# Does the State of Rhode Island Have a Role in Preventing Future Ballast-Mediated Marine Bioinvasions in Narragansett Bay?


By

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# ABBREVIATIONS

| | |
|---|---|
| ACOE | – United States Army Corps of Engineers |
| AQUIS | - Australian Quarantine Inspection Service |
| CRMC | – Rhode Island Coastal Resources Management Council |
| DEIS | – Draft Environmental Impact Statement |
| MARPOL 73/78 | - The International Convention for Prevention of Pollution from Ships, negotiated in 1973, constituting a single document with the 1978 Protocol added to the Convention. |
| MSO | – U.S. Coast Guard/Marine Safety Office – Providence, RI. |
| NERR | – National Estuarine Research Reserve |
| NIS | - Nonindigenous species |
| NOBOB | - “no ballast on board” |
| PSP | - paralytic shellfish poisoning |
| QPDI | – Quonset Point Davisville Intermodal |
| QPP | - Quonset Point Partners |
| RI DEM | - Rhode Island Department of Environmental Management |
| RIEDC | – Rhode Island Economic Development Corporation |
| SERC | - Smithsonian Environmental Research Center, Edgewater, Maryland. |
| SLC | – California State Lands Commission |
| UNCLOS | - United Nations Convention on the Law of the Sea |
| USCG | – United States Coast Guard |

ABSTRACT

Port development and expansion of the scale presented in recent proposals for Quonset and Providence can be expected to increase foreign vessel traffic in Narragansett Bay by at least 350%. Increase in ship traffic will mean larger volumes, and greater frequencies of ballast water discharges into the Bay. Since ship ballast is the largest known vector for transferring marine organisms between coastal regions, Rhode Island's risk of bioinvasions will become higher with the increase in vessel traffic. This study presents information on known introductions of marine organisms to Narragansett Bay, and summarizes some of the major social, economic and environmental costs that could result if an invasion occurs in the Bay. Based on the finding that Rhode Island will face a significantly greater risk of introductions, I address the question: Does the state of Rhode Island have a role in preventing future ballast-mediated marine bioinvasions in Narragansett Bay?

The question of whether Rhode Island has jurisdiction to address the problem of exotic introductions through regulating the ballast water of commercial shipping is complicated by the fact that some federal, as well as international ballast controls already exist. However, national and international legislation addressing the problem of marine bioinvasions is currently insufficient to ensure the optimal available protection to Rhode Island waters. Constitutional, statutory, and case law analysis, indicates that the state does have, within certain limits, concurrent jurisdiction to regulate the ballast of commercial shipping to prevent introduction of invasive marine species.

The study reviews several policy alternatives potentially applicable in state ballast control and bioinvasions prevention. Options considered include risk-communication,

direct regulation, ballast tax, and a liability system. A combination of mandatory ballast exchange regulations and a strict, collective liability system supported by assurance bonding has great potential to increase bioinvasions prevention and relieve state monitoring efforts. However, a liability requirement will present significant new costs to shipping, and if applied on the state, as opposed to national level, it will likely discourage vessels from calling on state ports. Therefore, after evaluating market and non-market strategies, I conclude that, from the several policies that show potential for state-level ballast management, a direct ban on the discharge of untreated ballast into state waters is the only currently available option that both ensures adequate prevention, and falls within the limits of state jurisdiction over ballast.

The most effective ballast treatment method currently practicable for ships in international trade is ballast exchange, i.e. the exchange of coastal ballast with open ocean water, generally recommended to take place outside the 200 mile exclusive economic zone and in water deeper than 2000 meters. To achieve needed improvements in protection against ballast-mediated species introductions, Rhode Island should, through a legislatively appointed lead agency on ballast (RIDEM or CRMC), enact mandatory ballast exchange regulations for transoceanic vessels calling on state ports, prohibiting the discharge of untreated ballast into state waters.

# INTRODUCTION

Rhode Island and the Narragansett Bay are increasingly susceptible to marine bioinvasions. The plans for development of an international intermodal containerport at Quonset, as well as the Providence River and Harbor Maintenance Dredging Project are major factors contributing to a heightened risk of species introductions. The new threats of such introductions stem from the increase in incoming transoceanic ship traffic, which is expected to result from port construction and the improvement of port access.

The introduction of exotic species, which can have serious ecological, economic, and human health consequences, is closely linked to ship traffic. The ballast water of commercial shipping has been identified as the single largest vector for nonindigenous species transport. While other ship-related transfer mechanisms, such as organisms in hull fouling, sea-chests and anchor chain lockers are also becoming a concern, ballast water remains the guaranteed inoculant.[1]

Even though the latest proposal for Quonset containerport development was recently (September, 1999) rejected by the state, the expansion of the existing port facility remains a goal for the current administration.[2] Such expansion will inevitably increase vessel traffic, amount of incoming ballast water, and ultimately, species introduction risks. The improved Providence River channel is also expected to not only

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[1] While organisms attached on the hull or found in anchor chain lockers or sea-chests may, or may not make it to the receiving water body, the release of ballast is always accompanied by release of a host of organisms.

[2] Both Governor Almond and the Directors of the Rhode Island Economic Development Corporation declared, in the fall of 1999, that a new containerport in North Kingstown remains a priority (Donovan, William J. 1999.

become safer and more accessible to existing traffic after the dredging, but also to attract new shipping, and with it, additional ballast from new sources.

This is a particularly important time to initiate preventive planning, since a number of significant risk increases remain in the future. At a time when the development of a Narragansett Bay master plan is considered parallel to the plans for port construction and channel improvement, it is particularly important that the issue of species introductions is addressed.

Narragansett Bay, an historically important shipping region, has already had several documented introductions, and it is certain that others have gone unnoticed since the Bay has not been the site of a major ballast water or exotic species study. The profile for a port in Quonset, as presented in the latest port proposal[3], suggests a significant intensification in the ballast water species transfer vector, given the projected origin of ship traffic, frequency of ship arrivals, and length of the average voyage. Such vector increase leads to expectations of corresponding increases in the number and rates of future introductions.

This study examines the state's role in preventing future ballast-mediated marine bioinvasions, given international and national regulatory activity already targeting the ballast water of commercial vessels.

The first part of my research estimates the risk of marine bioinvasions for Narragansett Bay by analyzing shipping history and shipping projections for the Bay in light of known mechanisms of ballast-mediated species introductions. The analysis of

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[3] Quonset Point Partners LLC, 1999.

current and projected ballast-related hazards explores the rationale for state preventive action.

The second part of this research reviews existing international, national and regional actions for control of ballast-mediated species transfers, and seeks to determine the scope of state jurisdiction over ballast. The issue of federal maritime preemption with its scope and implications for state jurisdiction over ballast is analyzed in Constitutional, statutory and case law context.

The third part of the study identifies policy options applicable to the control of ballast water, and selects from the suitable policies the ones that fall within the scope of state jurisdiction. The policy review takes into account the central goal of ballast management – prevention of untreated ballast discharges into state waters, while the identification of state agencies suitable to carry out the selected ballast policies is done on the basis of agency mandate and experience with regulating vessel-related pollution.

# CHAPTER I:

# MARINE BIOINVASIONS AND NARRAGANSETT BAY: MECHANISMS OF AQUATIC SPECIES INTRODUCTION AND IMPLICATIONS OF PORT EXPANSION FOR THE NARRAGANSETT BAY ECOSYSTEM

## Introduction

The purpose of this chapter is to examine whether the risk of ballast-mediated species introductions to Narragansett Bay can be expected to increase as a result of the plans for port improvement in Providence and port construction in Quonset. The chapter introduces the problem of marine bioinvasions and identifies the principal vector contributing to species transfer – the ballast water of commercial shipping. It focuses on general patterns and mechanics of species introduction, highlighting principles that are of immediate relevance to Narragansett Bay, and analyzes how the current and projected shipping patterns on the bay reflect on bioinvasion risks.

## Introduced Marine Species: Definition and Significance

A European green crab, an Asian clam, a Japanese shore crab, and a vast number of other non-native species can presently be found in different locations along the U.S. coast. Similar in their exotic, transoceanic origin, and in their potential to disrupt ecosystem dynamics at the place of introduction, many such species have nonetheless come to be regarded as a regular part of the coastal aquatic landscape. Non-indigenous species (NIS), also known as exotic species, alien species, and biological invasions, are defined as any species or other viable biological material that enters an ecosystem beyond its historic range, including any such organism transferred from one country into another.[4]

[4] Marine Board, 1996. p. 11.

The awareness of marine bioinvasions changed dramatically in the 1980s. The establishment of the fouling European zebra mussel in the Great Lakes, a toxic Japanese dinoflagellate in Australia, and a carnivorous North American comb jellyfish in the Black Sea - all of which led to critical economic, human health and ecological concerns - focused scientific, governmental, and public attention on an age old phenomenon – the introduction of non-indigenous aquatic organisms, transported to new locations in ships' ballast water.[5]

Several mechanisms can account for the process of marine bioinvasions, a process best characterized as a global transfer of organisms between nearshore waters. The most common means of transport are the movement of fouling communities on the bottom of ships, the movement and/or intentional release of aquaculture fishery and bait species along with their assemblages of associated free living and parasitic organisms, the connection of waterways through canals, and the release of organisms by discharge of ship ballast materials.[6] Despite the considerable spatial and temporal variations in supply patterns, the movement of ships' ballast water has been recognized as the single largest vector of exotic species transfer worldwide.[7]

The concern with ballast introduction risks is about transfers between nearshore and coastal regions. The different temperature, salinity, density and pressure conditions in the open ocean successfully prevent survival upon release of coastal and estuarine

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[5] Marine Board, 1996. p. 1.

[6] Cohen and Carlton, 1998; Ruiz et al., 1997; Ruiz et al., 1995. Ruiz et al.,1997, provide a good example for a succession of introduction mechanisms in time.

[7] Carlton, 1985; Carlton and Geller, 1993; Carlton, 1995; Carlton et al. 1995; Carlton, 1996; Cohen and Carlton, 1998; Hutchings, 1992; Kelly, 1993; Ruiz et al .1995; Ruiz et al., 1998.

organisms in open ocean environments, and vice versa.[8] Actually, exchange of the coastal ballast carried by ships on exiting a port with open ocean ballast [while underway] is used as a mechanism to prevent the introduction of exotic species to non-native coastal locations: the swap of coastal and open ocean water has reciprocal biocidal effect on the organisms contained in each. Estuarine systems are particularly susceptible to aquatic invasions because most shipping activities associated with NIS transfer are localized in estuaries and bays, and also, organisms originating in one estuarine environment have a better chance of surviving (and colonizing) if released into other estuarine environments.[9]

At present, approximately 400 NIS are known along the Pacific, Atlantic, and Gulf coasts of the U.S., and hundreds of others are reported from other regions of the world.[10] Because information is limited to a few regions, with many areas not studied at all, the actual number of NIS is clearly underestimated. Within the U.S., the estuaries subject to ballast water and species studies have proven host to large numbers of exotics. (See Table 1A-1, Appendix 1) It is also important to note that the scarcity of data on marine habitats, compared to information available for terrestrial and freshwater systems, does not allow for a good estimate of the proportion of nuisance species among marine invaders.[11] Nonetheless, with the increase in intensity of the ballast transfer vector, the number and rates of marine invasions, as well as invasion incidents with serious impacts seem to have also grown. Species transfer consequences, measured in human terms,

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[8] Marine Board, 1996. pp. 36-37; Carlton J.T., Presentation to Quonset Stakeholders, December 7, 1998.

[9] Carlton and Geller, 1993; Ruiz et al. 1995.

[10] Ruiz et al., 1997.

include significant health hazards, fisheries collapse, as well as some staggering losses to water-dependent industries.[12] Even more significant, however, are the ecological consequences: through transport mechanisms that instantaneously transcend the natural barriers of open oceans and continents, human activities are homogenizing, in tens of years, distinctly separate biotas that have taken millions of years to evolve.[13]

## The Role of Shipping

The modern ship can transport living organisms on its hull, in the sea chests, and elsewhere on the vessel, such as seawater piping systems, on the rudder, entangled in the anchor or in the anchor chain, or in the chain lockers.[14] It is ballast water, an inevitable corollary to shipping, however, that is the guaranteed inoculant, directly and consistently releasing large numbers of organisms in every major port every day.[15] Ballast water is taken on board vessels to achieve the required safe operating conditions during a specific voyage or portion of a voyage[16]. It can be defined as ocean or fresh water placed in a ship to increase the draft (i.e. make a ship sit lower in the water), change the trim (i.e.

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[11] Ruiz et al. 1997.

[12] The costs and consequences of nonindigenous species transfer are addressed in more detail in Appendix 1, Part B.

[13] Carlton, 1993b.

[14] Marine Board, 1996.

[15] Ballast sampling of ships with various regions of origin has demonstrated the presence of a large variety of species in ship's ballast water, as well as the vast taxonomic diversity of such species. Globally, based on shipping statistics, and the results of ballast water species counts, the magnitude of the problem that is shaping up is approximately the following: with several thousand ships (out of a world fleet of 35 000) with ballast water at sea at any one time, assuming 20 – 30 taxa per vessel, on any given day, several thousand species with the potential for dispersal and establishment into a non-native region may be in motion in ballast water "conveyor belts" around the world (Carlton and Geller, 1993).

change the difference between draft forward and draft aft), regulate stability, or maintain stress loads within acceptable limits.[17] For the purposes of the present study, the term ballast includes the sediment that accumulates in ballast tanks, which may be discharged with ballast water. Although ballast capacities vary widely among different ship types, some amount of ballast is carried on most vessel voyages. Ballast is routinely adjusted to provide for operational needs (proper draft) in port: ports and shoreside industries have draft constraints that may require ships to take in ballast in order to get under loading cranes or navigate under bridges, as well as require them to discharge some ballast to ensure safe passage out of shallower navigation channels.[18]

Several myths still surround the phenomenon of bioinvasions. Most popular is the claim that invasions are a part of nature, and all we are doing is speeding things up. In fact, species do not eventually travel between San Francisco and the Black Sea by way of ocean circulation alone. Equal in popularity is the myth that everything that could have invaded would have invaded by now – a claim challenged daily by global introductions increasing not only in numbers but, most importantly, in rate.[19] It is in answering the second myth that we get into the issue of vector size. With increase in vector size, and in the frequency of pulses, the risk of introductions also increases: greater amounts of ballast discharge, faster trips, more frequent intakes and discharges across different

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[16] As noted in Carlton and Geller, 1993, Hutchings, 1993, and Marine Board, 1996, ships have always required ballast to operate safely and successfully, but beginning in the 1880s, a switch was made from solid ballast to ballast water, to help avoid time consuming loading and unloading of solid materials.

[17] Marine Board, 1996.

[18] Carlton et al. 1995. p.44.

[19] Carlton et al, 1995; James T. Carlton at the First National Conference on Marine Bioinvasions, Boston, MIT, January 1999; Cohen and Carlton, 1998; Chesapeake Bay Commission, 1995.

biogeographic locations, and the presence of species-rich sediment in the bottom of ships' ballast tanks, have all been associated with greater likelihoods of invasions. Global shipping in the last decades has increased its volume, frequency, and speed of transit, due to an increased global demand in a world economy where approximately 80% of world trade volume is transported by ships.[20] All of these factors add up to produce a significant increase in the rates of exotic introductions.[21]

The set of factors that are currently thought to influence potential for success of NIS introductions includes changes in donor region, new donor regions, changes in recipient regions, invasion windows, and changes in the dispersal vector.[22] All these factors can be significant in determining the likelihood of future invasions in Narragansett Bay. Most of the discussion in the present analysis will focus on changes in dispersal vectors (i.e. changes in shipping and in the characteristics of shipping activity), and on the introduction of new donor regions (i.e. the new sources of origin for some of the vessel traffic which will be added to the bay's existing shipping). The implications of changes in Narragansett Bay as a recipient region are less clear, but still potentially very important. Such changes, brought about by recent pollution prevention and cleanup efforts, may influence the likelihood of colonization.

The proposed new port facility in Quonset, as well as the channel dredging at Port of Providence, will increase the ballast vector size and intensity in Narragansett Bay, and

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[20] Peters, 1993.

[21] Examples include the San Francisco Bay estuary and delta, where invasion rate increased from an average of one new species established every 55 weeks from 1851 to 1960, to an average of one new species every 14 weeks, from 1961 to 1995. (Cohen and Carlton, 1998); as the article points out, for the period 1850 to 1995, 55.2% of invasions were recorded after 1960, in other words, half of all invasions during the 145 year period were reported in the last 35 years.

