Shipping Industry Perspectives

Ballast Water Management:

A Marine Industry Perspective

ANJUNA LANGEVIN
Shipping Federation of Canada
300 Rue St Sacrement, Bureau 326
Montreal, QC H2Y 1X4 Canada
http://www.shipfed.ca/

INTRODUCTION

The Shipping Federation of Canada is an association of shipowners, commercial operators and agents representing 90% of ocean traffic calling at East Coast, St. Lawrence and Great Lakes ports. The Federation has been an active player in the implementation of ballast water management guidelines and regulations in both Canada and the U.S.

THE ECONOMIC IMPORTANCE OF THE MARINE INDUSTRY

According to statistics provided by Transport Canada, the value of Canada-U.S. marine trade in 2002 was $13.3 billion, while the value of Canada's international marine trade was a staggering $98.3 billion. Of the 61.9 million tons in total marine shipments recorded in 2002, more than half was attributable to cargo traffic along the east coast. More specifically, traffic moving from Canada's Atlantic coast to the U.S. Atlantic coast totaled 33.6 million tons, traffic moving from the U.S. Atlantic coast to the Canadian Atlantic coast totaled 3.8 million tons, and traffic moving from the St. Lawrence to the U.S. Atlantic coast totaled 3.6 million tons.

The marine industry creates 9,500 direct jobs in Atlantic Canada and 26,500 jobs in the Quebec region. Moreover, shipping is essential to the development of a number of major industries, including iron ore and steel, oil (offshore and refineries), agricultural products, mineral and concentrates, and wood and paper products.

MAIN AREAS OF CONCERN BASED ON TRADES

U.S. Coast Guard statistics for the Great Lakes for 2000 indicate that overseas traders reported that they were able to exchange their ballast water at sea in 95 to 97 percent of cases. Recent samplings and biological analysis from the Great Lakes Institute for Environmental Research (Reid et al. 2002) confirm that the actual compliance rate is in line with the reports received. Container, ro-ro, and cruise ships carry very small quantities of ballast water and often do not discharge it at all, while a few small tankers operating in liner services are able to discharge all their ballast (oiled ballast) at the refinery. Coastal traders from South and Central American and the southern U.S. are usually in partial ballast and have, in most cases, sufficient time to conduct an exchange before entering the EEZ. Some find it necessary to top off in 2-3 East Coast ports en route. Thus, bulk carriers (tankers and dry bulk carriers) engaged in coastal trades that do not have a return cargo on their regular routes discharge the major amount of remaining unexchanged ballast water into the East coast ports at this point.

HOW MUCH WATER ARE WE TALKING ABOUT AND WHERE?

Estimates based on the main cargo trades indicate that approximately 0.9 to 1.1 million tons of coastal ballast water are discharged in the Laurentian Channel annually, mainly from iron ore carriers bound for Port Cartier and Sept-Isles. In the Atlantic region, between 9.3 and 9.8 million tons of coastal ballast water are discharged annually, mainly from tankers bound for Come by Chance and Halifax, and from non-mineral bulk carriers bound for ports in the Bay of Fundy and St. John.

TECHNICAL CONSTRAINTS OF TREATMENT SYSTEMS

The ideal treatment system would meet standards that are accepted globally, or in the least, that are accepted in the main countries in which vessels trade. The ideal treatment system would also be safe, easy to install, time-efficient, simple for the crew to operate, and non-hazardous.

Current Preventative Measures and Costs

The annual cost of exchanging ballast water at sea for a dry bulk carrier en route to the U.S. is $2.09 million (or $3,875 per vessel) for a Handymax and $1.1 million (or $7,830 per vessel) for a Panamax. In the tanker trades, the cost increases to $4.64 million (or $2,622 per vessel) for a Handymax, and $2.74 million (or $3,982 per vessel) for a Panamax. This does not include the costs associated with approved ballast water management plans, hull fatigue and increased safety concerns.

The shipping industry has been highly proactive on the ballast water issue. For example, the Shipping Federation played the lead role in developing the Code of Best Practices for Ballast Water Management (see Appendix), and continues to raise awareness through information sessions for industry and the publication of circular letters, reports and other written material. A number of shipping companies also participate in research, and take part in on-board trials and permanent installations of treatment systems.

Coastal Traders

Coastal vessels are restricted by their trade limitations to transits within the EEZ. Full exchange for such vessel takes 24 to 36 hours, and deviating to 200 nautical miles could take longer then the actual voyages in which they are engaged. One of the most extreme examples of this would occur with a ship in full ballast condition undertaking a voyage from New York to Point Tupper (approximately 43 hours in length). Such a vessel would add 40 extra hours to its voyage in order to do an exchange at 200 nautical miles offshore; 36 extra hours to do an exchange at a depth of 2000 metres, and 20 extra hours to do an exchange 100 nautical miles offshore. For the same vessel transiting from New York to Placentia Bay (a voyage of approximately 80 hours), the extra voyage times would be 10 hours, two hours, and 0 hours, respectively.

Meanwhile, a dry bulk carrier in full ballast condition engaged in a voyage from Savannah to Belledune (approximately 130 hours in length), would add 21 extra hours to do an exchange at 200 nautical miles offshore and 12 extra hours to do an exchange 100 nautical miles offshore. If that same vessel were traveling from Norfolk to Halifax, it would add 23 hours to its voyage for a 200 mile exchange and 14 hours for a 100 mile exchange.

As illustrated in Table 1 by these examples, the largest deviations are for vessels originating from U.S. East Coast ports and bound for Nova Scotia, New Brunswick or the Gulf, with the major impact from deviations occurring when vessels are in full ballast and transiting short distances.

Cost of Deviations

The financial impact of deviations can be extremely high. For tankers, the hourly cost of deviation amounts to $1,000 (USD) in additional time charter fees and $300 in additional fuel fees. Thus, a tanker that incurs a 20-hour deviation in a given voyage will incur an additional cost of $26,000 for that voyage only. For a tanker operator doing 200 voyages per year, the annual costs of deviation would amount to a substantial $5.2 million.

In a market where the overall profit margin per voyage is often less than $10,000 USD, it is quite possible for a company to change ports due to a cost differential of less than $2,000 USD per call. There exists, therefore, a risk that deviations could cause some ports to become less competitive and potentially lose long-term contracts. Ultimately, of course, any increase in the cost of transportation will be passed on to the consumer.

Commercial Considerations

It is important to remember that deep-sea ships are engaged in international trades, subject

Table 1. Summary of deviations from route to meet 200nm, 2000m depth and 100 nm for tankers and bulk carriers based on two different routes. Daily additional costs for tanks is approximates $1000 for time charter and $300 for fuel for each hour; data not provided for bulk carriers.

Case 1: Tanker (full ballast condition) Time to exchange=24 hrs Distance=360 nm	Approximate Cost (time charter and extra fuel)
Deviations	
Route A – New York to Point Tupper (approx. 43 hrs)	$26,000 USD
200 nm	+ 40 hrs
2000 m depth	+ 36 hrs
100 nm	+ 20 hrs
Route B - New York to Placentia Bay (approx. 80 hrs)	
200 nm	+ 10 hrs
2000 m depth	+ 2 hrs
100 nm	none
Case 2: Bulk carrier (full ballast condition)[1,2] Time to exchange=36 hrs Distance=504 nm	
Deviations	
Route A - Savannah to Belledune (approx. 130 hrs)	
200 nm	+ 21 hrs
100 nm	+ 12 hrs
Route B - Norfolk to Halifax	
200 nm	+ 23 hrs
100 nm	+ 14 hrs
[1]Bigger deviations if bound for NS, NB or the Gulf [2]Major impact from deviations occur in full ballast, when transiting short distances	

to international and multi-national standards and regulations. Given the strong competition that exists among the various routes by which a given cargo can travel, the imposition of a new requirement in one area could result in cargo transferred to other shipping routes or transported by other modes.

