) to either retire outside the Australian territorial limit to do so, or to submit to scientific examination of its ballast which would ensure its safety for discharge. The regulations were enacted in 1989, but because of a storm of protest from the shipping industry, which would have to bear the substantial associated costs, they were suspended the next day. In February, 1990, Australia adopted a voluntary ballast exchange program, similar to the Canadian guidelines. It remains to be seen whether the default system will be effective.

Experience in the U.S.A. has been much the same, but of somewhat more

recent venue. The U.S. Congress is currently entertaining three bills addressed to this issue, two in the House and one in the Senate. Of these, by far the toughest is the bill proposed by Senator John Glenn. Basically, it is a zebra mussel bill, but its effect is to encompass all species that may be inadvertently introduced. Without dwelling on the details, the net effect is to introduce a tough set of regulations, as opposed to voluntary guidelines, governing the conduct of foreign shipping entering U.S. waters. In outline, the thrust of the proposed bill is much the same as was initially enacted in Australia. It remains to be seen if the bill proposed by Senator Glenn will encounter the same difficulties, effective opposition from the shipping industry in particular, as was the Australian experience.

In the light of these regulatory experiences, the Canadian approach of offering voluntary guidelines, limited at present only to traffic destined to enter the Seaway, may be thought to be weak. On the other hand, it is possible that the Canadian approach will ensure compliance that would not otherwise be available. The next year or two will establish the difference, and if voluntary guidelines are shown to be ineffective it will not be too late to then move toward the stiffer regulatory approaches that have been embodied in the initial Australian and U.S. approaches to the problem. There will be much to be learned from the experiences of other national jurisdictions.

5. Recommendations.

Based on the foregoing considerations, I offer the following recommendations for action.

5.1. Extend the use of the Laurentian Channel exceptional discharge zone for the 1990 Seaway shipping season. At present, there are no reasonable grounds to do otherwise, and as noted earlier, there are reasons to suspect that this represents an improvement over earlier practices with respect to the risk of species introductions to the Gulf as a whole.

5.2. Design and implement programs, such as described in section 3. above, to evaluate the problem from an Atlantic Canada perspective. Cooperation with agencies concerned with the Great Lakes problem would obviously be useful in pursuing this end.

5.3. Establish formal procedures for direct consulatation on these matters between CAFSAC and the agencies currently involved with the Great Lakes manifestation of the ballast water problem. It is neither prudent nor efficient to suppose that the ecosystems of Atlantic Canada exist in a vacuum, unaffected by adjacent ecosystems. DFO should establish a leadership role in this context.

5.4 Establish a formal procedure to assess the possible need to extend ballast water discharge guidelines to include all shipping entering Canadian waters. Relevant issues to consider include: continued retention of the Laurentian Channel as a backup zone when safe exchange is not otherwise possible, the possibility that ballast from regions perceived as particularly risky (e.g., the Baltic or Adriatic Seas?) should be accorded special scrutiny, and are voluntary guidelines likely to provide a satisfactory measure of protection, or is there a need to implement

mandatory regulations?

5.5. Recognizing that the issues raised here are not unique to the east coast, means should be established to inform the relevant Pacific Coast authorities of what is being done. Apart from our obvious interest in protecting the aquatic ecosystems of Canada, national consultations must of course precede any venture into obligatory regulations, should that need be perceived.

6. Action to date by CAFSAC (as of 27 May, 1990).

6.1 As a result of a teleconference by the members of the MEES subcommittee of CAFSAC, on March 14, 1990, several decisions were reached. First, a recommendation was made that the use of the Gulf of St. Lawrence backup exchange zone be authorized for a further year, (i.e., the 1990 Seaway shipping season), pending further information, and with the following additional restraints:

6.2 The change to present practices required by CAFSAC for continued use of the designated exchange zone in the Gulf of St. Lawrence is that it be restricted to the area between 61 and 63 degrees west longitude, in waters to exceed 300 metres depth. This has the effect of reducing the risk of a) advection of ballast discharge by the Gaspe Current over the Magdalen Shallows, and b) entrainment of ballast discharge in the residual current exiting Cabot Strait and flowing southerly over the Scotian Shelf. These additional provisions are based upon information (Gregory et al. 1989; Gregory and Smith 1988) that was not available at the time the 1989 Seaway Guidelines were drafted.

6.3 On advice from the MEES subcommittee, CAFSAC accepted the position outlined in 6.2 above.

6.4 On instruction from the chair of MEES, following acceptance by CAFSAC, I transmitted the required changes to the guidelines to the relevant representative of the Canadian Coast Guard (April 3, 1990).

7. Remaining Action to be Considered.

7.1 Continued use of the Gulf of St. Lawrence backup zone for ballast exchange will need to be reconsidered again prior to the start of the 1991 Seaway shipping season. It would be advisable if such decisions could be made sufficiently in advance of the shipping season as to allow the Coast Guard to prepare printed forms for ship's masters, etc. To state the matter frankly, DFO has not to this point represented itself as an agency that deals with matters of this kind in a prompt and efficient manner.

7.2 The problem of unwanted species introductions via ballast water will not go away. I urge that an expert committee be struck by CAFSAC to deal with this problem, especially the recommendations set out for action in section 3 above.

7.4 Apart from the immediacy of current concerns occasioned by the risk of species introductions, it should not be overlooked that the popularly perceived threat of global climatic warming has numerous implications for

the survival of introduced species. To some unknown degree, the rapid transport of potential colonizing species is a threat to be considered. This dimension should not escape notice by DFO committees charged with evaluating the impact on fisheries of global climatic warming.

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