[22] Carlton, 1996.

therefore heighten the risk of future aquatic species introductions. Reviewing general mechanisms of ballast water species transfers and then relating them to the specifics of proposed shipping on the Bay is an important step in understanding the scope of the problem of future introductions, as well as in thinking of how to address this problem through prevention.

The nature of ballast functions makes for complex ballasting patterns. Finely tuned partial discharges or intakes from one or several tanks at a time, a number of times during loading/unloading operations, as well as in the course of a voyage are often the case. One vessel may thus have water from multiple sources, accumulating organisms from multiple ballastings at many sites, and subsequently releasing these organisms to new locations.[23]

Containerships, which are expected to constitute the majority of new traffic resulting from port construction in Quonset, are one of the best examples of the constant movements of ballast between many sites in the course of a voyage.[24] This "scheduled movement of ballast" is best illustrated in containership transit records. (See Appendix 2, Table 2A-1) It is important to note that for new container vessels, adjustments in ballast are computerized, therefore any potential control of ballast releases acquires a different dimension than the simpler, crew driven adjustment intakes and discharges.

To understand the effects of partial intakes and discharges, and the implications of different amounts of ballast carried and discharged, it is important to note the different ballasting conditions and what those mean for the potential of species introduction, as

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[23] Carlton et al., 1995, p. 47.

[24] Carlton et al., 1995, p. 47.

well as for ballast water monitoring. Vessels are said to be in ballast when they have ballast water and no cargo on board. Vessels can be "with ballast" when they have cargo and some ballast on board.[25] In addition, there are vessels that have little or no pumpable ballast[26] and are thus being reported as "no ballast on board" or NOBOBs by their operators. NOBOBs, however, may have, on the bottom of their tanks, sediment rich in species.

For the analysis of future ballast risks in Narragansett Bay, it is important to notice that results of a 1995 shipping study by Carlton et al. indicate that while containerships have the lowest total ballast capacity compared to other types of vessels, they have been recorded to carry higher amounts of unpumpable ballast. (See Table 2A-2, Appendix 2) The significance of this finding in Rhode Island context is two-fold. First, in the case of NOBOBs, the effect of partial intakes and discharges is to further facilitate species introductions: partial intakes stir the aquatic life contained in sediment at the bottom of ballast tanks (normally undisturbed by routine pump-outs), and subsequent pumpouts release all or part of this sediment, and its species, into the environment of the ship's port of destination. The impact of such mixed sediment releases can best be understood through a reference to the Great Lakes experience where most of the introductions of exotic species occurred in a theoretical scenario where 75 to 95% of

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[25] U.S. Customs and port records do not normally record the amounts of ballast water when vessels are "in ballast", and usually do not record the presence of ballast water at all when vessels are "with ballast", creating a condition of unacknowledged ballast for all vessels that carry some cargo on board (Carlton et al, 1995, p. 55.). This situation has changed by the recent introduction of a mandatory ballast reporting requirement (see Chapter 2 for details).

[26] The design of ballast tank piping is such that a certain amount of water always remains in the tank, below the intake/discharge pipe opening, and is therefore unpumpable.

vessels were NOBOBs.[27] Second, since as a result of their design and operational specifics containerships often contain only unacknowledged ballast (recorded as NOBOB), the risk they pose in terms of ballast-mediated introductions is frequently ignored, neglected or denied by maritime professionals. However, as noted above, it is not clear that the usually smaller amounts of containership ballast present a lower invasion risk.

In the case of Narragansett Bay, the projected container shipping is likely to experience the constraint of channel depth and bridge and crane clearance when operations begin. The dredging of the main shipping channel has been a disputed issue[28], and the latest plans and agreements made a compromise including channel depths 8ft shallower than the ones set in the initial (1998) port proposal.[29] A shallower channel means that a ship which has taken in ballast to increase draft (sit lower in the water) for greater safety in open waters will have to discharge ballast, decreasing draft in order to secure channel bottom clearance. Therefore a likely scenario may include intakes, to secure bridge clearance, upon entering East Passage, subsequent discharges while navigating the channel, to secure bottom clearance, possibly followed by new intakes to secure crane clearance at unloading, depending on berth depth (or some similar sequence of intakes and discharges). In the case of the proposed new facility for the Narragansett Bay, the impact of ships with little or no [registered] ballast can be significant. Port

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[27] Reeves, 1999. p. 3.

[28] Because of the impacts of dredge on habitat, and especially due to uncertainty about plans to dispose of the contaminated dredge material, alternatives to the original proposal, reached as a result of the stakeholders process are proposing channel depths of 45 ft, 8 ft shallower than the depths of 52 ft in the initial proposals, and therefore presenting more constraints to [deep draft] ships entering and exiting the port facility in Quonset.

[29] Quonset Point Partners LLC, 1999.

planners have repeatedly mentioned that “there will be no discharges” or that “ships will be coming in as NOBOBs, or ‘no ballast on board.’”[30] As illustrated by the Great Lakes statistic above, the ecological significance of small [in quantity] partial discharges and intakes can be great in terms of facilitating introductions. NOBOB containerships coming in Narragansett Bay will inevitably be undergoing such partial discharges and intakes on their way to the port terminals, thus presenting a new risks of further species introductions to the Bay system.[31]

In conclusion, while the relationship between ballast vector characteristics and magnitude of invasion risk is difficult to quantify, existing empirical evidence defines the direction and shape of this relationship for important ballast characteristics such as [discharged] volume, [discharge] frequency, and the diversity and profile of donor regions. Such known patterns and connections are used in the analysis of ballast-related invasion risks for Narragansett Bay.

## Ballast Water in Narragansett Bay: Vessel Traffic and Species Transfer Risks

Analysis of current and expected shipping patterns for Narragansett Bay can be used to anticipate the direction of ballast transfer risks in the future.

### Bioinvasion Risks: Current Vessel Traffic

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[30] From discussions at stakeholder meetings, fall 1998.

[31] As discussed later in this chapter, containerships can be a high risk category for ballast mediated invasions for a number of other reasons as well.

Narragansett Bay serves as the principal commercial waterway for the states of RI and Southern Massachusetts.[32] Currently, there are 33 commercial port facilities located throughout Narragansett Bay, clustered in several locations – Davisville, Providence Harbor (includes Providence and East Providence), Tiverton, and Newport in Rhode Island, and Somerset and Fall River in Massachusetts. Twenty three of the port facilities are used for shipment and receipt of cargo.[33]

Several prominent characteristics of current vessel traffic and port facilities help delineate the present ballast profile of the bay, in spite of the lack of ballast information in shipping statistics/records. First, as a net importer of goods, most prominently petroleum products, Rhode Island should be generally exposed to more vessels that come in cargo and take in most of their ballast prior to departure, than vessels coming in ballast and discharging large amounts of ballast while loading.[34] In terms of bioinvasions, this scenario is dramatically different than one in which a state is a net exporter of raw materials.[35] If Rhode Island were an exporter, a large number of vessels would be arriving in ballast, and discharging this ballast in the bay during loading, potentially

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[32] J. Nield, Masters Thesis, 1999, p. 4.

[33] Nield, 1999.

[34] Such conclusions are also confirmed by recent observations of USCG MSO Providence, whose officers are currently inspecting a portion of the incoming vessels to determine compliance with mandatory ballast reporting requirements (see Chapter 2 for more details). Vessel experience since the beginning of ballast inspection and monitoring practices in July, 1999, has indicated that a large portion of the vessels calling on facilities in Narragansett Bay arrive fully loaded, therefore carrying little ballast. Such vessels leave without cargo, and therefore the large amounts of ballast are taken in prior to departure, as opposed to such large amounts being discharged upon arrival (Lieutenant McLaughlin, MSO Providence, personal contact (03.16.00). Also see note 55 above).

[35] Being a net importer or exporter of shipped goods has been previously used to gauge the ballast balance of a region (e.g. Hutchings, 1992).

increasing the risks of species transfer.[36] Second, there is a current decline in annual commercial vessel traffic on the bay,[37] and it is logical to expect decline in ballast to result from the general decline in traffic. (See Table 3A-1, Appendix 3) Finally, a large percentage of the total number of vessel trips on the bay – an average of 74.6%[38], are made by non-ballasting towing vessels and dry cargo and tank barges (See Table 3A-2, Appendix 3).[39] Such towing vessels and barges, as opposed to coastal and transoceanic commercial traffic, either do not carry ballast, or do not pose species transfer risks, since their ballast is from local waters.

Consequently, several factors, most importantly shallow shipping channels, extensive lightering, and net imports of shipped goods to the state, are presently keeping volumes and frequencies of incoming ballast lower than could be expected for Narragansett Bay under existing port capacity.

Even under these ballast conditions, invasions have continued to occur. Recent additions are the Japanese shore crab, *Hemigrapsus sanguineus*, whose range is expanding in the bay[40] and the macroalga *Grateloupia doryphora.*[41] *Hemigrapsus,* which

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[36] Further discussion of the bioinvasion risks faced by regions that are net exporters of raw materials can be found in Hutchings, 1992 and Kelly, 1993.

[37] J. Nield, 1999.

[38] 12-year average for the period between 1985 and 1996.

[39] The fact that most of the current traffic on the bay consists of domestic, non-self propelled vessels and the accompanying tow vessels is also confirmed by a recent white paper on commercial marine transportation in Narragansett Bay, put together for the Bay Summit 2000. See Bay Summit 2000, DRAFT, Part V, Grigalunas et. al, 2000.

[40] Currently, expansion is in the northern direction, and the species has been discovered as far up the bay as the northern part of Prudence Island, as well as on the Bristol shore and in the harbor (Dr. Christopher Deacutis, Research Coordinator, Narragansett Bay Estuary Program & Narragansett Bay NERR. Personal Communication (04.19.00).

was initially introduced via transoceanic ballast in New Jersey, arrived to Narragansett Bay and the Rhode Island shore through natural dispersal from the south. *Grateloupia,* a particularly invasive species,[42] first discovered in the bay in 1996,[43] is also a suspected direct introduction by either transoceanic or coastal shipping.[44] Some of the evidence pointing to ship's ballast or hull fouling as the introduction pathway is the location of initial *Grateloupia* populations, relative to patterns of ship traffic and the northward direction of water current through the East passage of Narragansett Bay.[45] While the exact ecological and economic significance of these two species in particular are not yet clear, their further spread in the bay continues.[46]

In a broader view, as indicated by unpublished data from J. Carlton, between 1960 and 1997, New England has had some 21 new invasions, 13 of which are shared by Rhode Island (Appendix 1, Tables 1A-3 and 1A-4). While this number represents an underestimate of unknown magnitude,[47] it is important to note that the data still indicates

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[41] Grateloupia can generally be found in the Pacific Ocean, Mediterranean Sea, and Atlantic Ocean from British Isles to Angola and from Florida to Uruguay (Dawson et al., 1964; Irvine and Farnham, 1983).

[42] Ardré and Gayral, 1961 (in Villalard-Bohnsack and Harlin, 1997); Farnham and Irvine, 1973; Ribera and Budouresque, 1995.

[43] Villalard-Bohnsack and Harlin, 1997.

[44] As Villalard-Bohnsack and Harlin, 1997 note, DNA analysis will be able to establish more precisely the exact geographic origin of the Rhode Island species, as well as the vector involved in its spread in Narragansett Bay.

[45] Pilson, 1985.

[46] See Appendix 1, Part C for further discussion of suspected NIS impacts in Narragansett Bay.

[47] It is practically certain that we are 'missing' a large number of exotics, since no one in Narragansett Bay specifically, or in New England in general is recording introduced worms, amphipods, isopods, copepods, diatoms, flatworms, hydroids, bryozoans, sponges, tiny mollusks, filamentous algae, etc. (J.T. Carlton, personal communication) In other words, since no specific observations are made on microscopic, invertebrate. organisms, mostly larger exotic organisms are the ones that get "discovered," often by members of the public, and especially fishermen and people working on the water.

a steady flow, as well as an increasing rate – there are 3 times the number of invasions in the 1980s and 1990s than there were in the1960s and 1970s.[48]

What would be the impact on invasion risk from port construction in Quonset and channel dredging and harbor maintenance at Port of Providence?

Bioinvasion Risks: Projected Vessel Traffic

The Providence River and harbor maintenance dredging, and the proposed port development and expansion at Quonset/Davisville are the major projects expected to bring an increase in Rhode Island vessel traffic.[49] Since the projects are representative of the types of port improvement and development envisioned for the state, their [past and current] proposals are used to analyze the ballast-related invasion risks that can be expected to occur with increase in transoceanic traffic on the bay.

The Providence River and Harbor Maintenance Dredging Project consists in dredging the currently silted Providence River shipping channel to the authorized depth of 40 feet, and breadth of 600 feet. The purpose of the dredging is to increase navigational safety and efficiency for deep draft vessel traffic that currently transits the channel, as well as to make the channel accessible to vessels presently limited in their access by draft requirements.[50]

Increase in channel depth is seen as a future attraction to new shipping. In bioinvasion terms, increased traffic will translate into an increased risk of introduction for

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[48] Carlton, J. T. 1993; Carlton, J. T. 1999; Carlton, J. T. 2000b.

[49] Neither of the two projects is currently under way, but both are on some level of planning and preparation.

**50** USACOE, DEIS, 1998.

ballast-borne exotics. Unlike the plans for Quonset-Davisville, current dredging studies do not quantify expected traffic increases to Port of Providence. Therefore, only a general trend of risk increase can be concluded here.

The second large port project on the bay, Quonset port development, presented, in its initial version,[51] a project of an unprecedented scale, not only for a state the size of Rhode Island, but also in comparison to other existing U.S. facilities, capable of accommodating "ordinary" as well as "next generation" container cargo carriers. Even though the immediate proposals, the last of which involved a medium-sized container facility, were recently rejected [September, 1999] by RI EDC, a container port facility in Quonset remains a potential option for the future. Therefore, I am using past proposals to illustrate the kinds of pressures Narragansett Bay will be facing as a result of port operations similar to the ones recently planned.

At full development, 728 vessels/year were projected to use the new facility. All the added containerport traffic would be transoceanic, therefore presenting immediate concerns of ballast-mediated exotics transfer. The new shipping to be brought by Quonset represents a 221% increase in the current average of combined vessel arrivals (combined domestic and foreign) to Narragansett Bay ports,[52] and a 350% increase in the current average of foreign arrivals.[53]

What are the bioinvasion risks associated with containerport operation?

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[51] Quonset Point Partners LLC, *1998.*

[52] For more detail on increase in vessel arrivals with port operation in Quonset, see Appendix 3, Tables 3A-3 and 3A-4.

[53] Averages for current combined and foreign traffic are derived on the basis of the MARAD data in table 3A-4.

Several characteristics of bioinvasions in general, and of ballast water as a transfer vector in particular, create obstacles to formal risk assessment for ballast-mediated invasions. The major uncertainty comes from the fact that marine invasion ecology cannot currently predict which species will invade, where and when an invasion will occur, and what the consequences of a particular invasion will be.

In the case of ballast, the relationship between vessel type, the likelihood of a species release, and the risks associated with a successful introduction from such release evade quantifcation.[54] While volume of potential inoculant is an appealing approach to characterizing risk, there is little scientific data to determine an exact correlation between the volume of ballast discharged and the likelihood (and consequences) of an invasion event.[55] The challenges in valuation of the invasion outcomes compound the difficulty of quantifying risk. We are unequipped, for example, to compare the consequences of several species of predominantly ecological impact, with those of a single species with significant economic cost. Currently, we have no meaningful way of comparing the absolute cost [and, therefore, the risk] of these two invasion scenarios.[56]

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**54** A large number of factors influence both inoculation potential and the risks of introduction, leading to a complex interplay of multiple combinations of variables. The uncertainty which results from this large number of variables does not allow for any global statements on the correlation between ship type, risk, and inoculation potential [for exotics]. For example, while we know that certain combinations of vector characteristics exhibit a proportional relationship to the likelihood of invasions [invasion events] – e.g. larger volumes of ballast, more frequent releases, and greater proportion of sediment in ballast are [generally] associated with greater inoculation potential, it is still difficult to determine the relative contribution of each of these characteristics to the risk of inoculation.