An international or national standard for ballast water treatment must still be defined. However, as far as individual ships are concerned, an acceptable level of investment will be closely linked to the remaining lifetime of a given ship. Additionally, some types of treatment systems will be inherently better suited to certain types of ships or trades.

Conclusion

Research and on-board trials of ballast water treatment systems must continue to be pursued, as must the provision of incentives for industry participation in such initiatives. In the meantime, however, it is important that coastal traders be provided with an alternative to ocean exchange. From our perspective, the ideal features of an alternative exchange zone should include: (a) 50 nautical miles or less from shore; (b) more than 500 nautical miles long; (c) applies for coastwise ships with ballast water intake originating south of the Chesapeake Bay. And finally, it is absolutely imperative that national regulations are in line with developments at the international level.

Literature Cited

Reid, D., H.J. MacIsaac, M. Dochoda, J. Gannon, M. Burrows and J. Hartig. 2002. Research and Management Priorities for Invasive Species in the Great Lakes. Prepared for: International Association of Great Lakes Researchers. 17 pp.

Maritime Industry Approaches to Reduction of Aquatic Nuisance Species: Actions and Activities

Kathy J. Metcalf
Maritime Affairs
Chamber of Shipping of America
1730 M Street, NW Suite 407
Washington, DC 20036
kmetcalf@knowships.org

Introduction

As an employee of a trade association which represents owners and operators of all ship types flying both U.S. and non-U.S. flags, I rarely attend a conference in which the concept of "polluter pays" does not arise. Since the validity of this concept and the deliberations necessary to determine what is pollution and who is the polluter in a given scenario could be the sole subject of a lengthy conference, I do not pretend to encompass this debate in this paper. However, as related to any scenario, the key to solutions for today's environmental challenges is to ensure that whomever is paying for whatever type of pollution is actually paying for something that benefits the marine environment while preserving the necessary flow of international commerce. As related to the control and mitigation of the impacts of aquatic nuisance species, this requires a clear definition of the problem, an understanding of the commercial industry to be regulated, and a collaborative effort to identify and quantify technologies that will achieve real results in an environmentally, operationally and economically viable manner.

Irregardless of our affiliations or backgrounds, when we discuss aquatic nuisance species management and the shipping industry, we are all tied to a single set of train tracks on which a number of different trains are bearing down on us at the same time. A number of initiatives, completed or proposed, at the international, national, sub-national (regional) and local levels seek to regulate ballast water discharges from ships; most if not all regulations are inconsistent one with the other. In discussing what part industry is playing, one thing is clear: this problem with all its scientific, technological, political and legal complexities is not going to be solved by any one of the interested parties. It will be solved only as a collaborative effort among the shipping industry, ports, environmental groups, technology developers and governments at all levels. Such collaborative efforts have resulted in real progress at the International Maritime Organization (IMO), which will likely finalize an international ballast water treaty in February 2004, and within the U.S. legislative and regulatory process at some time in the near future.

Specific Industry Activities

My organization, along with a number of national and international shipowner organizations have been participants in the IMO deliberations for a number of years both as members of national delegations and as non-governmental members of the IMO. In addition, my organization has participated in the deliberations of the U.S. Invasive Species Advisory Council, several U.S. Coast Guard subcommittees addressing technology and standards development associated with ballast water management, a U.S. Environmental Protection Agency sponsored group which is attempting to develop and finalize a standardized test protocol for measuring the effectiveness of various ballast water treatment technologies, and a science and technology development based grant program funded by the U.S. government. In addition, we have carried out numerous briefings to members of the U.S. Congress, their staffs and other governmental agencies. But perhaps most importantly has been our work within the industry in educating our colleagues that there is a real problem that needs fixing. We have also served as an information clearinghouse which a number of technology developers are using to get their message out to our members, their potential customers. We are long past the point of arguing that there is no problem with ballast water discharges from ships. Briefing our industry colleagues on the continuing saga of the zebra mussel, the Asian carp and the snakehead, replete with all the gory teeth-filled photographs we can muster has made our educational mission much easier. But the solution remains far less certain and far more challenging.

Costs, Concerns and Perceived Risks Associated with Ballast Water Management

Accepting the premise that ballast water management is the only viable legally recognized alternative for ballast water management to date is not necessarily to accept its permanence as a means for compliance. Large numbers of entrepreneurs are in various stages of developing and testing a number of ballast water treatment technologies utilizing ozone, physical separation, filtration, ultraviolet, heat, chemical biocides or some combination of these methods. In order to accurately assess the scientific and economic viability of these alternative ballast water treatment methods they need to be compared to the same implementation viability standards as ballast water exchange.

For example, with exchange comes a number of costs and concerns with its implementation including increased labor costs, crew safety issues associated with flushing large volumes of water over occupied main decks in mid-ocean, vessel trim and stability, energy costs and environmental impacts associated with increased use of fuels to drive the pumping systems, additional maintenance requirements and the potential diversion costs for vessels which do not transit mid-ocean areas for sufficient time to carry out the exchange during the normal transit (Table 1). Countering these costs and concerns are those associated with treatment systems which include the costs associated with experimental shipboard programs and the certification process, initial capital outlay for systems (estimated at a minimum of USD $150,000 with an already documented installation and test program exceeding USD $5,000,000), ongoing operating and maintenance costs (including treatment agents in some cases) and the potential for multiple capital outlays if future legal requirements require existing ships to continue to retrofit new systems when new standards are promulgated.

Considering these costs and concerns, each and every shipowner will be required to compare the impacts of exchange versus treatment, including integration of the uncertain legal structure in which requirements will be enforced to determine the "best" method of compliance for their particular ship and voyage parameters. When all is said and done, assuming that at some point in time exchange per se will not be an acceptable method of compliance, a treatment system that costs one million U.S. dollars may be quite affordable if, in the absence of that system, the vessel is required to add 3 days diversion to every 4 week period so as to conduct a "compliant" mid-ocean exchange, or worse yet is refused entry into its destination port. Factoring a very conservative charter rate of $30,000 per day and assuming a need for diversion, the vessel's treatment system would pay for itself in less than one calendar year. Unfortunately, this calculus is significantly impacted if that same vessel would require retrofitting with new systems every time the standard is made more stringent.

Table 1: Ship board costs, in USD, for ballast water exchange, treatment and experimental treatments.

Labor	Exchange	Treatment[1]	Experimental
Crew safety	No Data	Training, USCG	Training, USCG
Fuel to drive pumps, trim stability	Some costs incorporated into additional maintenance	Additional costs associated with equipment	Fuel cost associated with equipment
Maintenance	No Data	No Data	No Data monitoring
Diversion	$25-40 K per day	Not applicable	Not applicable
Capital costs	Not applicable	$150 K minimum	$250 K minimum
Retrofitting	Not applicable	No data	No data
[1]assumed approved			

Finally, the policy and political risks associated with management of ballast water from ships is a critical element in the calculations. These risks include the potential for inconsistency among international, national and sub-national programs which require multiple compliance strategies for each program (or in the worst possible case, make compliance with all impossible due to the inconsistency of one), inadequate incentive programs for the early implementation of experimental shipboard testing programs, and the potential for "continuous" retrofit for existing ships when final standards are changed over time.

The Bottom Line

Based on the considerations discussed and the inconsistencies among international and national programs detailed in my presentation, the following recommendations need to be implemented as soon as reasonably possible:

- Create a robust international program for ballast water management aboard vessels.
- Such international program should be of sufficient stringency to obviate the need for national/sub-national programs.
- Where nations do not believe the international program is sufficiently stringent, more stringent provisions may be acceptable as long as they are defined within the framework of the international convention.
- The international and national programs must contain vigorous reporting requirements for vessels so that much needed data is collected for ballast water research.
- International and national programs should focus on treatment as the long-term compliance method; however, exchange should be permitted where it meets the performance standards to which the treatment systems are subject.
- International and national programs should support the identification of alternate ballast water exchange zones as a short term compliance method.
- International and national programs must include the critical elements of performance standards, criteria for experimental shipboard testing programs, creation of standardized testing protocols and adequate grandfathering provisions to promote early participation and compliance with both the experimental program and the final performance standard.

Risk Assessment

Risk Assessment Systems for Ballast Water

Andrea Locke
Fisheries & Oceans Canada
Gulf Fisheries Centre
P.O. Box 5030
Moncton, New Brunswick
E1C 9B6, Canada
LockeA@dfo-mpo.gc.ca

Introduction

The overall goal of this workshop, the identification of "safe zones" in which to conduct ballast water exchanges or releases, requires that we conduct some form of risk assessment of ballast water that is transported within our Atlantic Canada/northeastern U.S. waters. Risk assessment, whether formally stated or implicit, is associated with every recommendation or decision on the management of ballast water. Therefore, it is useful to review the process of risk assessment, and the approaches that have been taken to risk assessment of ballast water.

My objectives in this talk are to provide a general introduction to the science of risk assessment, an overview of the formalized systems that have been or are now being developed for risk assessment of ballast water worldwide, and a summary of existing information (e.g., biology, oceanography, vessel traffic patterns, methodologies) that is relevant to risk assessments of ballast water in Atlantic Canada and the northeastern USA. Two examples from the Laurentian Channel will be used to illustrate how different approaches to risk assessment can result in highly divergent conclusions.

General Principles of Risk Assessment

What is "risk"?

The term "risk" expresses the chance of an undesirable event occurring as a result of some activity or action. In the context of risk assessment of ballast water, risk may be defined as "the likelihood of undesired/unwanted invasive species establishing and causing biological, economical, safety-related or social damage in areas where the species did not occur naturally/historically" (Haugom et al. 2002).

What is risk assessment?

The United States Environmental Protection Agency defines risk assessment as "a process for organizing and analyzing data, information, assumptions, and uncertainties to evaluate the likelihood of adverse ecological effects". The rationale for undertaking risk assessment is that it "provides a critical element for environmental decision making by giving risk managers an approach for considering scientific information along with the other factors they need to consider (e.g., social, legal, political or economic) in selecting a course of action" (US EPA 1998).

Why use risk assessment for ballast water?

Ballast water management can be undertaken as either a selective (risk-based) or a blanket (all ships) procedure. Regardless of which approach is selected, some form of initial risk assessment (either formal or informal) must have been conducted in order to determine if management is warranted.

Following the initial decision to undertake ballast water management, the blanket approach requires that the same management practices be undertaken by all ships. No further risk assessment is undertaken. For a regulatory agency, the blanket policy approach is simpler and less labour-intensive, requiring no ongoing investment in risk assessment. The disadvantage of this approach, however, is that it may impose unnecessary restrictions on low-risk ships (higher costs to the shipping industry), or that the requirements may be insufficient for high-risk ships (higher costs to the environment).

Risk-based management permits much more flexibility, allowing for specific restrictions or requirements to be imposed on individual ships, at the level warranted by the degree of risk associated with that ship. The goal is to make management more cost-efficient, by achieving the maximum risk reduction per unit cost. A disadvantage of this approach is that it is labour- and data-intensive for the managing agency, both to develop, and to use on an ongoing basis.

How many countries use risk assessment vs. blanket policies for ongoing management?

Strategies have been adopted by a number of countries for management of foreign ballast water. With the exception of New Zealand and Australia, management applies only to commercial vessels which originate from outside the Exclusive Economic Zone (EEZ). I have separated the strategies into five major categories. The lists of countries currently following each strategy are based on information obtained from the Intertanko web site in October 2003 (www.intertanko.com/tankerfacts/environmental/ballast/ballastreq.htm).

(1) Voluntary blanket ballast water management Formerly, this was the approach used by Canada. I am not aware of any country that publishes a ballast water management strategy for the use of mariners, and continues to use a solely voluntary approach.

(2) Mix of voluntary and mandatory blanket policies
- Canada (mandatory in Vancouver, voluntary elsewhere as of October 2003 but with a regulatory reform underway which is expected to expand the area of mandatory ballast water management).
- USA (mandatory in Great Lakes, Hudson River, California, and Valdez AL, again with the expectation that a regulatory reform now underway will result in a wider application of this approach).
- Argentina (mandatory policy applies only to ships coming from locations with cholera)
- Great Britain (mandatory in the port of Scapa Flow, Orkney Islands)

(3) Mandatory blanket management
- Chile (applies to all shipping from outside EEZ)
- Israel (applies to all shipping from outside EEZ)
- New Zealand (applies to all shipping, including that which originates within the EEZ)

(4) Risk-based management under development
- Norway (EMBLA project)

(5) Risk-based management in use
- Australia (applies to all ships entering Australian waters from outside the EEZ, and to ships entering waters of the state of Victoria, including vessels originating from other Australian states).

What are the features of an effective risk assessment?

Almost every document on risk assessment discusses the characteristics that contribute to the development of an effective procedure. The features which are listed below are based on the recommendations of Hayes (1998a), Haugom et al. (2002), and US EPA (1998).

(1) The assessment should be quantitative, with measurable endpoints (quantifying the likelihood of occurrence of the "undesirable event", which might be inoculation of an exotic species, or its establishment, economic impact, etc.). Subjective risk-assessment perceptions are seen as the most serious obstacle of risk management. Low probability/high consequence events tend to be overestimated, and high probability/low consequence events tend to be underestimated (WHO CEMP 1992).

(2)Uncertainty in the estimate of risk is clearly described.

(3) Invasion success is determined as a function of both species-specific and site-specific attributes (i.e., an invasion cannot be successful unless a species is available to be picked up and transported by the vector (ballast water) and deposited into an appropriate receiving environment).

(4) The assessment may be improved as groundtruthing progresses, as an iterative process.

(5) It is essential that the risk assessment be understandable to stakeholders.

Risk Assessment Systems for Ballast Water

Currently, three formalized risk assessment systems exist or are under development in the international ballast water community.

- Australian Decision Support System
- Environmental Risk Management System for Ballast Water Assessment
- GloBallast Risk Assessment System

The Australian Ballast Water Decision Support System (DSS)

The Australian DSS was developed at CRIMP (Centre for Research on Introduced Marine Pests), from 1993 to 2001 (Hayes 1997, 1998a, 1998b; Hayes and Hewitt 1998, 2000; Hewitt and Hayes 2002). It has been in use by the Australian Quarantine Inspection Service since July 2001.

Import Risk Assessment and Quantitative Risk Assessment paradigms, familiar to Australian scientists from earlier screening procedures of the quarantine service, form the basic framework of the ballast water DSS. The steps in the Quantitative Risk Assessment paradigm were summarized by Hayes (1998a) as:

(1) Identify potential undesirable events (hazards)
(2) Analyse their frequency / likelihood of occurrence
(3) Assess potential effects or impacts
(4) Calculate risk, expressed as a product of the probability of an undesired event and its consequences
(5) Examine the significance of the results; this may be in the wider context of other social, economic or political concerns.

The risk assessment is based on a target list of marine pests to be avoided, so it is species-specific but not site-specific (unless all waters of Australia are considered as a single site). The endpoint of the assessment is the introduction and survival of non-native species.