55 15 000 tons of ballast, released by a larger in ballast capacity bulk carrier, may contain a number of organisms with little perceptible impact on the host environment. At the same time, 500 tons of sediment rich ballast from a generally lower in ballast capacity containership may contain, in great abundance, a species with significant economic impacts upon establishment (James T. Carlton, personal communication, 02.10.00).

56 James T. Carlton, personal communication (02.10.00). The difficulties in comparative valuation of invasion events, as well as the obstacles in measuring the risk of bioinvasions are also well defined, and

It is important to note, however, that even though quantitative statements on the [precise] relationship between vessel type, inoculation potential, and risk of introductions are difficult, knowledge from existing empirical studies allows for local scale analysis of the relationship between vessel [traffic] patterns and trends in likelihood of invasion events. It is precisely such a local scale expectation that the present study attempts to construct for Narragansett Bay.

In terms of the known patterns and mechanisms of non-indigenous species transfer, several characteristics[57] indicate the possibility that the container vessels arriving in Quonset will increase the transfer potential in Narragansett Bay over and above the currently existing likelihood of species introduction. Some of the characteristics are shared among all containerships, and others are specific to the projected traffic pattern with an endpoint in Quonset.

First, containerships [in general] are perhaps the best example of the constant, virtually daily movements of ballast water, typically taking up and discharging some quantity of water in a "Johnny Appleseed" ("Johnny Clamseed") fashion,[58] wherever they go. Containerships calling on Quonset will be no exception to this general pattern.

Second, as mentioned above, even if a number of containerships arrive in Rhode Island as NOBOBs, as currently projected, these vessels will still be carrying residual ballast, which will likely contain some species-rich sediment. The potential for species diversity and abundance in NOBOB vessels arriving at Quonset is additionally increased

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discussed at some length in the 1997 Cawthron Institute (NZ) comprehensive ballast study (Cawthron Institute Report # 417, 1997a).

[57] Characteristics of container-shipping in general, and expected containership patterns on Narragansett Bay in particular.

[58] Carlton et al., 1995, p. xvii.

by the fact that the new port is hoping to attract the larger, deep draft vessels of the container fleet. As most ballast is taken on board in coastal and estuarine areas that tend to contain high levels of species-rich sediment, deep draft vessels that are usually floating very close to the bottom scour bottom sediment into the ballast system.[59] The outcome of these intake processes is, ultimately, increased inoculation potential, as vessels stir and discharge the suspended sediment while performing the partial intakes and discharges associated with port entry.

Related to, and strengthening the risk effects of these constant daily movements of ballast is the increasing speed of modern vessels. The faster speed of transits, in NIS terms, signifies potentially increased survival rates for ballast-borne organisms, and therefore increased invasion probabilities: an unpublished Smithsonian Environmental Research Center study confirms the common-sense suspicion that transit time has a strong inverse relationship to the survival of the organisms in a ballast tank.[60]

The appearance of successful invaders in the donor region is important for the current study. The origin for Quonset traffic (determined by the fact that a port in Rhode Island is trying to capitalize on a perceived need for rationalized routings[61]) will be in Southeast Asia, and containerships coming to the state will potentially be making stops in the Mediterranean. The Mediterranean, as a heavily invaded region, presents a risk of

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[59] Marine Board, 1996, p. 35.

[60] Reeves, 1999, quoting a personal communication from Dr. Gregory Ruiz, Smithsonian Environmental Research Center (SERC), Edgewater, MD.

[61] QPP presentation to stakeholders, Fall 1998. For the projected rationalized routings, see Appendix 3, Figure 3A-1.

Rhode Island becoming a hub for further dispersal of invasive species.[62] East and Southeast Asia, the point of traffic origin, is also a donor region (with proven potential for dispersal) for red-tide causing toxic dinoflagellates.[63]

In conclusion, the significant increase in number of [transoceanic] ballast-carrying vessels arriving in Narragansett Bay as a result of port construction represents an increase in the size and intensity of the ballast transfer vector. Such vector change will respectively increase the likelihood of introductions.

How does the reduction in proposed port size affect the bioinvasion risks associated with port operation?[64]

The plans for sizing and location of the initially proposed mega-containerport were adjusted several times in favor of downscaling.[65] Designing a smaller port, as recommended by stakeholders and public interest groups, leads to significant decreases in cost, amount of dredge and fill area, and total terminal area. (Tables 3A-6 and 3A-7, Appendix 3) In terms of expected ballast and ballast-related risks, however, improvements from smaller port size are not nearly as significant. The larger changes in port scale do not translate into a perceptible reduction in vessel traffic numbers and intensity. Initial and final TEU volumes are lower under the downscaled alternatives, but this decrease reflects in reduction of average ship size, while the number of vessels

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[62] Donor region abundance in exotic species essentially puts the beginning of a “hub and spoke” model where an invader enters a high intensity transport hub (the center of a potential dispersal wheel) potentially to be carried along a corridor (one or more of the spokes radiating from the hub) to another transport hub which lies at the end of the spoke, and which in turn is another hub, and so on. (Carlton, 1996).

[63] Hallegraeff, 1998; Hallegraeff and Bolch, 1991; Hallegraeff et al. 1990, 1989, 1988; Ho and Hodgkiss, 1993; Kelly, 1993.

[64] This analysis refers to the scale-down of the original QPP port proposal as a result of stakeholder input.

[65] The precise dimensions of downscaling are illustrated in more detail in Appendix 3.

remains the same as under the initial megaport proposal. Since containerships don't ever carry ballast to capacity, yet they retain larger proportion of [potentially] sediment-rich unpumpable ballast compared to other vessel types, there is no evidence that the amount of ballast arriving to the bay, and especially the amount actually released, will be any different for bigger than smaller containerships. As previously discussed, the major bioinvasion risks associated with containerships are not so much a function of discharge volume as of other vessel and voyage characteristics.

## Ballast management options: availability and potential

The movement and release of ballast water are such that no coastal site, whether it receives direct transoceanic shipping or not, is immune to ballast mediated introductions. Given this susceptibility, a number of ballast control options are currently being considered. The goal of ballast management is to eliminate risk of incidental releases of non-indigenous species by rendering ballast free of such species, or at least very low in abundance and density of the transferred organisms. The principles of ballast management are similar to the basic principles of quarantine science – ballast management seeks to prevent unwanted introductions, but an important corollary to this philosophy is that no technology is able to guarantee 100% prevention.[66] Therefore, ballast controls serve as a filter, rather than an absolute barrier to invasions, but even so management leads to significant reduction in the likelihood of a successful release and establishment.[67]

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[66] Carlton et al., 1995; Marine Board, 1996.

[67] Carlton et al. 1995.

The most effective control method currently practicable for ships in international trade is the exchange of coastal ballast with open ocean water.[68] Countries and regions that exercise some level of ballast control, rely on exchange as the principal management option.[69] Exchange has some safety and efficiency considerations that make it less than universally applicable,[70] but even with such constraints, it still is the prevalent approach, since it is the one control alternative that does not require any changes in existing vessel equipment, i.e. vessels can perform exchange without having to make changes in design and/or retrofit.

A number of other control alternatives are currently at different stages of development. Techniques for rendering ballast free of undesirable organisms are often

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[68] The effectiveness of exchange in preventing aquatic introductions is due to the fact that there is practically no possibility for reciprocal introductions between open ocean and coastal environments. Open ocean exchange is not practicable for coastal traffic, but the present study is concerned with the management of bioinvasion risks stemming from the ballast of transoceanic shipping.

[69] Exchange can be carried out in two ways – empty-refill exchange, which involves pumping out the coastal ballast until the tank is empty, and subsequently replacing it with open ocean ballast pumped into the tank; or flow-through exchange, which involves flushing out ballast water by pumping mid-ocean water at the bottom of the tank and overflowing the tank from the top until sufficient water has been exchanged to nearly or entirely replace the coastal ballast and to flush out the organisms suspended in this ballast. (Marine Board, 1996) Not all vessels, and not all ballast tanks are equipped to perform flow-through exchange, since some tanks/vessels have a single pipe which serves as both an intake and discharge for the tank, making empty-refill exchange the only option.

**[70]** In terms of safety, an empty-refill exchange can, under certain conditions, make a ship unstable or lead to exceeding the allowable forces on the hull, with catastrophic results in both cases. Loss of stability may lead to capsizing or burying the bow of the ship in the waves, both resulting in the vessel's sinking; if the allowable forces of the hull are exceeded, a vessel can actually break. A flow-through exchange can pressurize the ballast hold, jeopardizing the integrity of the ship. These risks can be avoided, for the majority of vessels by careful monitoring of the exchange process. Also, most modern vessels, such as containerships, have computerized ballast systems which ensure automatic monitoring of all safety factors related to ballast, stability, and stress loads on a vessel. On the efficiency side, both types of ballast exchange are less than 100% effective (Carlton, 1995a; Hallegraeff and Bolch, 1992; Marine Board, 1996). For example, an Australian experiment with flow through exchange on the vessel *Iron Whyalla* showed 95% exchange of the original water and 75% removal of the dead plankton after a flush-through of approximately 3 times the original volume of water (AQIS, 1993). These results are corroborated by comprehensive ballast research conducted by the Cawthron Institute, New Zealand (Cawthron Report # 417, 1997a).

categorized in terms of the voyage approach to ballast management, dividing the control options depending on the stage in a vessel voyage at which they occur[71] – on or before departure, en route, or on arrival.[72]

It is now commonly recognized that a single preventive treatment for all vessels and all species transferred in their ballast is difficult to identify.[73] Given the multiple constraints and different vessel design limitations, an integrated approach, making available several alternatives from a broad menu of options, will eventually maximize the strength and success of ballast management. A number of important studies emphasize shipboard treatment methods as the control methods with greatest flexibility, and therefore greatest potential in the future[74] (See Appendix 2, Part B for more detail). Addressing the bioinvasions problem [inherent in ships' ballast operations] on-board, while the vessel is underway, will, in the long run, avoid the costly delays that can result from shore-treatment or close-to-shore treatment (e.g. receiver vessels). In addition, the creation of the necessary shore-based infrastructure, even if shore-treatments prove to be as promising in eliminating unwanted organisms as on-board alternatives, is not possible in every port. Therefore, such infrastructure will present only a partial solution to the problem, either restricting the mobility of ballast-carrying vessels, or compromising the

[71] Other examples of conceptual approaches to ballast management are the vessel, treatment, and industry approaches, where the vessel approach focuses on the size of the vessel and the distinction between existing vessels and future vessels, the treatment approach makes a distinction between control options based on the method of treatment (e.g. biocidal, mechanical, preventive), and the industry approach is concerned with economics and vessel and human safety of management options (Carlton et al., 1995).

[72] Marine Board, 1996. More detail on ballast management options availability and classification is provided in Appendix 2.

[73] Carlton et. al., 1995; Marine Board, 1996; Reeves, 1996.

[74] One of the influential studies ranking shipboard treatment options highest, because they are most flexible, is the Marine Board's Committee on Ballast Water study (Marine Board, 1996).

quality of treatment for locations that do not have the needed shore-treatment infrastructure, neither of which is acceptable. Presenting a menu of on-board options, from which each vessel can choose the most appropriate for its specifications and routings treatment is an advance that will not only increase the current efficiency of management practices, but possibly make compliance with ballast management requirements easier for the industry.

Finally, some research effort is also directed towards the development of better sampling and analysis techniques for ballast water.[75] Currently, monitoring parameters [salinity, for example] cannot provide conclusive results as to how much of the ballast had been exchanged [since vessels can rarely exchange all of their water].[76] Work in the area of monitoring is particularly important, since adequate sampling techniques are key to successful enforcement of ballast management regulations.

## Conclusions

This chapter provides some background on the marine bioinvasions phenomenon, and introduces the principal known vector for exotic species transfer – the ballast water of commercial shipping. The goal of the chapter is to address a question of increasing relevance to Rhode Island: What would the impact of channel dredging in Providence and port construction in Quonset/Davisville be on future risks of ballast-mediated introductions to Narragansett Bay? The review of port development planning, and the analysis of the bay's current and expected vessel traffic profiles in light of known ballast transfer and invasion dynamics leads to several important findings:

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[75] Cawthron Report # 418, 1997b.

[76] Carlton, 1995a.

**2.** First, a significant increase in vessel traffic can be expected to result from port construction in Quonset and channel dredging at Port of Providence. While precise projections for vessel traffic added by channel dredging have not been made, Quonset containerport construction (of a scale comparable to that of the latest proposals) can be expected to bring a 350% increase in the annual number of foreign vessel arrivals.

3. Increase in vessel traffic will also mean an increase in the frequency and intensity of the ballast transfer vector, and can therefore be expected to become the cause of increased introduction risks. A further increase in introduction risks may be associated with containership vessel and operational specifics, such as frequent ballast intakes and releases, and greater speed of transit

- Contrary to popular beliefs, the fact that many containerships may arrive as NOBOBs (that is, with no *registered* ballast on board) does not eliminate the risk of species introduction. A vessel registered as NOBOB may still carry several hundred tons of sediment laden, species rich ballast, which finds its way into local port waters as a result of the complex ballasting and deballasting operations performed during vessel entry into port.

Increased state attention to the problem of ballast-mediated bioinvasions is justified, considering the projected increase in bioinvasion risk for Narragansett Bay and the potential socio-economic consequences of a successful invasion. Increased amounts of transoceanic ballast released to the bay will mean a greater number of exotic organisms entering the bay ecosystem daily. While not all releases of exotic species result in invasion events, a number of released nonindigenous species may become harmful. These potentially harmful exotics and their serious consequences set the stage for ballast vector management in Rhode Island.

CHAPTER II:

## NATIONAL AND INTERNATIONAL CONTROLS ON BALLAST AND STATE JURISDICTION OVER THE ISSUE

### Introduction

The question of whether Rhode Island has jurisdiction to address the problem of exotic introductions through regulating the ballast water of commercial shipping is complicated by the fact that some federal, as well as international action targeting the issue of ballast-mediated bioinvasions already exists. This chapter reviews international and national controls on the ballast transport of exotic species, to identify gaps in the current regime of protection, and determine the extent and scope of state jurisdiction to regulate ballast.

### International Controls on Ballast

Exotic species introductions were first recognized with the mass occurrence of the Asian algae *Odontella (Biddulphia) sinensis* in the North Sea, in 1903.[77] The problem presented by such introductions was only acknowledged in the 1970s,[78] while policy response took even longer in shaping. In the 1973 International Maritime Organization (IMO) conference summoned to adopt a Convention addressing all aspects of marine pollution from ships (currently MARPOL 73/78[79]), the ballast water-species

[77] Hallegraeff, 1993.

[78] IMO, 1998a.

[79] International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 to become known as MARPOL 73/78 (short for Marine Pollution); IMO, whose mandate extends to ship pollution, and who serves as MARPOL's Secretariat, supervised the initial negotiation. The goal of MARPOL 73/78 is to create a verifiable, enforceable regime to prevent polluting discharges from ships. It consists of five annexes, each controlling a specific type of pollution. Regulations covering oil pollution (Annex I) and noxious liquid substances in bulk (Annex II) are mandatory for all MARPOL parties. The other three annexes are optional for adoption by parties (Hunter et al., 1998) MARPOL 73/78 Annex I and

introductions problem was raised, but specifically in the context of ballast transport of pathogens harmful to humans.[80] In the late 1980s, the catastrophic consequences of several invasions in Canada, Australia, and most prominently, the Great Lakes (zebra mussel), focused UN and IMO's lasting attention on the issue. A systematic, comprehensive framework is still needed to adequately address the problem in the future, but most major actions on bioinvasions continue to be taken as a response to invasion events with significant human impact. A chronology of political and legal actions on ballast transport of exotics helps illustrate the sporadic, event-triggered nature of ballast controls (Appendix 4, Table 4A-1).

The problem of ballast-mediated species transfer has received some recognition by broad environmental forums. Agenda 21, adopted at the 1992 UN Conference on Environment and Development, requests states to consider the adoption of rules on ballast water discharge to prevent the spread of non-indigenous species.[81]

The regulatory challenge of managing ballast is heightened by the diversity of both vessels and their ballasting systems, and the diversity of shipping routes, ports, and associated ecosystems.[82] Uniformity in operating procedures and training standards in accordance with an international legal framework is often seen as an optimal policy for reducing confusion and human error, and for promoting efficiency in control and risk reduction. The prospects for achieving international uniformity in managing ballast lie

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II are currently accepted by 108 states, representing 94.07% of world's merchant marine tonnage. U.S. is a signatory of Annexes I, II, III (Pollution of harmful substances carried in packaged form) and V (Pollution from garbage); Annex IV (pollution from harmful substances carried in sewage) is not yet in force.