A quantitative risk assessment is provided for each tank of the vessel. High-risk vessels are required to exchange or treat ballast water, or retain it on board.

Environmental Risk Management System for Ballast Water Assessment (EMBLA)

The EMBLA decision support system was developed by DNV (Det Norske Veritas), starting in 1998 (research.dnv.com/marmil/ballast/) (Haugom et al. 2002). The system was to have been completed by 2002 but there was no indication of its present status on the project web site in October 2003. The program was funded by the Norwegian and other Nordic governments and shipping interests. The project was also coordinated with the EU Concerned Action Group on Ballast Water. The questions addressed were:

- Which phase(s) of the ballast water transfer process is critical to the risk level?
- Where is it most efficient to introduce risk control measures?

Data and analytical requirements of the system include:

- Development of a Ballast Water Transfer Atlas (a summary of biogeographic compatibility, see Figure 1)
- Lists of risky species
- Determination of the environmental compatibility of risky species with the recipient port
- Hazard analysis to determine the probability of survival of viable populations of hazard species through the process of ballasting/transfer/de-ballasting

From these data inputs, the DSS estimates ecological, economic and safety impacts and determines whether these are at an acceptable level. If not, a reassessment can be run, taking into account the effect of different risk-reducing measures, and resulting in recommendations for ballast water treatment (Figure 2).

The GloBallast Risk Assessment System

The GloBallast (Global Ballast Water Management Programme) risk assessment system was supported by GEF/UNDP/IMO (Global Environment Facility/ United Nations Development Programme / International Maritime Organization). Pilot systems have been or are still in development in Brazil, China, India, Iran, South Africa, and Ukraine (globallast.imo.org). Development began in 2000 and is

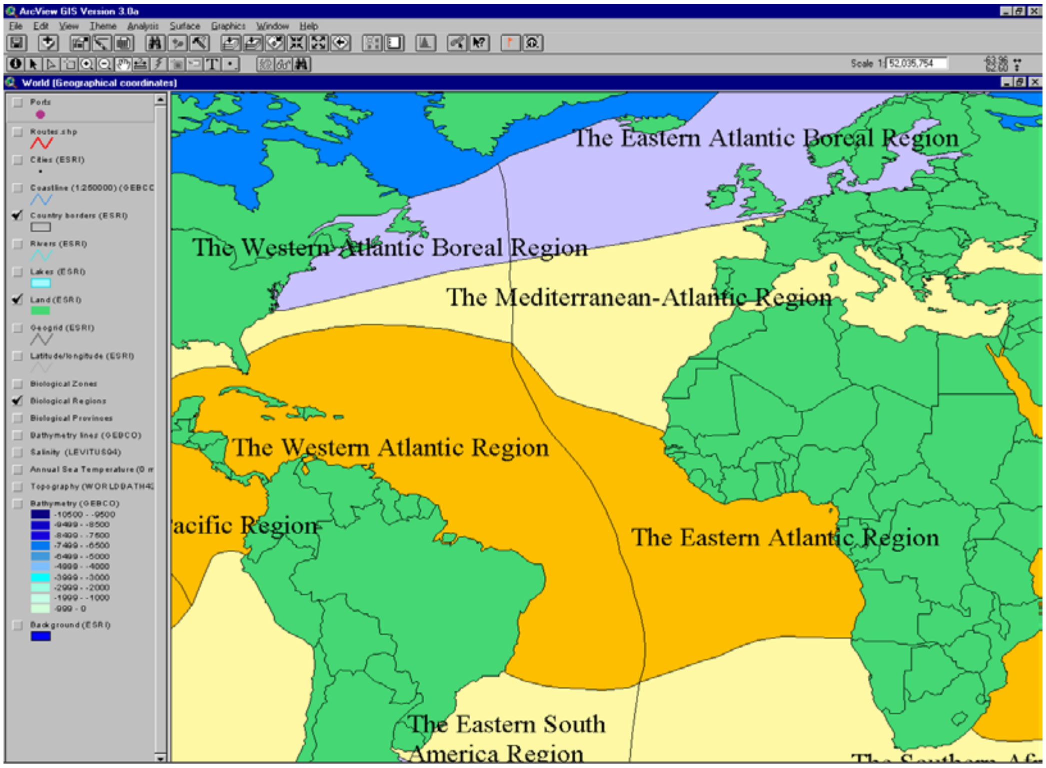

Figure 1. Biogeographic regions identified in EMBLA's Ballast Water Transfer Atlas. Source: EMBLA web site (see text).

scheduled to continue until 2004. The final project report for the Iranian site has recently been published, and explains the methodology in detail (Clarke et al. 2003).

The assessment is semi-quantitative. It identifies the riskiest trading routes for each recipient site, but does not identify the specific risk associated with an individual ballast tank. The major question that is addressed is: "Which ballast water sources and destinations need more vessel monitoring and management?"

The general approach has many parallels with that of EMBLA (Figure 3), and the data and analytical requirements are similar:

- Environmental matching
- Lists of risky species
- Ship-based risk factors (days in transit, tank size).

Elements of Risk Assessment in our Region

There have been no risk assessments of ballast water in the Atlantic Canada/northeastern US region, that come close to meeting the requirements of the formalized risk assessment protocols described above. Several studies (listed below) fulfill some requirements of risk assessment, but generally utilize approaches that are very different from those of the Australian, EMBLA, or GloBallast protocols.

From the three international examples in the preceding section, it is possible to identify some data requirements that are essential components of risk assessment. At a minimum, these common data requirements include: a list of risky species to be excluded from the recipient area, data on the biota and environmental conditions of both the donor and recipient areas (required for environmental matching), and information about the voyage (duration, origin, destination, type of ballast water management, etc.). In order to identify suitable exchange zones, it is further necessary to have understand the physical oceanography of the region. Many elements that could be used as the initial inputs to such a risk assessment do currently exist in our area. In the following list, I have included only reports

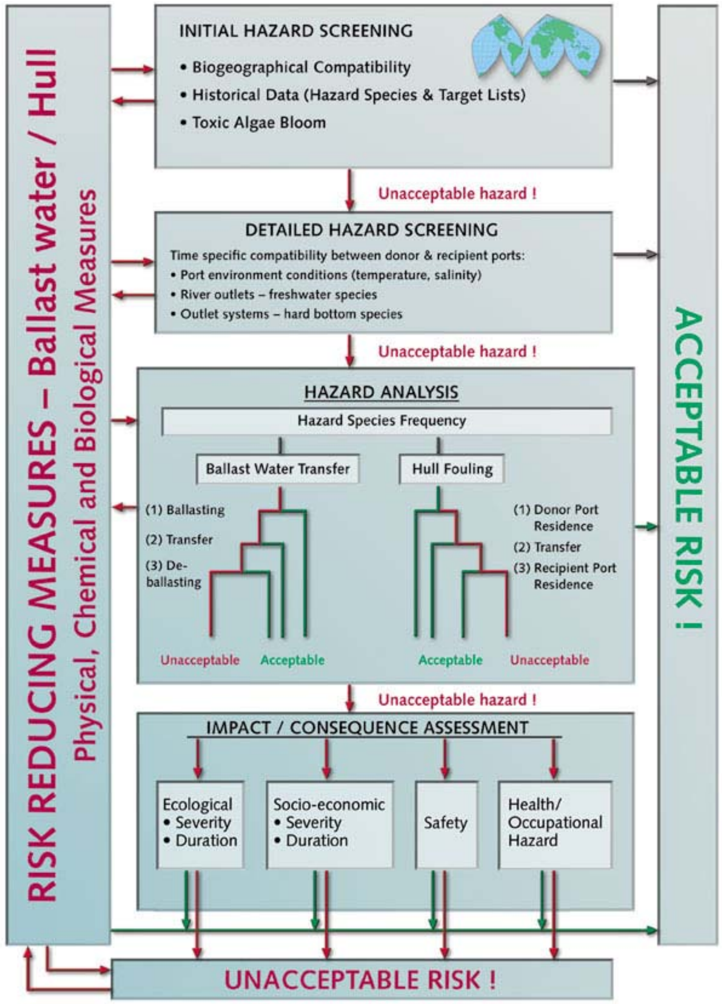

Figure 2. A flowchart of the major components of the EMBLA ballast water management system. Source: EMBLA website (see text).

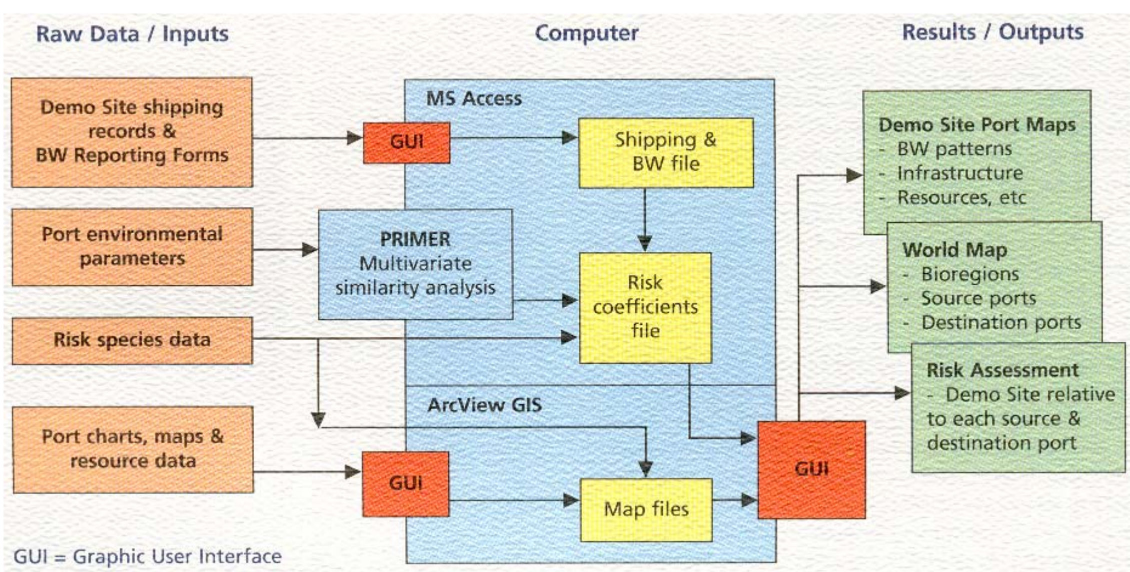

Figure 3. A flowchart of the major components of the GloBallast risk assessment procedure (GloBallast 2002).

dealing exclusively with ballast water. In addition, many reports in the general scientific literature contain relevant information, especially on biology and oceanography.

- Reports on biota in incoming ballast water, combined with oceanography and/or traffic patterns:
    - Magdalen Islands; Gosselin et al. (1995)
    - Ports of Estuary & Gulf of St. Lawrence; Harvey et al. (1999)
    - Laurentian Channel exchange zone; Gilbert and Saucier (2000)
    - Ports of NS; Carver and Mallet (2001)
    - Ports of NS, NB, PEI, NF; Carver and Mallet (2002)
- Hazard lists, or list of dangerous arrivals in incoming ballast water:
    - US State and Federal hazard lists; various datasets from SERC, SeaGrant, etc.
    - Atlantic provinces (algae); Subba Rao et al. (1994)
    - Invasive species lists for each FAO region; SNC/Lavalin (2003)
- Reports on oceanography, relative to ballast water exchange zones:
    - Potential for exchange zones in NE US; Beeton et al. (1998)
    - Potential for exchange zones off NF and Scotian Shelf; Petrie et al. (2001), Petrie and Soukhovtsev (2002)
- Reports on traffic patterns:
    - Maritimes, 1998; C.E.F Consultants (2000)
    - Maritimes, 2000; Balaban (2001)
    - St. Lawrence, 1978-1996; Bourgeois et al. (2001)
- Other related report (quantitative risk assessment based on traffic patterns):
    - Laurentian Channel exchange zone; RNT Consulting (2002)

Examples of two "risk assessment" approaches used in the Laurentian Channel

As with many things, what you get out of a risk assessment depends very much on what you put in, as well as how you go about the process and which question you are attempting to answer. One very controversial issue in ballast water management on the east coast has been the designation of the Laurentian Channel as an alternative ballast water exchange zone for the Great Lakes/St. Lawrence River traffic since 1989. Two very different forms of risk assessment, neither fulfilling all the requirements of an "ideal" risk assessment, have been conducted and have reached very different conclusions about the suitability of this area as an exchange zone.

The Circulation Study (Gilbert and Saucier, 2000)

Table 1. The goals and method used in the circulation study by Gilbert and Saucier (2000).

Goal	Method
Simulate the dispersal and fate of plankton (zoo- and phyto-) in ballast water discharges in the exchange zone.	Model the Gulf of St. Lawrence using a three-dimensional model of circulation and thermodynamics. Conduct simulations of the movements of zooplankton and phytoplankton particles released in the Laurentian Channel.
Identify areas where waters are flushed/retained.	

In this study by Gilbert and Saucier (2000) "risk" was not explicitly estimated, but it is assumed that areas where planktonic organisms are expected to be carried to the coast, or where they are retained for long periods of time, are "riskier" than areas from which the particles will be flushed and dispersed. Further assumptions, and a more complete description of the results, may be found in de Lafontaine and Simard (this volume).

The simulation model indicated that zooplankton and phytoplankton released in the Laurentian Channel would be advected throughout the Gulf and lower Estuary of St. Lawrence. Furthermore, many areas within the Gulf retain particles for > 45 days, and in some areas and seasons, particles may be retained for 90 days or more. Retention areas occur mainly in the southern Gulf over the Magdalen Shallows, and in the lower Estuary, and with lesser frequency in the northeastern portion of the Gulf. The high probability of advection of planktonic particles to, and retention in, these important zones of wild fisheries and aquaculture was considered risky. The only area in the Gulf where retention does not occur is the Cabot Strait. Thus, Gilbert and Saucier concluded that the lowest risk area (to the Gulf) for ballast water release was the Cabot Strait. However, their model does not model whatever happens to this water after it exits Cabot Strait, and they noted the possibility that ballast waters released in the Cabot Strait would affect the Atlantic Coast.

Recommendations, comprising the basis of a risk-based management strategy, were made to reduce the risk to Gulf marine waters of ongoing ballast water releases in the Laurentian Channel. Species-specific and site-specific considerations are implicit in this process.

Table 2. Recommendations made to reduce risk to Gulf waters, from Gilbert and Saucier (2000).

Allow exchange	Do not allow exchange	Consider other factors in decision
Freshwater BW	BW of salinity>30	Brackish BW
Late fall through spring		Other seasons
Last port tropical or subtropical	Last port temperate or subarctic	

The traffic patterns study of RNT Consulting (2002)

The goal of this study was to evaluate the risk of Laurentian Channel exchange relative to the risk from ballast water discharges elsewhere in the Gulf, Estuary and River. Note that the geographic scope of the study is much larger than that of Gilbert and Saucier, who did not investigate the effects of ballast water releases outside of the Laurentian Channel. Another major difference is that the RNT Consulting assessment did not consider the movement of any introduced species following release of the ballast water, while this is an integral part of the Gilbert and Saucier model.