[80] Ibid. 78.

[81] IMO, 1998b.

[82] Marine Board, 1996.

with the IMO Marine Environment Protection Committee (MEPC), which has been working on the problem since 1990. IMO has issued updated sets of ballast management guidelines, providing administration and port state authorities with information on minimizing risk of ballast-mediated introductions.[83]

The current status of the issue with IMO is defined by the ongoing work of the Ballast Water Working Group (BWWG) on drafting mandatory ballast management regulations. The observed IMO/MEPC shift from voluntary guidelines towards mandatory regulation is also characteristic of several national, regional, and local approaches. The shift reflects the evolving understanding of the mechanics and seriousness of the problem, as well as of evolving concepts on the management of ships' ballast as the most viable option for avoiding more bioinvasions in the future.

The projected time frame for further IMO action includes adoption of mandatory rules during the first decade of the 21 century. Regardless of the acceptance date, entry into force for the mandatory ballast regulations may take considerable additional time, depending partly on the selected international legal framework.

It is important to mention that some of the difficulties in compliance verification and enforcement encountered in regulating ballast on all levels of government can be particularly challenging if ballast regulation becomes exclusively in force at the international level**.** Detecting ballast related violations is difficult, and attributing a violating discharge with its invasion consequences to a particular vessel is mostly not

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[83] IMO, 1993. *Guidelines for Preventing the Introduction of Unwanted Organisms and Pathogens from Ships' Ballast Water and Sediment Discharges.* IMO Assembly Resolution A.774(18); IMO, 1997.*Guidelines for Preventing the Introduction of Unwanted Organisms and Pathogens from Ships' Ballast Water*, IMO Assembly Resolution A. 868(20); IMO, 1998. *Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens*. IMO, London, 1998.

possible. Adding to this detection and liability proof difficulties, in vessel pollution control on international level, enforcement and punishment of violators also present significant challenges, because of the separation of authority among flag, coastal and port states. The regulatory challenges presented by this separation are discussed in more detail in Appendix 3.

While it can mean a large progress towards uniformity and improvement of ballast controls, a binding international framework on ballast management may still encounter significant obstacles in securing prevention. It is, however, important to note that the path, direction, and development of IMO action regarding ballast control is representative of the development and direction of policy thinking on the problem across a number of countries and regions.

## National Controls

Some of the currently existing national and regional controls on ballast follow the IMO guidelines, and some, as in the Australian case, are the prototype for these guidelines. Therefore, while the voluntary and mandatory nature of ballast controls varies across nations, the large number of substantive operational requirements (precautions in ballasting, open ocean exchange, or ballast retention while in port) are similar across most of the few currently regulating countries. The fact that national control options that could be detrimental to the creation of a unified international control framework have not been exercised is one good indicator for the viability of national controls, until a more comprehensive framework is developed. It is also important that countries working on technological solutions to the ballast problem are collaborating with the MEPC-BWWG towards the development of internationally binding ballast management regulations**.**

The status of ballast controls on the national level, for the countries that currently exercise some level of control on international (and national) shipping carrying ballast to their coastal waters is summarized in Table 4A-4, Appendix 4. As partly illustrated by Table 4A-4, all the countries with existing controls mandate ballast treatment or exchange. The current prevalence of the strict regulatory approach is important to note, since there are a number of other options. For example, New Zealand, who prohibits discharge of foreign ballast without a permit, requires some vessels to post a bond of $ 10 000 to ensure compliance.[84] Another approach of interest is the Australian work on a ballast water risk assessment system to aid in a decision support system being developed to allow Australian authorities a more effective management of ballast water discharges from international (and coastal) vessels.[85] The ballast water risk assessment system envisions species-specific risk assessment for every vessel voyage, where assessment is based on variables such as port infection status, vessel infection scenarios, journey survival, etc. Some of the benefits to the risk assessment versus the blanket regulation approach, as listed by Australia are 1) improving the [perceived] low return on blanket strategies, through flexibility to determine whether the ballast of each incoming vessel poses actual risk 2) potential to minimize the risks of introduction of harmful aquatic organisms and pathogens into the Australian aquatic environment, 3) capacity to provide timely advice on whether exchange will be required, ability to provide ships' masters

[84] Cohen, 1998.

[85] The ballast water risk assessment is currently being developed by the Centre for Research of Introduced Marine Pests (CRIMP), to serve as a part of a decision support system developed by AQIS.

with scientific basis for a high-risk classification of their vessel, and capacity to give vessel captains guidelines on how to avoid high-risk classification in the future.[86] There are a number of problems with such risk-based approach, as discussed in the following chapter.

**U.S. Controls on Ballast**

IMO preventive principles and guidelines are an integral part of U.S. response, and the United States strongly supports the work of MEPC towards legally binding regulations on ballast.[87] The current sources of federal authority to regulate ballast and the transfer of exotics include dedicated ballast legislation as well as some federal statutes potentially applicable to the problem of marine bioinvasions. NANPCA 1990 and NISA 1996[88], complemented by the Presidential Executive Order on invasive species prevention[89] are dedicated to ballast control and species transfer prevention. Existing federal environmental legislation that could also be interpreted to encompass the problem of aquatic introductions includes the Clean Water Act (CWA)[90], the Endangered Species Act (ESA)[91], and the National Environmental Policy Act (NEPA).[92]

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[86] IMO 1999a; First National Conference on Marine Bioinvasions, January 24-27, 1999, Massachusetts Institute of Technology, Cambridge, Massachusetts.

[87] For example, The U.S. proposed revisions to the 1997 guidelines to encourage the development of new methods and technologies to address bioinvasions, and to provide a flexible framework for the adoption of these new methods and technologies (IMO, 1999c)The U.S. is also a signatory of all MARPOL annexes currently in force (see note 77 above).

[88] Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA 1990), later amended by the National Invasive Species Act (NISA 1996): 16 USC § 4701 *et seq.*

[89] Executive Order 13112 – Invasive Species, February 3, 1999, Pres. Fed. Reg. 35(5):157-210.

[90] 33 USC § 1251 *et seq.*

[91] 16 USC § 1531 *et seq.*

NANPCA started with voluntary ballast management guidelines for ships arriving at the Great Lakes from overseas. The voluntary guidelines became mandatory automatically, two years after enactment.[93] Mandatory ballast water regulations were amended in 1994 to include ships entering the upper Hudson River (see Appendix 4, Table 4A-2).[94] NISA 1996, which amended NANPCA, retained the mandatory regulations for the Great Lakes and the Hudson River, while enacting similar in content, but voluntary in nature guidelines for the rest of U.S. waters. Unlike the Great Lakes regime originally established by NANPCA, NISA did not stipulate for the voluntary guidelines to automatically become mandatory after a legislatively determined period of time.[95]

The Presidential Executive Order on invasive species prevention confirms a current trend towards increased attention to the problem.[96] In summary, NISA 1996 and

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[92] 42 USC § 4321 *et seq.*

[93] NANPCA allows alternative ballast water management methods if the Secretary of Commerce determines that these methods are “as effective as ballast water exchange in preventing and controlling infestations of aquatic nuisance species (NANPCA § 1101(b)(2)(B)(iii)). There have been no such determinations made or requested. However, on four occasions the Coast Guard has allowed ships not in compliance with regulations to conduct ad hoc alternative treatments: adding salt in the form of liquid sodium chloride (not likely to be permitted again), adding chlorine as liquid chlorine and sodium hypochlorite, and heating the water(a capability that few vessels possess (Cohen, 1998).

[94] Cohen, 1998.

[95] The transition to mandatory regulation depends on compliance with voluntary guidelines, where “degree of compliance” is to be estimated from the mandatory ballast reporting forms, required by USCG pursuant to NISA. Advice about what can be considered a “satisfactory” degree of compliance is currently being formulated by an ANSTF Committee convened specifically for the purpose. The USCG initiated transition to mandatory regulation can only take place 24 to 36 months after the initial date of voluntary guidelines’ entry into force. Given that the CG was 2 years late in enacting the voluntary guidelines (May 17, 1999, instead of the expected October, 1997), mandatory regulation would not even be considered before the year 2001 or 2002.

[96] The order calls for the creation of an Invasive Species Council, as well as for special consideration of all federal agency actions affecting the status of exotic species (See Appendix 4, Table 3 for further detail on the mandates of the Executive Order).

the Executive Order set a framework for prevention of harmful ballast-mediated introductions. They require further research on prevention and control methods, and mandate federal-state cooperation and regional coordination. Most importantly, NISA focuses on the establishment of prevention mechanisms to help avoid future introductions. The cornerstone of the legislation is the requirement for Coast Guard regulatory rulemaking to prevent the introduction and spread of aquatic nuisance species. To this end, the critical provisions in the ballast water regulations (released by the Coast Guard on May 17, 1999, pursuant to NISA requirements) are: 1) amendments to existing regulations for the Great Lakes and Hudson River ecosystems; 2) voluntary precautions for minimizing uptake of aquatic organisms and pathogens at ballasting and voluntary guidelines for open ocean ballast exchange (or alternative management) for commercial vessels with foreign ballast from outside the EEZ; 3) mandatory ballast reporting requirement for all vessels[97] coming from outside the EEZ. Table 4A-2, Appendix 4 gives more detail on the content of current federal regulations applicable to ballast. Also, Table 4A-3, Appendix 4 lists the sources of federal authority and the implementing agencies. [98]

The National Pollutant Discharge Elimination System (NPDES)[99] and “impaired water bodies” provisions of the CWA can both be interpreted to apply to ballast. NPDES

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[97] Except a few specifically exempted categories, such as vessels of the Armed Forces , for example.

[98] The principal ballast control regulatory and enforcement agency, as stipulated by NANPCA 1990 and NISA 1996, is the United States Coast Guard (USCG). An interagency body, the Aquatic Nuisance Species Task Force (ANSTF), co-chaired by the Fish and Wildlife Service (FWS) and National Oceanic and Atmospheric Administration (NOAA), has a NISA 1996 mandate to consult the Coast Guard on issues relevant to regulation. ANSTF also takes on the important functions of cooperating with regional, state and local governments in efforts to prevent further introductions, as well as of allocating authorized funds for research and management.

[99] 33 USC § 1311(a).

requires that all discharges from point sources [such as pipes] to water bodies [lakes, streams, the ocean] be regulated by [NPDES] permits. Vessels fit the definition of "point sources," as given in 33 U.S.C. §1311, and exotics released with the discharge can be interpreted as a "biological pollutant," but EPA still exempts vessels from the NPDES requirement. Under "impaired water bodies," a body of water classified as impaired due to a pollutant (including biological pollutants) gets listed, and a total maximum daily load (TMDL) of the pollutant in question needs to be stipulated by EPA.[100] A TMDL of zero ballast discharges would be the only way to prevent further impairment by exotics.[101] Therefore, while the CWA is by no means specific to marine bioinvasions, it is applicable to the problem of ballast mediated species introductions on at least two levels.

Similarly, the ESA could be used to prohibit ballast release. Since ballast from international shipping always contains a number of exotics, and since effects of such species on the habitat are unpredictable until they are too large to reverse, any release of ballast to a habitat of a listed species can be seen as jeopardizing such species. Ballast releases in areas that are known habitats of listed species can be viewed as a "taking" of listed species, [102] and therefore be prohibited under ESA. Obviously, the scope of ESA in addressing ballast-borne exotics is much narrower than the scope of the CWA: ESA only

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[100] 33 USC 1313(d) is the section that deals with additional state-determined effluent limitations (in the form of TMDL) for impaired water bodies.

[101] The California list of impaired water bodies, which included a finding that San Francisco Bay and the Sacramento-San Joaquin Delta are impaired by exotic species, was approved by EPA in May 1999. This triggered a requirement to develop a TMDL for exotic species, and the state agency responsible for implementing the CWA – the San Francisco Bay Regional Water Quality Control Board (RWQCB) – has proposed a TDML of zero for exotic species. The first step in establishing the zero-TMDL will be amending the Region's Basin Plan to prohibit the discharge of viable exotic organisms from vessels, allowing time to develop and implement appropriate technologies. (*Coastlines*, a publication of the Urban Harbors Institute, UMASS, Boston, www.epa.gov/nep/coastlines/).

applies to situations where both a listed species and ballast discharges are simultaneously present.

Finally, NEPA's Environmental Impact Statement (EIS) program, which mandates the completion of an EIS for any "major federal project significantly affecting the environment," can be used to require an assessment of the bioinvasion risks associated with federally-permitted shipping-related projects. Such assessments can lead to possible discussions of alternatives to ballast discharges.

None of the three [CWA, ESA, NEPA] potential sources of federal authority to regulate ballast have been used by federal agencies to date. In addition, the "mantle of voluntary protection" provided by NANPCA and NISA is still inadequate for ensuring optimal prevention from future exotic introductions.

Even though the current federal regulatory system is a framework for control of undesirable ballast-mediated introductions, it is not necessarily the framework that brings an optimal degree of prevention. There are gaps in the current regulation (and the potential for their perpetuation, even if the regulations become mandatory), which make the system insufficient in terms of the prevention it provides. The present shortcomings go beyond the certain [expected] degree of "permeability" characteristic for any quarantine system.

First, NISA mandated ballast exchange guidelines are voluntary for all U.S. waters except the Great Lakes and the Hudson River, where mandatory ballast management is in force. Second, the safety exemption for all U.S. waters [besides the Great Lakes] leaves ballast exchange entirely to the captain's discretion, with no

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[102] *Bruce Babbitt, Sec. of Interior v. Sweet Home Chapter of Communities for a Great Oregon,* 115 US 2407 (1995).

opportunity for Coast Guard to question a master's rationale for not performing an exchange. Under the voluntary guidelines, when the "safety exemption" is evoked, the Coast Guard has no power to suggest remedial steps such as non-discharge, or the use of receiver vessels. Remedial management procedures are the much more logical and balanced approach of the Great Lakes regime. This safety provision, amended to its present state by shipping industry insistence, is debilitating for the effectiveness of the entire set of guidelines. If a switch to mandatory ballast management is made while preserving the current scope of the safety exemption, this exemption can become a sizeable loophole compromising the integrity of the regulatory and management regimes.

Third, the decision of whether ballast regulations are to become mandatory is dependent on the degree of compliance with current voluntary guidelines, to be gauged on the basis of compliance reporting via the Ballast Water Reporting Form.[103] This form is filled out by the master [or officers] of each vessel arriving to a U.S. port, and only spot checks are performed by the Coast Guard as a form of verification for the truthfulness of reporting.  Finally, compliance verification and enforcement, especially in the case of ballast management, (which is even more complicated to verify and enforce than other instances of vessel-related pollution such as oil pollution for example) will remain a problem, leading to disincentives for compliance with suggested voluntary management practices.

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[103] The Ballast Water Reporting Form was developed by the National Ballast Water Information Clearing House in accordance with NISA mandates. The Clearinghouse was established in 1997 by the Smithsonian Environmental Research Center (SERC) in conjunction with USCG, pursuant to NISA requirements. It is currently collecting the information from all ballast water reporting forms, in order to compile the information which will help gauge the effectiveness of the voluntary guidelines in ensuring vessel ballast management.

## State Jurisdiction

U.S. law in the area of ballast management and marine bioinvasion control tends to contain mostly voluntary standards. Ultimately, regulating ballast is a quarantine type approach – some invasions will still continue to occur, no matter what type of ballast management system is implemented, now or in the future. However, the existing federal system fails to optimize the available ballast management potential, and has a number of gaps in terms of prevention. On the other hand, the relevant federal laws (NANPCA and NISA) explicitly encourage State participation in exotics prevention. In spite of this, the existence of federal legislation on ballast, as well as the international and trans-boundary nature of ballast regulation potentially raise the issue of federal preemption under the Supremacy, Treaty and Interstate Commerce clauses of the U.S. Constitution.

There are several possible causes of the type of federal-state regulatory conflict that would lead to federal preemption of state ballast controls. In general, where uniformity of national rules, or obligations to foreign countries are at stake, Congress can *expressly preempt* state action (altogether ruling out such action).[104] In the absence of express federal language, *conflict* or *implied preemption*[105] could still exist, weighing against state action. However, the base-line presumption is usually against preemption, and in

[104] Plater et al., 1998; Reeves, 1999; Nadol, 1999.