In this study, a Probabilistic Risk Assessment procedure was followed. The endpoint was the introduction of a non-indigenous species. The model was developed to express the "relative risk" of ballast water release in Laurentian Channel, Gulf, Estuary or River, as a proportion of the invasive species that might have been present in the ballast water at the time of uptake, and that would be released upon ballast water discharge.

The method was based on an "Event Tree", which was used to break down the risk factors for ships entering each destination zone (e.g., transit time, mid-ocean exchange, Laurentian Channel exchange). It was assumed that mortality was 0% for voyage < 5 days, subsequently increasing to 50%. Exchange was assumed to replace 80% of the ballast water. Either 13 or 43 ships exchanged ballast water annually in the Gulf. The number of ships releasing ballast water in the other zones was based on historical traffic patterns. Finally, it was assumed that brackish-water species do not survive in marine salinities.

The result was the sum (for each arrival zone) of the product of probabilities of introduction associated with transit time, mid-ocean exchange, Laurentian Channel exchange, and ship traffic patterns. Only mean estimates (point estimates) were obtained. No uncertainty analyses were conducted, and therefore, no confidence limits were obtained.

The total risk to the Gulf, Estuary and River was estimated to be 25% (i.e., 25% of any alien species contained in the ballast at the point of origin will be introduced). The risk associated with FAO region of origin was 9% for region A (Northwestern Atlantic), 8% for region B (Northeastern Atlantic), and 6% for region G (Southeastern USA and Caribbean). The risks for the various destinations of the ballast water within the St. Lawrence system were: 13% for the marine/brackish Estuary, 8% for the River, 2% for the freshwater Estuary, 0.3% for the Gulf exclusive of the Laurentian Channel, and 0.2%

for the Laurentian Channel. Thus, the relative risk of ballast water exchanges in the Laurentian Channel was determined to be 0.5% of the total risk to the St. Lawrence River, Estuary and Gulf system.

Conclusions

Clearly, risk assessment can give very different answers, depending on exactly what question is being asked and how it is approached. In the examples for the Laurentian Channel, one might choose very different management strategies based on the results of the two models. Which one is correct? Probably both contain some elements of the truth, but neither is complete.

In terms of a general approach to risk management for ballast water, we must consider the following questions:

- Is it better to undertake a selective (risk-based) or a blanket (all ships) approach to ballast water management, considering the pros and cons of each?
- If risk-based management is chosen, which model is best?
- Should the same ballast water risk assessment standards apply to domestic and international shipping?
- And finally, who pays? This question could be applied equally to the cost of management, and to the cost of failure of management.

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Open Discussion

Workshop Panel Discussion

Moderator:

Bivan R. Patnaik
Regulatory Coordinator
U.S. Coast Guard's Aquatic Nuisance Species Program
Environmental Standards Division (G-MSO-4)
U.S. Coast Guard Headquarters
2100 Second Street, SW
Washington, DC 20593
BPatnaik@comdt.uscg.mil

Bivan Patnaik, Regulatory Coordinator, U.S. Coast Guard Headquarters, moderated the session. He identified this as an open forum between the audience and today's speakers on the issues of developing an alternate ballast water exchange zone.

QUESTION FROM AUDIENCE: This question is for Bernie Kelly. When you were giving your presentation and we were looking at the maps of the ballast end points, I was talking with someone else, and we were thinking that it paralleled some of the physical oceanographic currents in the Northwest Atlantic. I was wondering if you had looked at any correlations between the current systems and where the ships are exchanging ballast water and, what have your analyses found. Or is this a future project you foresee undertaking?

KELLY: I would have to say it is something for future exploration. My mandate is basically to provide location data and information along with ballast water information. I think that this is probably a future question. Having seen some of the physical oceanography presentations this morning, I can see that there is some correlation.
SMITH: I believe using the GIS system you could superimpose a cartoon of currents with the ballast water information. My point was that with the GIS system, you can take the schematic of currents that we showed this morning and superimpose it on event points, and you will have an idea of where they lie relative to the major currents. However, you have to take into consideration the position of seasons and inter-annual events, so there are other impacts to consider. One of the things we were talking about earlier was, do the end points correspond with currents that would be relatively safe with regards to invasions or inoculations? And by safe, I mean where they tend to be along the shelf edge or further offshore as opposed to the inshore zone. So, that way, you can try to make the correspondence between a ballast water discharge zone and the perceived danger of onshore advection as one place to start in terms of developing regulations.

LOCKE: Just one more comment to that. I would caution that if we superimpose those endpoints onto a currents map, we do not mix what is actually endpoint and the times to do the exchange and the route, which may be far from the point that we are on the map.

SMITH: The point was that the exchange is occurring over the whole track, not just at the endpoints so you really need a definition of where the water is being exchanged, not just the endpoints.

QUESTION FROM AUDIENCE: It seems to me that what we have concluded that a risk assessment needs to be conducted, and one of the major problems with any kind of risk assessment is you need a fair amount of data to really do a good job in terms of being very specific. So, we are talking about a situation right now where we really do not have a lot of that site-specific data, we do not have a lot of information about being able to predict which organisms are going to invade and so forth, so I guess I would ask a general question to the panel on some of things we really should be thinking about. When do you conduct a formal risk assessment and how would we define this? What are some of the important issues that we need to be thinking about for tomorrow?

O'DONNELL: I am not sure if I am the right person to ask, but one thing to consider is we need to know how long organisms survive in the receiving environment where they are discharged. Ballast water is a major source of introductions. Therefore, killing everything is the only truly effective way to zero the risk, but I think that is technically unachievable. Then to predict risk one needs to know how long the organisms are viable.

HINES: That question is insane. First of all, you assume that you know what species you have. All the taxonomy of marine organisms is based on adult characteristics. It has nothing to do with larval characteristics by and large, so we do not know what species we have. Then you are assuming that organisms such as zebra mussels do not occur in the Arctic, and saying that they are not a problem if you have a ship coming from Panama into I do not know where, let us say Halifax is okay, but the fact is most of the ships coming into Halifax are not from Panama. So, it gets really crazy. Even the issue about what invasive species is the highest risk of invasion. Look at green crabs, the poster child for marine invasions now. Green crabs invaded New England long ago and they are widely distributed on outer coasts and rocky intertidal systems, but on the West Coast, there are only invasions in estuaries and non-rocky intertidal systems, so what would you predict on that? If you look at the list of invasive species out there, almost none of them was predicted.

O'DONNELL: Predictions are often wrong, but that does not mean one stops trying to predict. I think that there is a philosophical difference we may have.

DE LAFONTAINE: I am in perfect agreement that we need a lot more data before we do risk assessment. We have a massive collection and analytical system and a lot of funds going into predicting weather, but almost nothing has gone into predicting marine invasions to this point and to suddenly state that we are going to arrive at a reasonable risk assessment is not likely. I just do not see it happening right away. Does that mean we should stop? No, I mean we should start pursuing that because the consequences are pretty great if we do not try.

BALABAN: I would like to comment on that. While I think that resources are short and we do have a limited amount of data, I do not see why we should focus on all the regions of the world. They are addressed at least partly now by vessels conducting ballast water exchange at sea, so I think vessels coming from outside should continue to do their exchange until we find a better option.

We should focus on coastwise trade and I think we have much data from the coastal traders: to know from where they are coming, exactly from which ports, and to which ports they are going to, and also we have data on what the main quantity of water is and where it is coming from. You have the rare case of some ships on random trips along the East Coast and stopping at three different ports, but these do not involve a major quantity of water. So, I would suggest that we focus our resources and limited amount of data on what is the main risk here as opposed to waiting until we have lots of data and all the possible information to implement the system that is like the one that is implemented in Australia. I personally do not want to wait four years before we have this system in place. I would like to see something done before that. We are in the regulation reform process now in Canada and we have a chance here to develop national regulations. If we miss this chance, the next time Canada under goes regulatory reforms will be not before 2006.