[105] *Conflict preemption* arises if it is impossible to comply with both the federal and the state provisions of law, but such preemption does not extend any further than the actual conflict – other provisions of the state law remain valid. *Implied preemption* is present when the general nature of the Congressional scheme implies a need for uniformity of regulation, or a need not to impair the negotiations of international regimes. Implied preemption may also be the case if Congressional legislation addresses a matter in which there is a "dominant federal interest," in which case the federal government may have an implicit intention to occupy the field of regulating a particular activity (Reeves, 1999; Allen, 2000).

favor of the validity of concurrent regulation by both the federal and state governments.[106]

A conservative view on the scope of federal maritime preemption rejects presumed validity of state vessel laws.[107] This view asserts that in the present era of international standards, when state statutes address a subject that is as comprehensively regulated by federal statutes and treaty obligations as the subject of merchant vessel safety and pollution prevention, any court reviewing those state laws in a preemption challenge should be guided by the decisions in *Ray v. Atlantic Richfield Co.*[108] This is meant to

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[106] A good illustration for the coexistence of federal and state law regulating vessel pollution/vessel discharges, as well as of the limited scope of conflict preemption can be found in the 1984 case of *Chevron USA Inc. v. Hammond,* 726 F.2d 483 (1984). In this case, an oil company challenge against Alaskan state law which prohibits oily ballast discharge into state territorial waters was overturned by an appeals court. The court ruling concluded that 1) in enacting the Ports and Waterways Safety Act (33 USC §§ 1221 *et seq.*) as amended by the Ports and Tanker Safety Act, Congress did not implicitly intend to occupy the field of regulating discharges of pollutants from tankers into a state's territorial waters, and that 2) the Alaska statute prohibiting oil tankers from discharging ballast into the territorial waters of Alaska if the ballast has been stored in a vessel's oil cargo tanks was not void on the ground that it conflicted with USCG regulations. Since the regulations in the Alaska statute did not conflict with those of the Coast Guard regulations, and since there was no irreconcilable conflict when the Alaska statute and the Coast Guard regulations were applied concurrently in Alaska territorial waters, the court concluded in favor of validity of the Alaskan statute regulating oily discharge.

[107] Allen, 2000.

[108] *Ray v. Atlantic Richfield Co.*, 435 US 151, 1558-159 (1978). In *Ray,* the Supreme Court reviewed the Washington Tanker Law (Washington Revised Code, WRC §§ 88.16.170 *et seq.*), following a shipowners' objection to a set of regulatory requirements imposed on tank vessels operating in Puget Sound. The state Tanker Law was reviewed in light of related provisions of the federal licensing, vessel inspection, maritime pollution, and port safety statutes administered by the US Coast Guard. The exact purpose of federal legislation applicable to a field in which the state seeks to regulate was at stake in this case, and the Supreme Court came to different conclusions regarding different contested provisions in the Washington State Tanker Law. Therefore, the case provides a useful checklist for preemption analysis (Reeves, 1999). The highlights of the *Ray* case, in terms of preemption analysis include the following findings by the Supreme Court:

- State regulation of major transoceanic vessels does not, *per se,* offend the Commerce Clause or the general structure of the Constitution; the Court emphasized that it does not "question in the slightest the prior cases holding that enrolled and registered vessels must conform to 'reasonable nondiscriminatory conservation and environmental protection measures…' imposed by a State." (enrolled vessels are those licensed under federal statutes to operate in the interstate/coastwise trade, while registered vessels are those licensed under federal statutes to operate in international trade)
- State requirements for pilot licenses in addition to those already required by the Coast Guard for vessels enrolled in the coastwise trade is explicitly prohibited by federal licensing and inspection statutes (46 USC § 215, 364). However, the validity of state and local pilot requirements for registered

suggest that such courts should largely reject the validity of concurrent state legislation.[109] The scope of federal preemption in *Ray* is, however, limited, and it is misleading to interpret the case as the basis for rejection of all state vessel regulations.

This "strict" approach to maritime preemption is based on a conviction that the purposes and objectives of federal law on merchant vessel safety and vessel-source pollution prevention will be undermined by state or local laws that disrupt uniformity or deny foreign vessels the benefits of reciprocity.[110] However, it is important to note that in the particular case of ballast, there is no binding international uniformity in regulation, and the national uniformity brought by NISA is one of voluntary guidelines insufficient to provide adequate protection. It is precisely the overall lack of uniform requirements, and the insufficiency of ballast regulations that create the legal and technical space for local and regional controls. In a situation where federal legislation is at the stage of minimum standards, states can [reasonably] be expected to exercise their legitimate police power in protection of citizens and natural resources. It is also important to note that if uniform international standards on ballast become available through an IMO generated, legally binding document, the shape of the document, as well as the signatory

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vessels, i.e. those vessels licensed [by the US] for international trade is expressly upheld; vessels registered for international trade have been traditionally regulated by the states, and are not covered in the federal pilotage statute.

- All construction and equipment requirements (specified horsepower, twin screws, double bottoms, etc) in the Washington Tanker Law were held invalid by the Supreme Court, subject to the "implied field preemption" against any but the federal regulation of design, construction, equipment, etc. of vessels (implied field preemption stemming from the PWSA (33 USC §§ 1221 *et seq.*) and other Congressional legislation aimed at regulating design, construction, manning, etc. with the express purpose of preventing environmental disasters as well as loss of property and life) (see Reeves, 1999).

[109] "Unless the governing federal law prescribes only "minimum" standards or otherwise provides state authority to issue different or more stringent standards, the overlapping state regulation is displaced. Any other approach would deny the supremacy of the federal law." (Allen, 2000).

[110] Allen, 2000.

conditions under which US enters a binding international treaty on ballast will be the ones to determine whether or not preemption of state law becomes necessary. In general, federal preemption should not affect state NIS and ballast regulatory schemes.[111]

Some tension between different views on federal maritime preemption remains. The narrow margin between legitimate exercise of state police power and state regulation subject to federal preemption is an important complicating factor in the discussion of state jurisdiction over ballast. A recent Supreme Court case touching on the subject of state regulation on shipping illustrates some of the complications.

In *US v. Locke*[112] the Supreme Court struck down four tanker safety regulations, enacted by the State of Washington in response to the 1989 Exxon-Valdez oil spill. *Locke* relied heavily on the 1978 decision in *Ray v. Atlantic Richfield Co.* , where the court found federal preemption over a similar set of Washington state tanker regulations, but also acknowledged that state regulation of major transoceanic vessels does not, *per se*, offend the Commerce Clause or the general structure of the Constitution.[113] Therefore, both *Ray* and *Locke* preempt state governments from regulating oil tankers in certain ways, because it has become an established federal priority (manifested through continuous federal legislation and international agreements[114]) to regulate tankers in these

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[111] As long as the state's regulation is sufficiently different as to serve a legitimate, identified state purpose, and as long as such regulation does not contradict with the federal scheme, so as to make it impossible to comply with both federal and state requirements, states are safe in adopting exotic prevention measures. Also see Nadol, 1999, and Allen, 2000.

[112] *US v. Locke,* (US Supreme Court, March 2000 [citation not yet available]).

[113] The Court in *Ray* emphasized that it does not "question in the slightest the prior cases holding that… vessels must conform to 'reasonable nondiscriminatory conservation and environmental protection measures…' imposed by a State."

[114] Federal legislation and international agreements regulating vessel design, safety, and operation include: The Tank Vessel Act of 1936, 46 U.S.C. prec §3701 and 46 U.S.C §3703; Ports and Waterways Safety Act of 1972 (PWSA), 33 U.S.C. §1221 *et seq.* ; The Oil Pollution Act of 1990 (OPA), 33 U.S.C. § 2701 *et seq.*;

ways (namely design, construction, alteration, repair, maintenance, operation, equipping, personnel qualification, and manning).[115]

There is no reason why the preemption of Washington state regulation on safety, crew training, manning/watchstanding should carry over to state regulation on ballast discharges from commercial vessels. Looking at the language and analysis in *US v Locke*, it becomes clear that even though state ballast regulations will be affecting vessel operation by posing an additional operational requirement – ballast exchange – this requirement is not the type that touches on operational dimensions[116] clearly (even though implicitly) reserved for federal regulation in accordance with international agreements. Even though both the ballast discharge and tanker safety regulation in question are motivated by state environmental concerns, state ballast regulation is different from state regulation of oil tankers questioned in *Ray* and *Locke* in that there is no implied federal intent to occupy the particular field of ballast regulation. To the contrary, relevant legislation manifests a federal interest in cooperation with the states on the task of ballast-mediated bioinvasions prevention. This interest amounts to granting concurrent state jurisdiction.

Further analysis of NANPCA 1990 and NISA 1996, the dedicated federal legislation on ballast water and nonindigenous species prevention, shows no federal

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International Convention for the Safety of Life at Sea 1974 (SOLAS), 46 U.S.C. §3201 *et seq.*, also 33 U.S.C. §1602; MARPOL 73/78; and the International Convention of Standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW), 46 U.S.C §8105 and 46 U.S.C. §14305.

[115] In its decision to strike the Washington tanker regulations, the court noted that "…wording in the federal Ports and Waterways Safety Act of 1972 that preserves state power to penalize oil spills does not open the door to the kind of regulations enacted by Washington state" and that in the areas of national and international maritime commerce "there is no beginning assumption that concurrent regulation by the state is a valid exercise of its police powers."

[116] I.e. standards of training, certification and watchkeeping etc.

intent to outrule state ballast action. There are no indications of implicit preemption either, to the contrary, NISA 1996[117] has multiple references to, and provisions for federal-state cooperation on the aquatic bioinvasions problem, including stipulations for federal funding of state plans addressing the problem on regional level.[118] The clear lack of federal intention to preempt is declared in a specific anti-preemption clause, which clarifies that

> "Nothing in this chapter shall affect the authority of any State or political subdivision thereof to adopt or enforce control measures for aquatic nuisance species, or diminish or affect the jurisdiction of any State over species of fish and wildlife."[119]

Therefore, state ballast regulation passes both the case law and statutory preemption tests.

Another source of possible federal preemption over state ballast controls, is the Commerce Clause,[120] which reserves for the federal government the right to regulate

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[117] NISA 1996, as mentioned above, complements and amends NANPCA 1990.

[118] Sections of the legislation explicitly dealing with Federal-State cooperation on the issues of ballast control and bioinvasions prevention include 16 U.S.C. §§ 4701 (a)(15); 4712(a)(3C); 4722(b)(3) &(c)(2); 4724.

**119** 16 U.S.C. § 4725. Congress' decision not to preempt state action is also explicitly stated in the USCG regulations enacted pursuant to NISA: "The Coast Guard will try to maintain nationwide consistency in methods for control of invasive species and is committed to ensuring national consistency for any regulations touching on the design, construction, equipment, manning and operation of vessels that were established as international rules and regulations adopted by the International Maritime Organization and ratified by the United States. However, this regulation isn't intended to preempt any State, regional, or local efforts that exceed but do not conflict with the standards set forth in this rule…" (Federal Register, Vol. 64, No. 94 (May 17, 1999), pp. 26672-26690).

[120] The Commerce Clause grants Congress the power "to regulate Commerce... among the several States." U.S. Const. art. I, 8, cl. 3.

interstate and foreign commerce, and, respectively, prohibits states to act in ways that burden such commerce.[121]

There are two potential Commerce Clause issues with state ballast controls. The first arises from the fact that the only way for the state to control ballast-related risks is to prohibit discharges of untreated ballast in state waters, and/or refuse entry to violators.[122] However, such restrictions may be perceived as an obstacle to commerce that is too large to be permissible, the goal of preventing invasions notwithstanding. The second Commerce Clause issue relates to the fact that state regulation, much like current federal controls, will only apply to transoceanic vessels, because there are no available, economically feasible options for managing the ballast of coastal traffic.[123] Technically, this could be perceived as a discrimination between different categories of the same type of commerce, and therefore considered a commerce clause violation.

In general, state legislation is offensive "economic protectionism" if it discriminates between interstate or international commerce, and the commerce of the regulating state. Discriminatory *effects* are acceptable, if the primary purpose of the state regulation is nondiscriminatory and *related to a traditional area of legitimate state regulation*.[124]

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[121] The Commerce Clause is also referred to as "dormant commerce power," since even if Congress has not specifically legislated in a particular area, the clause imposes negative implications that limit state powers to legislate (Plater, 1998).

[122] Outside its 3 mile territorial water jurisdiction, the state cannot impose requirements for vessels, that is, the state cannot "make" vessels exchange ballast 200 miles out to sea or obligate them to adhere to safe ballasting practices. On the flip side, however, the state can refuse to grant entry into its waters to vessels that have not performed ballast exchange and/or safe ballasting practices as described in existing ballast management guidelines.

[123] It is not practical to ask a vessel going between New York and Boston to go 200 miles out to sea and exchange ballast. Since exchange is the only practicable control measure, there is currently no rational way of managing the risk from coastal ballast.

[124] Reeves, 1999.

The fine margin between permissible and impermissible burden on commerce, and permissible and impermissible discriminatory effects, as imposed by state legislation protecting state's natural resources and environment, is well illustrated by comparing the cases of *Maine v. Taylor* (1986) and *City of Philadelphia v. New Jersey* (1978). In *Maine*, the Supreme Court upheld a [straight] prohibition on the importation of live baitfish from out of state, imposed by the state of Maine in order to protect its fisheries from parasites and non-native species entering with such live bait. The Court held that the Commerce Clause limitations on state regulatory power are not absolute, and that the States "retain authority under their general police powers to regulate matters of 'legitimate local concern.'" The Court's decision to uphold Maine's ban was based on the fact that the Maine regulation satisfied both requirements of the*Hughes* test,[125] namely that 1) Maine's ban on the importation of live baitfish served a legitimate local purpose and 2) this purpose could not adequately be served by available nondiscriminatory alternatives**.**[126] The court accepted the evidence that there was no other practical means to protect against the parasites and exotics, also stating that "the fact that other states may not have enacted a similar ban" and the fact that "fish can swim directly into Maine from New Hampshire" were not ground for preventing a state from using its best efforts to limit an [environmental] risk.[127] It argued that the ban was not a simple case of "arbitrary discrimination against interstate commerce,[128] and this result is particularly important for

[125] From *Hughes v. Oklahoma*, 441 US322 (1979), the test was constructed to distinguish between permissible and impermissible burdens on commerce, as imposed by state legislation and regulations.

[126] For further discussion about the significance of the case in determining the scope of state jurisdiction to regulate ballast and exotic species, see Reeves, 1999, and Nadol, 1999.

[127] *Maine v. Taylor*, 477 US 131, 150-1 (1986), and cases cited therein; also quoted in Reeves 1999.

[128] Ibid. *Maine…*

our discussion of the scope and extent of state jurisdiction to regulate ballast water in prevention of future exotic species introductions.

In the other case, *City of Philadelphia v. New Jersey,*[129] (1978), the result was quite opposite, and a New Jersey state ban on the importation of most solid and liquid waste originating outside of the territorial limits of the state was overturned, as it was considered to violate the Commerce Clause. The ruling was based on the fact that even though the ban served a legitimate state purpose – protection of the state's environment through protecting the limited capacity of state landfills,[130] this purpose could have been equally well served by regulation that was not discriminating, on its face, against interstate commerce; for example, the state could have restricted the total amount of trash accepted by the state's landfills, instead of plainly excluding out-of-state waste. In other words, the New Jersey statute failed to pass the *Hughes* test[131], thus qualifying as an unconstitutional under Commerce Clause scrutiny.

With respect to ballast, refusal of entry and/or discharge to non-complying vessels is the only leverage that allows a state to exercise ballast controls in protection of its aquatic and other resources. Regarding the amount of burden ballast regulations would impose on waterborne commerce, contrary to some popular beliefs, the ballast exchange requirement is not an unreasonably costly/difficult procedure which is apt to discourage trade. The arguments that mandatory ballast exchange requirements in one port will force

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[129] *City of Philadelphia v. New Jersey*, 437 U.S. 617 (1978).

[130] The rationale in the New Jersey statute banning the importation of waste (N.J. Stat. Ann. § 13:11-10) was that if the volume of solid and liquid waste continues rapidly to increase, the treatment and disposal of such waste will pose an even greater threat to environmental quality in New Jersey, as the capacity of available and appropriate landfill sites within the state is continuing to diminish, etc. (Plater et al., 1998).

[131] *Hughes v. Oklahoma,* 441 U.S. 322 (1979).

shipping to go deliver its goods to a different, more distant, but non-regulating port have never been backed by data. Given the high costs of the ever increasing in speed and technological sophistication modern shipping, undertaking an extra day [or several hours] in transit to avoid a port with ballast regulations will be much more costly than the several thousand dollar operational cost for ballast exchange. Therefore, state ballast regulation passes the Hughes test, and with it, Commerce Clause scrutiny: it does serve a legitimate state purpose – protection against invasions, and this purpose cannot be achieved by means that are less restrictive to commerce than the prohibition of untreated discharges.[132]

As to the distinction between vessels on coastal voyages versus those international voyages -- given the present complexity in the ownership and flagging of vessels, in controlling transoceanic ballast, a state will be effectively targeting a representative [and random] sample of shipping, in terms of ownership, flags [nationality of registry], and origin of voyage.

Constitutional and case law analysis therefore indicates that the state, in its pursuit of reducing the risk of bioinvasions, can impose ballast water controls, without fear of federal preemption.

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[132] The legitimacy of such exercise of state police power, even when regulation of waterborne commerce is concerned, is further reflected in the Supreme Court decision in *Huron Portland Cement Co. v. City of Detroit*,. 362 US 440, 447 (1959). In this case, shipowners docking their vessel in Detroit objected to a Detroit Smoke Abatement Code restriction on their vessel's smoke output. Shipowners argued that such regulation by the city was preempted by the comprehensive scheme of federal regulation of shipping in 46 USC and other statutes. The court held that "The mere possession of a federal license…does not immunize a ship from the operation of local police power, not constituting a direct regulation of commerce," and "Legislation designed to free from pollution the very air that people breathe clearly falls within the exercise of even the most traditional concept of what is compendiously known as the police power. In the exercise of that power, the states and their instrumentalities may act, in many areas of interstate commerce and maritime activity concurrently with the federal government."

Once again, it is important to note the clear limit to the state jurisdiction for regulating ballast. The mandate to regulate technological and safety aspects of the design, construction, manning and equipment of vessels belongs exclusively to the federal government, through a Congressional scheme expressing a “dominant federal interest” in a federal regime “filling the field” for that particular subject and purpose.[133]

As long as the state is mindful of its current constraints, it can still regulate ballast in a way that produces an important increase in prevention from invasions but does not overstep the limits to state jurisdiction.

Some states have already exercised their jurisdiction to regulate ballast and/or exotic species. Such states fall in three categories:

- those that regulate the introduction of exotic species, but do not include in their regulation controls on ballast water
- those who regulate the ballast water of commercial shipping, but not with bioinvasions prevention in mind
- those who regulate ballast with the goal of preventing future ballast mediated marine bioinvasions.

California is the only state that has presently assumed its jurisdiction over regulating ballast to prevent further introductions of exotics. The state recently enacted legislation mandating ballast management for all vessels coming into state waters. The California legislation essentially takes the federal ballast management guidelines (which

[133] Reeves, 1999. This principle is also reflected in the recently issued Coast Guard regulations on ballast (see citation from the 1999 Coast Guard regulations, above).

are practically the same as IMO and other national guidelines) and makes them mandatory for vessels coming into California ports. The legislation also narrows the scope of the safety exemption, asking for remedial management measures, such as exchange in a state-designated backup zone, or sealing of ballast pipes and non-release, for vessels that come in declaring it was unsafe for them to exchange ballast at sea, as required by the state's regulations.

Many states, including Rhode Island, regulate discharges of contaminated ballast, such as oily ballast.[134] However, no other state besides California has yet moved to regulate ballast discharges to prevent of exotic species releases.[135] Research into the legislation of three other Pacific Coast states - Oregon, Washington, and Alaska, points to the lack of ballast provisions in state laws dealing with the introduction of undesirable wildlife. The omission of ballast controls is a serious gap, which is likely to invalidate other steps currently taken to prevent introductions, as some of the greatest risks are posed by ballast.[136] Some regions, such as Port of Vancouver, have also moved to regulate ballast to prevent bioinvasions. Several other Canadian ports were considering the option, but did not act because they were either not exposed to transoceanic shipping, or because of anticipated legal challenges or enforcement difficulties, and or both.[137]

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[134] Rhode Island Public Laws § 46-12.5.1. The statute prohibits the discharge of ballast carried in the [oil] cargo holds of tank vessels into waters of the state. Also: Alaska Statute § 46.03.750, which also prohibits discharge of ballast water that had been carried in the cargo tanks of oil carrying vessels.

[135] For a brief account of legislative efforts to pass ballast water regulations in several other states (all of which pursuits turned out unsuccessful due to resistance in state legislatures or anticipated legal challenges), see Chesapeake Bay Commission, 1995.

[136] Nadol, 1999.

[137] Captain Dave Woodman, Harbormaster, Prince Rupert Port Authority, CA. Email communication (02.11.00).

Conclusions

This chapter addresses the question of whether Rhode Island has jurisdiction to regulate the ballast of vessels coming to state waters from transoceanic voyages. The question of state jurisdiction is somewhat complicated by the fact that there already is some federal and international action regarding management of ballast water. The main findings of the regulatory and legal analysis can be defined as follows:

- Ballast discharge is addressed in international and U.S. law, through the IMO Guidelines for the Control and Management of Ships' Ballast Water, [138] and the U.S. National Invasive Species Act.[139] However, the State of Rhode Island still has jurisdiction to act on ballast controls, for the following reasons:
- The federal ballast control and exotics prevention legislation currently applicable to state waters, and the regulations enacted by the USCG pursuant to this legislation, are, due to their voluntary nature, insufficient to provide optimal protection against bioinvasions in Rhode Island.
- Rhode Island has a legitimate interest in protecting state waters from the potentially catastrophic socio-economic and ecological consequences of aquatic invasions.
- The dedicated federal legislation on ballast and marine bioinvasions prevention allows for concurrent action by the states. State controls on ballast also fall within the limits imposed on state jurisdiction by the Commerce Clause of the Constitution, because ballast regulations serve a legitimate state purpose, without posing a burden

[138] IMO, 1998c.

on waterborne commerce that is large enough to justify Commerce Clause preemption. Therefore, in pursuing its legitimate interests as a natural resource trustee, the state will not be in danger of federal preemption, as long as state ballast regulations do not touch on design, equipment and safety aspects of vessel construction and operation.

- State-level action to control ballast will have the important added benefit of indicating to the maritime industry the seriousness with which Rhode Island views the problem of ballast-mediated species transfer.

[139] NISA 1996, 16 U.S.C. §§ 4701 *et seq.*

CHAPTER III:

WHAT ARE THE OPTIONS FOR RHODE ISLAND ACTION?

## Introduction

The shortcomings in the international and federal regimes for bioinvasions prevention, together with the expected increases in introduction risks for Rhode Island's coastal and estuarine ecosystems create a powerful rationale for state involvement with the issue. In spite of some limitations in state jurisdiction, there are important contributions Rhode Island can make towards strengthening the current degree of bioinvasions prevention. This chapter explores policy options suitable for controlling ballast at the state level and attempts to identify state actors and institutions which can implement these controls to protect state waters.

## Policy Instruments and Policy Choice

Series of policy options are currently available for addressing various environmental problems. Such options range from the more unidimensional, but widely applicable command and control [direct regulation] instruments, to the increasingly popular incentive-based tools for capturing the environmental consequences of industrial processes.[140] The spectrum includes approaches combining instruments from several categories, such as the combination of regulatory standards with flexible market

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[140] Some prominent examples of direct regulation include the instruments employed by major federal environmental legislation, such as the National Pollutant Discharge Elimination System (NPDES) discharge permits of the Clean Water Act (33 U.S.C. §1311, 1342) and the national ambient air quality standards (NAAQS) of the Clean Air Act (42 U.S.C. § 7409). Among the most common market-based instruments are the different deposit-refund systems, which put a surcharge on products or residuals whose improper disposal causes environmental problems, incorporating fee/surcharge recovery with approved disposal.

strategies. Such combinations can allow affected industry to comply with regulations by using traditional mechanisms for minimizing marginal costs.[141]

A range of concerns is associated with the instruments in each of the major policy categories. Direct (command and control) regulation, even though critical for achieving environmental protection in a number of vulnerable areas, is often associated with high administrative costs and a potential for chilling effect on industry-driven [pollution control] innovation, as well as with inefficiencies due to oversimplification of standards or the lack of complete knowledge of the regulated industry.[142] Market incentives, in spite of their purported advantages in efficiency and their stimulating effects on industry [pollution control and prevention] innovation, can fall short in ensuring equitable distribution of environmental costs and benefits. Given the difficulties in monetizing the benefits of environmental and ecological services,[143] it is also hard to be sure that market strategies set the right price for industrial use of such services, i.e. to be sure that all environmental costs are internalized in the industrial decision-making process.[144] Compliance monitoring and enforcement of different policies and regulations also remains a common challenge across categories of policy instruments.

One of the underlying issues in policy formulation is the question of choice among different policy instruments. An important side of the policy choice equation is the question of "fit" between a policy instrument or strategy and the issue that needs to be

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[141] E.g. tradable discharge permits, where a standard for maximum allowable total discharge is combined with the creation of an artificial market for the trading of discharge permits among industries.

[142] Vig and Kraft, 1997.

[143] Constanza et al., 1997.

[144] Vig and Kraft, 1997; Page, 1978.

addressed. Another important factor influencing instrument choice is the order of priorities in addressing a problem. For the same environmental concern, a goal of achieving the most efficient policy solution will result in a different choice of tools than a goal of achieving the most equitable outcome. The increasing shift towards maximizing the cost effectiveness of selected management and regulatory strategies has also had important impacts on the thinking about and practice of environmental policy, leading in some cases, to reorganizing priorities in regulation, and in others, to re-writing the regulatory equation to include cost.

A policy context for ballast management

What 'tools' can the state use to prevent the discharge of untreated transoceanic ballast into its waters?

A coherent menu of ballast control policies has to take into account the characteristics of the ballast transfer vector, and select policy options on the basis of "fit" to the context of the problem and to the primary goal – prevention of untreated discharges.

Ballast water is distinct from other vessel-related discharges with environmental impact. The first difference between the release of exotics and that of conventional pollutants is the unidirectional, irreversible nature of invasions. Once well established, invasive species are not extricable from the environment. To call invasions "biological pollution" is thus to perhaps set up hopes that we can "clean it up," as we do with most other pollutants, [145] which cannot be done with exotic species.[146] The irreversible nature

[145] James T. Carlton, personal communication, (11.15.99).

[146] Moreover, a number of exotic species -- on land, in freshwater, and in the ocean -- would or could hardly be regarded as "pollution," such as the thriving and economically important Japanese (Pacific)

of bioinvasions is the critical feature that makes prevention of species release, and in this case, prevention of untreated discharges of ballast, the only meaningful management technique

The second important difference between ballast and other vessel discharges of concern is the high uncertainty associated with the outcome of a particular ballast discharge event. There is no applicable across discharge events relationship between a species introduction and the resulting ecosystem impacts.[147] There is also no calculable numerical probability applicable to a set of discharge events and characterizing the likelihood of an invasion associated with such an event.

Related to this uncertainty in prediction is a third difference: ballast is not amenable to a risk-based control approach. Risk analysis methods can help evaluate alternatives and optimize the selected control strategy for a specified unwanted organism, while the heart of the problem with marine bioivasions is that in the majority of cases it is not possible to "specify," unwanted organisms, or likely invaders. Dealing with specific organisms only addresses a small subset of the problem, given the continuing invasion "surprises" and their increasing rates.

The fourth difference between ballast and other vessel-related discharges is the fact that ballast, as opposed to, for example oil, is invisible in the marine environment. This means that by observing a vessel discharge, we have no means of quickly determining whether it is discharging treated or untreated ballast. There is no way of

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oyster industry of Washington and British Columbia (James T. Carlton, personal communication, 11.15.99).

[147] That is, there is no general type of effect that can be expected in the case of a ballast discharge, while the effects of a crude oil spill for example can be anticipated, within a range.

testing the recipient water and making a deduction about the nature of the discharge either, and (because of the expected delay between the occurrence of an invasion event and its discovery), it is impossible to trace an introduction back to a particular vessel or discharge.

The fifth difference between ballast and other risk substances is that as yet there is no way of fingerprinting ballast to establish, beyond doubt, whether it has been exchanged as prescribed or not.[148] Since ballast tanks may contain water from multiple sources, mixed together, logical approaches to testing such as salinity or chemical composition, may not always produce conclusive results. Sampling for organisms and their subsequent identification, while possible, is very time consuming and can be expected to present problems in large scale monitoring schemes. On the positive side, there are possibilities for alternative monitoring approaches, which would allow exchange verification without direct inspection. One such option is a “black box” type device, such as a ballast pipe flow meter that records the location (through a GPS system), time, and amount of ballast intakes/discharges, and feeds this information as “read only” data to the ship’s computer, which can electronically transmit the data to a compliance monitoring agency, prior to ship’s entry into territorial waters. Such easily verifiable technological options, which are not currently available for ballast (but could greatly facilitate compliance monitoring and verification), are key to the success of MARPOL’s oil pollution prevention protocol, for example.[149]

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[148] Reeves, 1996.

[149] Hunter et al., 1998.

These specifics of the ballast water vector indicate the need for a carefully designed policy approach.

**Ballast policy criteria**

The central question of "How can Rhode Island prevent the discharges of untreated transoceanic ballast into state waters?" can be answered by looking at two related issues: the policy instruments and strategies applicable towards the goal of regulating transoceanic ballast in state waters, and the agencies and actors who could become a part of the prevention and control process.

In terms of policy instruments, a list of prerequisites for a successful state ballast control policy can be constructed on the basis of the distinctive characteristics of ballast water, with recognition of the limitations to currently practicable [ballast] control technologies, and the limitations to the quarantine system itself. Such requirements can be divided into two categories: minimum requirements, or the ones which must be present in a policy option for that option to be applicable to ballast, and highly desirable requirements, or the ones that would make a policy option particularly good fit for ballast control. This study identifies four minimum requirements for the success of a state-level ballast policy (see Table 3-1).

**Table 3-1: Criteria for a successful state ballast control policy**

| STATE BALLAST POLICY – MINIMUM REQUIREMENTS |
|---|
| • Strong focus on preventing the discharge of untreated ballast, and a reasonable capacity to deter (as opposed to penalize after-the-fact) such discharges[150]<br>• Adherence to policy and management options that fall within the scope of state jurisdiction[151]<br>• Flexibility and applicability across the entire range of transoceanic vessels calling on state ports[152]<br>• A reasonable balance between deterring untreated discharges and discouraging shipping to state ports altogether[153] |

| STATE BALLAST POLICY – HIGHLY DESIRABLE CHARACTERISTICS |
|---|
| • Potential for transferring the burden of compliance monitoring and verification away from the state and on to the industry[154]<br>• Lower requirements for bureaucratic capacity, compared to other policies of equal effectiveness[155]<br>• Lower cost of implementation, compared to other policies of equal effectiveness[156] |

[150] This requirement, again, comes from the irreversible nature of invasions, which makes prevention the only approach for addressing the core of the bioinvasions problem. Preventing untreated discharges is very different from simply imposing a fee for such discharges, as well as from reliance on fines after-the-fact. Whether prevention is achieved through powerful regulatory deterrence against untreated discharges, or through incentives that are strong enough to ensure that ballast management is performed, the existence of a strong preventive capacity is the most critical feature of a successful ballast control strategy in general, and a state control strategy in particular.

[151] Because of the somewhat limited scope of state jurisdiction over shipping, state ballast controls cannot impose design, construction or retrofitting requirements (that is, requirements for additional ballast treatment equipment); requirements touching on safety and/or watchstanding etc., even if such are relevant to the control of ballast, are also outside the scope of state jurisdiction.

[152] Policies have to be selected so that they are non-discriminatory among the different members of the shipping industry, given that the vessels calling on state ports range from modern, mega-company owned ships, to older vessels owned by smaller shipping companies.

[153] That is, a balance between deterring non-compliance and punishing violators on one hand, and preserving [not impairing] the attraction of state ports to shipping on the other.