QUESTION FROM AUDIENCE: I just recalled in 1989, when the alternate ballast water exchange zone was set in the Gulf. It was set up on a temporary basis. Everyone agreed that let us try it for one year, and then reassess given the shipping traffic patterns. In 1999, they reassessed and just moved the zone. We have been living with it for 15 years without further data. We have a model, but it is not data. We have to wait for data. I would say at that time, in

1990, basically it was an expert judgment. People sat down and, to the best of their knowledge, they came up with a zone, and thus, we are still living with that. Are we satisfied with that? No, but there are pro and cons, and if we wish to develop a full risk assessment, we may wait forever without having any alternate zones. We need alternate zones and we might have to rely on an expert judgement like it was done 10-15 years ago.

SMITH: It is pretty clear that ballast water is producing a lot of invasions, so there is a very high risk associated with that. You could say that the risk of an individual, for example, 0.5% or something, might be low, but that is still enough of a risk for invasions to take place. But even so, we need a commitment to make a change because we also know that aquaculture and stock enhancement programs are also producing lots of invasions. And, even though we know that, people are still going forward and proposing to do it. Chesapeake Bay is going to have Asian oysters purposely introduced into it; it is inevitable, no matter how much risk is there. I do not think that having a detailed risk assessment that requires some elaborate matrix of all organisms that a ship coming from some country across the Atlantic Ocean is suddenly going to improve our risk assessment. I do not know, this all seems insane to me.

O'DONNELL: I think I agree with that. The risk assessment approach does not seem to me to be too profitable given the amount of data that is necessary to make it defensible. I do think, though, that it is time to do something and some simple regulations would do a lot. One regulation would be where everything, under normal conditions, no discharge of ballast water in Chesapeake Bay. However, one could also allow the discharge of ballast on the shelf within the Bay out to 40 or 50 km from the shore. I think that is pretty defensible too. But, it is a judgment call just now because the experiments that would need to be done to prove the results of the numerical model of the tact that you described earlier are very expensive, would need to be done at each site, and would need to be done dozens of times because there is natural variability when you do an experiment. You get the conditions that are occurring when you actually launch the drifters or release a tracer dye. So, you need to do it tens of times to be robust. So, it is going to come down to the professional judgment of such interested scientists, I think.

METCALF: I would like to throw another ratchet into this mess here too. When I think about the number of permutations that we have— just look at the number of species that are in the world, and the number of aquatic ecosystems— this is hard enough to fathom. A third factor is the variety of potential treatment systems or ballast water management techniques, in lieu of exchange, and the uniqueness of those methods applied on every single ship. An ultraviolet technology on the same ship may work with variable effectiveness from one voyage to the next. The same system on two different ships may produce a net risk that is different in the same port. And as mentioned earlier, with the limited resources and with the fact that it is doubtful we are going to be able to identify every species and their full distribution in all the receiving ports in the world, it just seems to me, this is why we are trying to make exchange more effective in the short term and trying to find effective treatment systems in the long term.

Because we are going to spend a lot of money on surveying probably what would amount to a tenth of the biological inventory for the world, we need to be able to do a risk assessment that is scientifically valid. Countries within IMO are conducting risk assessments, Australia probably is the only country that I know of right now that would say, "We have a good system." Australia is the only nation that has got a real system that is in operation, and that is a positive. But for the long-term, a number of countries just do not believe that they have enough resources to generate the data in a scientifically valid way.

PEDERSON: And I think the advantage of having a good model is that it could really show what organisms are being transported.

O'DONNELL: One problem with risk assessments is that a different group of people may use the same variables using a similar approach and could come up with substantially different results.

LOCKE: You really have to think about what you are assessing in terms of your assumptions and the way you evaluate is.

O'DONNELL: Yes, then there is also a certain arbitrariness to the choice of each variable and when you multiply them up you can get in trouble. It is well known that your multiplier in certain numbers can increase the uncertainty. Richard Fineman effectively criticized the National Aeronautical Space Administration's (NASA) use of that analysis during the investigation into the Challenger disaster. He really showed it and we could face the same criticism here too, I guess. The probability of a space launch blowing up is easily calculated by the number of times it happens divided by the number of launches and it turned out to be about 5% to 10% However, NASA's prediction was that it would be like 10 to minus five. So Fineman said that clearly the methodology was clearly wrong. So, here in this case, we know about how many times an invasion occurs, we know the rate of invasive species success, and we can estimate how many invasive species are getting inoculated into a particular ecosystem. Those numbers should be consistent with the results of risk analysis and I do not know if they are or not.

DE LAFONTAINE: At the risk of stating the obvious and putting this in laymen terms, I have seen many of the articles on that and you are absolutely right, that acceptable risk level is perfectly fine if you are NASA in general, but not so good if you are the astronaut on that launch where the odds are not in your favor. And I think that is the approach the industry seems to be taking, that we will never get to zero anything, but we believe we can get progressively better and better at what we are doing.

And again, who is going to pay for all this. There are limited funds the industry and government, the scientific community, and everywhere else. So trying to pool funds to achieve results, versus a system that is going to take centuries to perfect should be the way to go. If we wait for perfection it would be an unfortunate use of resources.

QUESTION FROM AUDIENCE: I noticed that most of the organisms in this little booklet, "Assess our Organisms," and I just wondered how confident are we that the vector of introduction is actually ballast water, rather than mere attachment to holds and anchors, etc.?

METCALF: Globally, Stephan Gollacsh from Germany, has been very active, and he provided, I cannot remember precise numbers, but it was an astonishingly huge number of introductions that he associated with hull. It is not like 1% with attachments to the hull and 99% via ballast water, it was a high percentage, which is another issue the industry must deal with because tributyltin (TBT) has been banned. TBT is a great antifoulant, but it may not be so good for the environment, particularly for vessels that are sitting in marinas day in and day out. Now the industry is searching for a viable alternative. Some are out there and some are very expensive, but most have not yet proven themselves for the time period and so forth.

DE LAFONTAINE: If I remember it was 98% of the vessels coming into the North Sea had some sort of nonindigenous species on the hulls of the ships generally, but approximately 50% of the vessels had nonindigenous species in their ballast water.

METCALF: And there was some discussion on whether or not they were actually detaching from the hull. They were riding in, but whether they decided to stay was another question. The potential was there for introduction.

HINES: We did some rough calculations of the size of ships and their surface areas and the number of ships that arrive and estimated that annually, the hull bottom surface area the size of Connecticut arrives at U.S. ports every year. These are not very evenly distributed in their hull fouling. Sea chests and moorings are much more frequently fouled than some of the exposed surfaces due to high speeds, anti-fouling paints, and they are very uneven as to how much maintenance is applied to them. Oil tankers on the West Coast have their hulls repainted about every two years, whereas who knows about your proverbial tramp streamer and the full spectrum of organisms they are bringing here. But, the bottom line is that we are recognizing that hull fouling as well as ballast water is potentially a major source of introduction of nonindigenous species.

QUESTION FROM AUDIENCE: Has hull fouling been addressed legislatively?