[154] Such transfer can include selection of requirements that are well-defined and easily verifiable, and can therefore be entrusted to private certification agencies, or the selection of policy options with such strong deterrent capacity, and penalties if an invasion occurs, that strict compliance monitoring becomes unnecessary.

[155] This also means that strategies that make it easier [or altogether unnecessary] to [physically] monitor vessels on a regular basis, if such are available to the state, will be preferable to monitoring-intensive policy strategies and instruments.

In terms of ballast control technologies and technical management alternatives, it is now well understood that no one option or alternative can satisfy a management philosophy seeking to prevent the introduction of all organisms, ranging from bacteria and viruses to algae and higher plants.[157] As a result, the synthetic approach of choosing a number of [technical] alternatives from a broad menu of options is gaining in recognition and use. Ballast management should very much be an integrated approach on the policy level as well, since the complexity of the ballast problem is best addressed by a combination of policy instruments. The policy analysis of state control options will therefore discuss individual policy instruments potentially applicable to state ballast management, together with combinations of such instruments into ballast strategies. The ultimate choice of a state policy, however, will be guided as much by an understanding of the need for integrated approaches, as by the recognition of limitations in the latitude for state action with respect to ballast.

The categories of information [or knowledge-based] instruments, direct regulatory instruments, and market incentive instruments are frequently used to classify different policy tools.[158] This classification is partly relied on in the [following] analysis of policy approaches potentially applicable to ballast control in Rhode Island. The policy options analyzed in more detail, in order to determine their potential for state-level ballast management, are summarized in Table 3-2.

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[156] Ibid.

[157] Carlton et al., 1995.

[158] Fiorino, 1995; O'Hare, 1989.

**Table 3-2: State Ballast Controls – Policy Alternatives**

| Policy Strategy | Ballast Control Application | Main Advantages | Major Dis |
|---|---|---|---|
| **<u>Risk communication</u>** | <u>Voluntary guidelines</u> – provide shipping industry with information needed to understand the risk of bioinvasions, and with ballast management guidelines to help shippers reduce this risk | - Lower implementation costs (lower compliance monitoring requirements, no enforcement requirement, since the hope is that the voluntary guidelines will elicit compliance through persuasion) | - Insufficie high risk of therefore [p preventive |
| **<u>Direct regulation</u>** | **<u>A ban on discharge of untreated ballast</u> --** (accompanied by regulations detailing acceptable treatment, in the case of the state – ballast exchange, as the only currently available off-the-shelf technology that does not require changes in vessel equipment in order for a vessel to comply) | <u>- Significantly strengthens the level of bioinvasions protection (and prevention against untreated discharges) provided by voluntary guidelines</u><br><br><u>- Easy to comply with</u><br><u>- Applicable to all vessels</u> | <u>- Administ compliance falls on the</u><br><br><u>- There are or control t</u> |
| **<u>Incentive-based</u>** | **<u>Strict, collective liability system</u> –** Compliance is measured by the presence or absence of new invasions; collective liability is sought for each new invasion, and assurance (performance) bonds are required [to be posted] by shippers to ensure liability coverage | <u>- Strong deterrent capacity – non-compliance becomes so expensive, that compliance is virtually guaranteed</u><br><br><u>- Lower cost of monitoring and enforcement</u> | - A gap -- n technologie potentially 100% comp practices (n difficult to<br><br>- Likely to applied on |
| **<u>Incentive-based</u>** | **<u>Ballast tax</u>, charging differentially treated and untreated ballast** | - Relatively straightforward | - Creating i<br>- Virtually<br>- Therefore |

**Policy options for state ballast control**

The current federal system for controlling ballast in prevention of bioinvasions relies heavily on risk communication, a knowledge-based policy approach. The initial federal response to the species introduction risks posed by the ballast operations of transoceanic shipping was to provide the shipping industry with information needed to understand the risk, as well as with voluntary ballast management guidelines that could be used to reduce such risk in the future.[159] As with other knowledge-based instruments, the expectation with voluntary ballast management guidelines is that they would influence behavior towards avoidance and reduction of the risks. Are information-based instruments, such as risk communication through voluntary guidelines, a promising tool in state-level prevention of untreated ballast discharges? This key question can be answered by comparing ballast to another environmental problem -- radon, where risk communication is successfully used to influence behavior towards risk reduction. Radon, which occurs naturally in the soil can result in [heightened] human exposure if a combination of high radon levels and poorly ventilated or structurally damaged housing is present. State and federal agency radon guidelines communicate risk to households as a form of persuasion.[160] Such guidelines are successful in reducing household radon levels because of the strong incentives that households have, once informed, to act on eliminating the risk of exposure in their homes. Comparing the cases of radon and ballast, we can find a critical difference: with ballast-related invasion risks, there is a decoupling between those who bear the risk and those who are in a position to reduce this risk. While

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[159] Initially, all ballast management guidelines were voluntary, followed by a [legislatively mandated] switch to mandatory regulations for the Great Lakes and the Hudson River in 1993.

[160] Fiorino, 1995.

with radon households both bear the risk and are in a position to mitigate it, in the case of ballast-borne exotics the public at large carries the risk, while the shipping industry, as the cause of this risk, is the one in a position to reduce it.[161] This decoupling can be expected to impair the potential success of knowledge-based tools in ballast management and prevention. Indeed, the shipping industry has shown no interest in reducing the risk of ballast-mediated invasions, and has demonstrated its reluctance to act in different ways and on multiple occasions.[162] The lack of industry interest in managing ballast undermines/diminishes the potential for success of not only risk-communication, but of technical assistance approaches as well: providing compliance assistance to shipping that appears to have little intention of complying with voluntary guidelines would hardly contribute to the over-all success of a preventive strategy. The community right-to-know information model, based on providing communities with information on potential threats to local health and the environment, and therefore empowering such communities to work with industries towards reducing risk, is even less likely to fit in the case of ballast. The large uncertainty associated with the likelihood of introductions, the fact that vessels don't know what types of organisms they are carrying in their ballast, the high mobility of shipping as the risk source, and the decreased visibility of commercial shipping due to the removal of port facilities away from the centers of population and commercial

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[161] Note that this analysis throws further light on the reasons for insufficiency of protection provided by the voluntary federal guidelines on ballast management.

[162] The shipping industry's reluctance to reduce invasion risks by managing ballast is clearly demonstrated in a number of ways: 1) the unsubstantiated claims that ballast management is too expensive 2) the frequent exaggeration of the risk component involved in exchange, and the continuous [and successful] lobbying for broadening the scope of the safety exemption, to the point where the exemption is so broad for most US waters as to practically invalidate the purpose of the ballast management requirements, and 3) the continuing rhetoric of "just give us a reasonable [ballast] management strategy, and we'll gladly comply with it," always followed by an attack of proposed measures on cost, safety etc. grounds.

activity, would all act to impede any possible community participation in decisionmaking about ballast water and ballast management.

Direct regulation is a second possible way for the state to approach the problem of controlling untreated ballast discharges. While a number of instruments fall under the category of direct regulation (including ambient standards, emission standards, restrictions, and bans), a ban describes most accurately the current federal approach to controlling ballast in the Great Lakes and the Hudson River, where the requirement for ballast exchange prior to entry is equivalent to a prohibition on discharge of unexchanged ballast.[163] Several factors make ban-type instruments a well-suited regulatory tool for ballast.[164]

Would a ban on the discharge of untreated ballast work at the state level, and how? Rhode Island can significantly increase its current level of protection against untreated ballast discharges by taking the voluntary federal guidelines and making them mandatory for vessels calling on ports within state waters. To achieve this increase in

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[163] As a reminder, ballast regulations currently in place in the U.S. (enacted by the USCG pursuant to NISA mandates) include the mandatory ballast exchange/management requirement for vessels calling on ports in the Great Lakes and the Hudson River. Similar mandatory exchange requirements are in place for the Port of Vancouver, British Columbia, as well as…

[164] Most importantly, all levels of government are limited in the scope of their maritime jurisdiction to prescribe. Even national governments, who have the broadest scope in terms of maritime jurisdiction, are limited in their capacity to prescribe rules and regulations by the 12 mile territorial sea limits (UNCLOS). Outside of the territorial sea, governments cannot impose any requirements on vessels, besides the vessels carrying their country's flag/i.e. the vessels licensed in their country. In other words, while vessels registered in the U.S. can be "made" to exchange ballast on the high seas (a requirement, or standard) other international vessels posing the same ballast risks cannot be required to perform such operations, since prescribing actions to foreign registry vessels on the high seas would be an exercise of extraterritorial jurisdiction, which is beyond the power of both national and regional government. Since all transoceanic shipping, regardless of country of registry, poses a similar risk of ballast-mediated invasions, uniform ballast regulation for all transoceanic shipping, regardless of country of registry, is necessary on both practical [bioinvasions prevention] and economic and political [avoidance of trade protectionism type actions] grounds. Therefore, the flip side of prescriptive regulation -- a prohibition on the release into national or state/regional waters of ballast which has not been [previously] treated according to specified regulatory standards --becomes the optimal response to the invasion risks posed by transoceanic shipping.

prevention, the state will also have to narrow the scope of the federal safety exemption, making sure that vessels which claim that they were unable to safely exchange ballast at sea were really motivated by safety concerns. To that end, the state can compile and monitor compliance records, and investigate vessels with repeated non-compliance. Such strategy will send a message the shipping industry, indicating that the state is serious about enforcing ballast regulations, a message that in itself will deter non-compliance. Sealing of ballast tank pipes to prevent untreated discharges in state waters [for repeated non-compliers] can be used to reinforce the message of state intent. To provide adequate exotics protection, state regulation should also explicitly prohibit any sediment disposal in state waters.

Rhode Island can prohibit the discharge of untreated ballast without triggering federal preemption, as long as state ballast legislation does not try to mandate vessel equipment standards, or crew procedures during exchange. A ballast exchange requirement will also satisfy the conditions for uniform treatment of all regulated vessels, and for reasonableness of the burden on shipping[165] (see chapter 2 – ballast exchange is not so difficult or expensive as to discourage ships from calling on ports in regulating regions/states).[166]

[165] Once again, both with direct regulation and the other policy instruments involved, this analysis only considers ballast exchange, because it is the currently practicable control option, and also applicable to a relatively wide range of the commercial vessels currently in operation.

[166] Other regulatory instruments, such as emission standards and ambient standards cannot really be considered as viable approaches to ballast control: given the uncertainty associated with the organismal content of individual vessel ballast, and particularly with the consequences of individual ballast releases, and given that marine invasion ecology is unable to narrow this uncertainty to a reasonable predictive capacity, there is no basis for the setting of emissions or ambient standards, except at a zero level. Given the continuing challenges of assessing the ecological consequences and economic costs of bioinvasions, zero-discharge of exotic organisms is the only reasonable standard to set. This brings us back to the idea of a ban on untreated discharges. Of course, as mentioned several times before, zero-discharge is not practicable in the context of ballast operations, but the policy and technological approaches that come closest to minimizing organismal discharges are the only rational alternative.

The problem presented by vessels registered as “no ballast on board” (NOBOBs), is likely to become significant in Narragansett Bay. To address this problem, the state can explore, in addition to the general ballast exchange requirements, regulations for preventing incidental sediment disposal resulting from in-port ballast operations of vessels originally arriving under the NOBOB classification (see Chapter one for a detailed explanation of the mechanism). Options such as receiver vessels and partial flushing prior to any intakes and subsequent discharges in state waters should be considered. Onshore sediment disposal could also be an alternative. The practical viability of such approaches, however, will have to be determined through cost studies (currently not existing) and further legal analysis. The results of the cost studies may have an impact on the outcome of the legal analysis of state jurisdiction, since a prohibitively high cost may trigger commerce clause concerns and the potential for federal preemption of state onshore sediment disposal and/or receiver vessel requirements. Requiring vessels to regularly clean their ballast tanks of sediments, as a pre-condition for any ballast operation involving discharge in state waters, as well as requiring adherence to “good housekeeping” practices[167] will be a useful provision in any state ballast legislation, even though the value of these requirements will be more “aspirational” than practical, since the state lacks any extraterritorial jurisdiction to monitor and enforce such conditions. On the other hand, the state is in a position to inspect the ballast management records of vessels, and such records, if properly maintained, would contain sediment disposal information.

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[167] E.g. the practice of not ballasting at global “hot spots,” near sewage outfalls, during algal blooms, at shallow spots where propellers are likely to stir sediment that is subsequently taken in with the ballast water, etc.

There are several drawbacks associated with regulating ballast directly. Most importantly, the administrative cost of monitoring and enforcement can be high, given the difficulties associated with compliance verification for ballast exchange. The most successful regulatory and enforcement schemes used in other instances of regulating vessel related marine pollution, such as the strategies used against oil pollution by MARPOL 73/78, are unfortunately not transferable to ballast regulation. While MARPOL relies on combining mandatory non-discharge standards with easily certifiable technical [vessel] specifications, and uses private certification societies for verifying compliance with the technical requirements, ballast management will be hard put to duplicate this approach. For one, there are no easily certifiable technical requirements for ballast, which makes compliance verification more expensive, since the cost of such verification cannot be passed on to the industry through mandating the use of private certification societies. In addition, even if there were easily certifiable technical requirements, the state would be unable to take the initiative in imposing such requirements, since regulating vessel equipment, design, construction etc. is outside the scope of state jurisdiction. Finally, the fact that non-compliance is less obvious, and more difficult to spot in the case of ballast, eliminates the use of innovative compliance strategies, such as a bounty system aiding state monitoring and enforcement efforts. If in observing a discharge it were possible to distinguish “OK” discharges from “bad” ones, which is not the case, a bounty system for rewarding citizens/vessels reporting unauthorized discharges could be set up in addition to targeted state inspections.

Despite the current lack of a mechanism providing absolute certainty in compliance verification, the existence of a strong monitoring and enforcement scheme, built on the fact that violations can be detected, even if not 100% of the time, would in itself be a strong incentive for compliance with ballast management requirements. This is especially true, since in the presence of mandatory ballast reporting, incorporating less direct strategies into the compliance monitoring scheme, such as monitoring ship logs[168] for ballast operations data, can prove very useful in the short term.

In general, a regulatory ban on discharge of untreated/unexchanged ballast into state waters is an important instrument for increasing prevention against bioinvasions for the state's coastal and estuarine ecosystems. Such ban will directly reduce the likelihood of future invasions, and the state is in a perfect position to step in and exercise its function of a natural resource trustee, preventing ballast-mediated introductions through direct regulation of transoceanic ballast.

Given industry resistance to ballast exchange guidelines and requirements, some direct regulation will be a necessary part of any state management strategy. Therefore, it becomes important to consider different compliance and enforcement techniques that can be applied to state ballast controls in order to reduce the administrative burden of compliance monitoring, as well as to strengthen industry incentives to comply.

## Additional options

One compliance strategy that can not only increase industry motivation to follow state ballast management regulations, but also relieve part of government's compliance monitoring effort, and ultimately make the industry a stakeholder in the development of new ballast management and monitoring technology is a strict, collective liability system on exotic species introductions, supported by assurance bonding requirement for

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[168] The log is the critical operational information document on board each vessel, and its keeping/entry

shippers, as well as for private operators of [major] port facilities in the state. The basic precept behind a liability system is that degree of industry compliance is best reflected in the occurrence/non-occurrence of new introductions after the date of entry into force of mandatory ballast management regulations. Introductions occurring after this date are interpreted as evidence of non-compliance, and collective liability is sought from all shippers calling on the regulated waters during the period in which the new invasion is estimated to have occurred. To ensure that there will be no default on such liability, the regulating government can require posting of assurance bonds by all shipping companies whose vessels are using state port facilities. While there has to be a ceiling on the amount of individual bonds, the value of such bonds will have to be set sufficiently high, to account both for the fact that in the case of an invasion the bond money may be called upon to cover potentially catastrophic consequences, and for the fact that because invasions are irreversible, their ultimate cost, whether it is fully monetized or not, will [likely] be much higher than the collective assurance bonding system is able to cover. At the same time, the necessarily high value of the individual bonds will serve as a powerful deterrent against noncompliance, a highly desirable outcome given the irreversible nature of species introduction. Since the value of the assurance bonds [if they are collapsed upon] will be covered under vessel insurance, the bond-supported liability system will also create an important incentive for insurers to take interest in the ballast compliance records of vessels from shipping companies they insure. Insurance companies' vested interest in vessel compliance is another desirable outcome: it passes part of monitoring on to the private sector, getting industry to internalize some of the cost for addressing the ballast transfer problem caused by its operations.