METCALF: I think historically we have focused more on ballast water because the invasive species problems in North America were recognized more in connection with the Great Lakes: zebra mussels, and ballast water. Hull fouling has been much less of an issue because if a vessel is coming from freshwater, going through salt water, and then going back to freshwater, you are less likely to have organisms living on your hull that can survive in their freshwater destinations. In fact, if you look at the distribution of species that have been inventoried in the Great Lakes, there has been a much larger proportion of ballast water species there than were found in places like San Francisco Bay. Hull fouling is probably going to be the key for the Northeast Atlantic region. So, we were influenced, I guess, by the Great Lakes agenda into looking extensively at the ballast water issue and much less so on the hull fouling issue, although for our waters the latter may well be a very large proportion of our problem.

MODERATOR: The proposed National Aquatic Invasive Species Act has language in it that addresses hull fouling. And although hull fouling is an important issue the purpose of this panel and workshop is to discuss alternative ballast water exchange zones.

PEDERSON: If you look at this environmental issue regarding ballast water, it is probably one that carries a huge amount of speculation and uncertainty. A focus on one issue is which process introduces an organism. We all believe it is ballast water, but the evidence is simply not there. We do not know if it is coming from the sea chest pushing backwards with the pump or if it was in the tank versus the sediment. We have a list of species that we keep adding on and adding on, but we have no clue as to the actual process of how species are introduced, whether it is ballast water, hull fouling, or by some other means.

SIMARD: Except for plankton introductions, the process would have to be ballast water.

METCALF: Well, I am an optimist, and there is good news. The good news is that the hull fouling cleaning of Alaskan tankers stated earlier is not because of hull fouling, that is because of some other internal U.S. regulations. The average foreign-flag ship, with a foreign flag and a classification that is trading into U.S. ports is dry-docking approximately every five years. That does not include passenger carriers and some of the more high-speed vessels. But the good news, is that the International Maritime Organization (IMO) is bringing different vessel types very slowly into a program called Enhanced Survey Inspection and a much larger number of the foreign flagships coming into North American countries are going to be undergoing more frequent dry-docking schedules. The other piece of good news is as a ship owner, it is not good to have stuff crusted on your hull because it is bad for your fuel consumption, so there is a real economic incentive for a ship owner to try and minimize the hull fouling as much as possible so we are all working towards the same goal.

QUESTION FROM THE AUDIENCE: It occurred to me when I just heard of this issue, I was just wondering if anybody had done a scientific or economic analysis of why are ships traveling in ballast anyway? Are ships looking into traveling without ballast?

MODERATOR: There is research being conducted now for ships to be ballastless as well as moving ballast water internally so there is no discharge.

LANGEVIN: I can tell you we are trying that every day and when a vessel is on route there are looking for returning cargo with no empty voyages, but in some trades, it is nearly impossible. Some ships just have fixed contracts and one destination and no return cargo because there is simply no production to go the other way so if there is a better way to find return cargo for every ship, I would be glad to hear about it.

HINES: True, but Port Valdez does not want what Los Angeles has to offer.

DE LAFONTAINE: It is true. I think first of all it is a matter of safety. They feel the ship has to be stable at sea so if they do not carry cargo, they are going to carry ballast water. What is difficult to understand is that the proportion of no-ballast ships has increased in the Great Lakes dramatically since Canada established some of the guidelines. Something happened: how come suddenly the shipping industry has found a way to fill their cargo and not carry ballast anymore? How come in the 1960s and 1970s they were carrying large amounts of ballast and they do not do that anymore? I mean no one has seemed to have an explanation for that, but that is the actual data and this is what we have been observing.

SIMARD: Well, I do not have an answer for that, but I have a question. Before ballast water reporting was mandatory, where did the data on ballast water or no-ballast come from?

DE LAFONTAINE: I am referring to Jenson, he has compiled a lot of data from everywhere and come up with figures.

SIMARD: I am going to ask him about that; I am curious.

METCALF: Do you want some more good news because there is some more good news. For a long time, we had oil tankers and bulk carriers and solely in the 1950s through the 1970s, people began to create a ship that could carry both. So, by doing that you maximize the flexibility to have cargo in both sides of the voyage. The more traditional huge volume of ballast, at least to the United States, is large crude oil tankers that are loading in West Africa. Now obviously, they are coming in loaded so, in this case, they are an exporter of ballast water unfortunately, back to their originating countries that should probably have at least a control program. But that is the scenario. And as far-fetched as it seems, we would love to have back-load cargo because the shipping industry does not get paid for carrying water, but the good news is, people are starting to do some smart ballast design such as the case of some railroad ships that are being built on the West Coast, they are building permanent ballast. Now keep in mind that that permanent ballast is just that, it is always there, therefore the whole dead-weighted cargo-carrying capability of the ship has not been agreed upon, they have not said, 12% or 10% or 5% of the net dead-weight of the ship is now going to be always dedicated to ballast is acceptable, will not be designated to cargo handling. If you can get buy in from vessels such as container ships and passenger liners that may have the ability because they are doing ballast water operations very frequently, much more frequently than a crude oil tanker running from West Africa to the East Atlantic coast. However, they are operating with much smaller volumes so they have to dedicate less proportion of the carrying capacity of the ship to this function. That is one thing, and somebody is actually trying to design a no-ballast ship that Bivan stated earlier.

WELLOCK: The reason why the amount of ballast onboard vessels has gone down is because the trade has changed. North America has become more of an importer than an exporter. Where in the earlier times, we were exporters, both the United States and Canada. Mostly the goods were exported out, and now we import more. So the vessels doing the importing are not carrying ballast, they are bringing the goods in, off-loading them, and if they do not have enough goods to carry back out again, they carry ballast water. We have a trade imbalance in both the United States and Canada with Europe or Asia as we are importing more than we export. But, that is part of the answer without looking at the numbers. And again, I do not know but I find it hard to believe somebody can come up with very accurate numbers on how much ballast was actually carried onboard ships before there was any reporting requirement. I could see in a particular trade where you could derive numbers. For example, in the tanker business when prior to the 1960s you had to come up with an oil record book and as part of the data in that oil record book you had to report what was put into those tanks, whether it was ballast or oil, but most other industries did not report ballast unless it was used in their engine rooms. So that oil record book for freighters, passenger ships, and for other general cargos or containers, they did not maintain accurate records on what was kept onboard for ballast. Tankers might, but anything prior to a mandatory reporting is pretty skeptical to me. I have not read Jensen's report, but on face value, having been in the industry for a long time that is my history of shipping.

SIMARD: Something else we have to look at is the rate of invasions with respect to cargo practices.

WELLOCK: I can tell you this much, again, we have a lot of data from when I was in the private industry versus a trade association. Vessels were coming into our refineries from Pennsylvania and I narrowed it down to three companies. They were going to control vapor recovery from ballast tanks. So we did an extensive data search going back three years to look at every vessel that had come in to our refineries. This was made it easier by time charts with the refineries in place so we had the time factor. We started looking at the amount of ballast water those ships were bringing in. There was some complication involved with the air quality issues, but that is not relevant here. We found out is that large vessels that were coming in, (between 8000 dead-weight and 140-150,000 dead-weight) had anywhere between 17 to 23% of the carrying capacity of the vessel brought in as normal ballast capacity. We did see, from time to time, as high as 35%, when a vessel was running right through a hurricane. It was storm ballast, basically. But keep in mind, those vessels do not want to have to sit at the dock any longer than they have too. Their charterers do not want them, the refiners do not want them, and the vessel owner does not want to do it so a captain is going to try to minimize the amount of ballast the ship is bringing in. Sometimes it has been done in the extreme where vessels have bounced through the tail end of a hurricane and actually done damage because they tried to go as minimum with ballast as they can so that the minute they get into port they are ready to start the cargo. There is some economic incentive for the owners to minimize the amount of ballast discharging.

MODERATOR: Stimulating as this discussion is, we are going to have to wrap up now. It is time for the social hour and we can continue the discussion there. I would like to thank the speakers for their presentations and for their time.