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protocol requirements are regulated internationally and by countries with merchant fleets.

A liability system will be closely dependent on reliable and consistent field monitoring that is able to detect introductions as they occur, therefore triggering liability enforcement.

The major problem with a strict liability scheme is in the fact that there is no management practice that guarantees a complete elimination of invasion risks, that is, it is possible for an invasion to occur, even in conditions of full compliance with management requirements by transoceanic vessels.[169] There are two possible ways to deal with this problem. Both start with acknowledging that even if ballast management, like any other quarantine system, remains somewhat permeable, the rate of invasions with ballast management is significantly lower than the rate of invasions when no management is performed. Understanding this difference in rates, an attempt can be made to determine a maximum possible number of invasions that can be attributed to permeability in the quarantine system. An alternative approach, and one that better accounts for the fact that an invasion that occurs in the conditions of perfect compliance can still have a catastrophic economic or ecological effects, is to follow a simple liability system, where every invasion triggers a collection of assurance bonds money. A ballast policy framework based on this approach will essentially acknowledge that even though an invasion can occur in the conditions of perfect compliance with ballast management requirements, the financial burden for addressing the consequences of such invasions

[169] In addition, an invasion can be caused by coastal traffic, which is not subject to the ballast exchange requirements, but which has exposure to exotic organisms previously introduced to adjacent coastal areas. It can be argued that in the case of coastal transfers, the organisms that arrive via either coastal traffic or range expansion to an area that regulates transoceanic ballast, can be identified as coastal transfers, and therefore distinguished from other introductions due to non-compliance with ballast regulations, etc. Such identification will be easier if consistent monitoring of species composition was the case in all regions, which it is not. Nonetheless, it is important to note that there are ways to distinguish direct transoceanic ballast transfers from coastal transfers or aquacultural releases, etc.

should still be on the industry, which is ultimately responsible for perpetuating the process of species transfer. If the great differences in invasion risks (and therefore liability costs) with and without ballast management are well communicated to the industry, a liability system should still retain its deterrent capacity.

Shipping industry interests in minimizing costs will be directly contradicted by the possibly significant cost attached to daily operations by the collective liability system. Therefore, a liability system is likely to make the industry a stakeholder and active participant in the search for technological innovations in both ballast management and ballast monitoring. Strict, collective liability is the only currently viable liability option, since introductions cannot be traced to a particular vessel, and it is not presently possible to 'prove' compliance. If, it was possible for a vessel to prove, through a "black box" type device,[170] and without being directly inspected, that it had performed the required ballast management procedures, then the liability system can be changed from collective to individual. In that case, only vessels that have not proven compliance become liable for new introductions. If a strict, collective liability system gets enacted universally, or even in key shipping destinations such as the U.S., Australia or Canada, there will be a serious incentive for the shipping industry to get involved in the development of ["black box"]  technology, which will enable a switch from collective to individual liability.

Is a liability scheme viable on state level? While the state has jurisdiction to enact liability requirements stricter than the requirements in the federal penalty regime, a compliance and enforcement scheme based on strict liability will not be practicable on a

[170] That is, a device which records the required activity and transmits it electronically to a compliance monitoring agency, such as a ballast pipe flow meter, placed beyond crew reach, feeding "read only" data to the ship's computer which subsequently transmits the data electronically to a monitoring agency, for example.

state level. The major, and most desirable outcome of a large-scale liability scheme is deterrence against non compliance, and especially the technology-forcing effect likely to result in [a faster] improvement of both ballast management and ballast monitoring techniques. If applied on a small scale in the state, the most likely outcome of a liability system will be to discourage shipping from calling on state ports, since it will become cheaper to take the extra time to go to Boston or New York, than to risk liability costs. In addition, a state-level liability scheme has the potential to put small shippers at a considerable disadvantage, because they are less able to afford the increase in operating cost that will come with collective liability. With a liability  system applied on an international (IMO) level, and resulting in technology forcing, innovation will have to come from the larger companies, while compliance assistance and other knowledge-based government policies can be used to assist smaller companies and vessel owners to keep up to date with requirements and technology. In other words, while a liability system is equitable in terms of getting the industry to internalize at least a part of the invasion prevention and bioinvasion costs, if applied on state level, it will have an uneven effect on different members of the industry, and therefore be inequitable in that respect.

Therefore, while a tool with important potential on a country, and especially international level, a liability system is not well suited for augmenting ballast regulations at the state level, and if attempted at this level may result in undesirable consequences, such as discouraging vessels from calling on state ports altogether.

Given the limited state-level application of liability-based strategies, several economic instruments can also be reviewed for potential use in controlling ballast. First, the simplest scheme of taxing ballast discharges can be considered. In theory, the state can use the existing federal voluntary guidelines, and add a state ballast tax, charging differential amounts for the discharge of treated and untreated ballast. The charge on untreated ballast can be set high enough so as to make it economically rational for vessels to exchange their ballast, rather than pay the tax. Measured against the requirements for a successful ballast control strategy, however, a ballast tax falls short in two important ways. First, a ballast tax does not really have the required potential for preventing untreated discharges. Because it is very difficult to set the tax at the right amount (so as to make it too expensive for vessels to discharge their ballast untreated), a ballast tax system is very likely to result in vessels paying the "penalty" fee and continuing to discharge untreated ballast. In addition, the technical difficulties in verifying ballast exchange will create a powerful incentive for false reporting, ultimately resulting in a number of untreated discharges. Such an outcome is exactly opposite to the major goal of ballast management changing vessel behavior to ensure prevention. Second, ballast tax can become a legal problem, since it will only apply to the ballast of transoceanic vessels. While there is a valid biological and logistical rationale for targeting exclusively transoceanic ballast, a state regulation charging different fees, based on the vessel's last port of call, can become subject to challenges of protectionism.

An incentive strategy of lowering port tariffs for vessels that exchange their ballast presents the same deficiencies as a ballast tax, and is therefore a poor choice for state ballast management.

**Table 3-3: State policy alternatives and the ballast management criteria**

| Control Option | Response to State Ballast Management Criteria from Table 3-1 | | | | |
|---|---|---|---|---|---|
| | **Preventive Capacity** | **State Jurisdiction** | **Flexibility** | **Balance -- Deterrence/ Discouragement** | **State Monitoring/ enforcement burden** |
| Risk Communication (voluntary guidelines suggesting management practices) | Low | yes | yes | yes | none |
| Direct regulation (a ban on discharges of untreated ballast, accompanied by regulations on acceptable treatments) | High | yes | yes | Would not discourage vessels from calling on state ports | Higher than the other options in this table |
| Liability system in combination with regulations (i.e. a ban on discharge of untreated ballast, where compliance is measured by the presence or absence of new invasions, and strict, collective liability is sought if an invasion occurs) | Very High | yes | yes | Will discourage vessels from calling on state ports, if RI is the only state to adopt a liability system. | Lower than direct regulation |
| Ballast tax (a tax on untreated ballast, that is adjusted high enough to make it sensible for shippers to perform ballast exchange/treatment) | Very Low | yes | yes | Would not discourage vessels from calling on state ports | High (as high as direct regulation, perhaps higher) |

However, a fee, formulated as a vessel-voyage fee for transoceanic arrivals, and collected towards a state ballast control and monitoring fund, can and should be used as a part of the mandatory ballast exchange regulations.

In conclusion, direct ballast regulation through mandatory exchange and reporting requirements, and supported by a vessel-voyage fee, can be identified as the only option, that satisfies the initial conditions for a successful state ballast strategy, and at the same time fits within the somewhat limited scope of state jurisdiction over ballast. An important question remaining to be addressed is the question of state agencies suitable to implement a state ballast control system based on direct regulation.

Agency role in implementing state ballast controls

Agency mandate, jurisdiction, current scope of action, and prior experience in dealing with vessel-related discharge problems were considered as relevant factors in evaluating which state agencies are suitable to promulgate and enforce ballast water regulations.

Two agencies – the Rhode Island Department of Environmental Management (RI DEM) and the Coastal Resources Management Council (CRMC), have the potential to take the lead in regulating ballast, based on their mandates, current jurisdiction, and prior experience. Such experience comes primarily from regulating the movement of oil and petroleum products by tankers and barges, as well as from regulating vessel-to-vessel and vessel-to-shore oil transfers, and providing for spill prevention and emergency management planning. CRMC is primarily responsible for controlling transfer operations for petroleum, designating anchorages for vessel-to-vessel transfer, and for permitting lightering operations,  pursuant to CZMA requirements for coastal agency involvement in controlling the movement of petroleum and petroleum products in state waters, and by authority given in Chapter 46-23 of RI General Laws. DEM regulates ballasting of oil carrying vessels, works towards prevention of oily ballast discharges, and has a large part of the cleanup responsibility in the case of a spill; its authority comes from provisions in the federal CWA, and from Chapters 46-12, 42-17.1, and 42-35 of Rhode Island General Laws. There is some overlapping coverage in agency regulation of areas such as vessel-to-shore transfer.[171]

For the purposes of this analysis, however, it is particularly important to notice that both agencies have limited or no experience with compliance monitoring and enforcement of their vessel control regulations, largely because the concurrent Coast Guard jurisdiction on matters related to oil pollution from vessels allows the CG to do all the monitoring and enforcement of state oil transfer and pollution prevention regulations.[172] Both agencies have come to rely on the Coast Guard, which has left them without any of their own experience or capacity.

In California, the only state that currently has mandatory ballast regulations, the principal ballast regulatory, implementing and monitoring agency, the California State Lands Commission (SLC), was chosen as the leading state body on ballast on the basis of its perceived "wealth of maritime experience,[173]" acquired through regulating offshore oil facilities as well as oil transfers between vessels and shore facilities. Unlike DEM and

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[171] It is important to notice that this overlapping coverage, and a certain amount of confusion resulting from it, can be partly attributed to consequences of the balance-of-power debate within Rhode Island. While CRMC is directly under the control of state legislation, the position of DEM is less clear – it is an executive agency, but has its mandates determined by the state's legislature.

[172] James Ball, RI DEM, Compliance and Inspection Office; personal communication (03.16.00).

[173] Tirschwell, 1999.

CRMC, which share similar jurisdiction over oil transport, transfer and storage in Rhode Island, the California SLC has nearly nine years of experience with monitoring and enforcement of oil transfer regulations. Through a Memorandum of Understanding with the USCG, the Marine Facilities Division (MFD) of the SLC has largely taken over the duties of monitoring and enforcement of the safe transfer of crude oil and products between tank vessels and land-based facilities.[174] Therefore, it can be argued that SLC's extensive experience with not only regulation, but also monitoring and enforcement of vessel pollution prevention, leaves it better prepared than its Rhode Island counterparts.

On one hand, the California analogy helps confirm a Rhode Island agency choice based on prior agency experience with regulating vessel-related oil pollution. On the other, it is useful in pinpointing the gap in Rhode Island agency experience with monitoring and enforcement of vessel pollution regulations. This gap is critical to bridge since the USCG, which is a federal agency with limited mandate, cannot become a part of any scheme for monitoring and enforcement of state ballast requirements. The CG MSO Providence currently monitors compliance with mandatory ballast reporting, and samples ballast water for a subsection of all vessel arrivals, in order to verify the information provided in ballast reporting forms (the test is for salinity, which has to be greater than 30ppt). Such monitoring has been in place since July 1, 1999 (the effective date of the USCG ballast regulations enacted pursuant to a NISA mandate), and is done based on weekly requests from CG HQ where the monitoring agenda is set on a weekly basis.[175] In spite of its related monitoring activities, the Coast Guard does not have

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[174] Bob Shilland, Marine Terminal Safety Specialist, MFD, SLC, personal interview (03. 15. 00).

[175] Lieutenant McLaughlin, MSO Providence, personal communication (03.16. 00).

authority to enforce state ballast regulations that differ from the federal regulations.[176] Since the state will be unable to rely on CG enforcement for state ballast regulations, it is particularly important to focus agency attention on the creation of a 'marine inspection' unit with the responsibility of monitoring compliance (through checking ballast salinity, and inspecting logbook ballast records plus ballast water reporting forms) with ballast management regulations. The physical monitoring (ballast water salinity checks) can be done for all incoming vessels, or (if arrivals get heavily concentrated in particular periods) for a certain percentage of incoming vessels, chosen on a priority basis (with priority setting based on factors such as previous compliance records, port of origin, and information contained in the ballast water reporting form).

Even though DEM and CRMC currently lack compliance monitoring and enforcement experience with commercial vessels, a legislative extension of agency mandates, through a Rhode Island ballast water law, can guide and facilitate the necessary agency adjustments. As part of any state ballast control program, the Rhode Island legislature will need to chose one of the two agencies as the principal regulatory agency for ballast. For the designated agency, the adjustment needed for successful implementation and monitoring of a state ballast management program, will be further facilitated if the program is funded by a per-vessel voyage fee applicable to all transoceanic vessels calling on ports in Narragansett Bay. Such fees can be set, within certain limits, to match the administrative cost of implementation and monitoring for the state ballast program. The potential for federal funding of state ballast control and exotic species prevention is an additional motivation for the development of a coherent state

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[176] The Coast Guard mandate with respect to ballast is defined in 16 USC § 4701 *et seq.*, and carried out through the enactment and enforcement of the ballast water regulations detailed in 33 CFR 151.

ballast program. Federal sources of funding include a specific NISA allocation for Narragansett Bay research on the prevention, monitoring and control of exotic marine species,[177] and the more general allocation (and appropriation) of money for the implementation of state exotic species management plans that have been approved by ANSTF.[178] The process of agency adjustment should be further aided by the fact that compliance monitoring and enforcement of state ballast regulations should not require a huge administrative capacity. Taking the port of Vancouver's monitoring program as an example (since Vancouver has a traffic pattern similar to the pattern expected for Narragansett Bay after the increase in traffic from the new port) can give an idea of the personnel requirements and expected cost of monitoring and enforcement.

In Vancouver, monitoring of the port's ballast management program is conducted by the port patrol vessel staff, consisting of ten full time and five part time employees operating the three port patrol vessels (ranging in length from 38 to 45 feet) around the clock and throughout the port. Only one patrol boat is manned 24 hours a day, and a second boat is manned during dayshift Monday to Friday, but in addition to ballast monitoring the patrol boat crews do emergency response, pollution prevention, by-law management, environmental monitoring and support to other port departments. The ballast water program takes an estimated 10-15% of the total patrol boat time. The

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[177] 16 U.S.C. § 4741 (f) authorizes the appropriation of $ 1 million for research on prevention, monitoring, and control of aquatic nuisance species in Narragansett Bay. The appropriation is to be made to the Director of the National FWS, and made available to RI DEM. The money authorized in this section has not been appropriated, and appropriations for research have been transferred from FWS to the U.S. Geological Survey. No appropriations for research have been made in recent years (Sharon Gross, US FWS ANSTF, personal communication, 08.12.99).

[178] 16 U.S.C. § 4724 outlines the opportunities and procedures for federal implementation grants for states whose aquatic nuisance species management plans have been approved by the ANSTF.

annual operating costs (in US Dollars) for the entire patrol vessel section is approximately $700,000,[179] but Port of Vancouver has approximately 2800-3000 deep sea vessels each year (about 2000 more than the expected 728 foreign vessel maximum for Narragansett Bay)[180], and every one is boarded by the patrol staff.[181]

Scaled down to fit the smaller vessel traffic numbers for Narragansett Bay, as well as the more limited scope of patrol vessel tasks, the cost of ballast monitoring in Rhode Island should fit well within the funds generated through a vessel-voyage fee in the order of several hundred dollars.

Also, since a marine inspection/marine patrol unit created by the primary regulatory agency (CRMC or DEM) will not be fully occupied by monitoring ballast at all times, creating the patrol unit for the purposes of ballast monitoring can allow for strengthening state involvement in, and the general quality of monitoring for other vessel-related sources of pollution. Prior reviews of ship-related environmental risks in Narragansett Bay have recommended the increase of financial and human resources for oil pollution prevention and enforcement activities, suggesting measures such as empowering state conservation officials with enforcement and pollution ticketing authority.[182] Since patrol personnel will be able to divide their time between ballast

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[179] The capital costs for each patrol boat is approximately $800,000.

[180] Quonset Point Partners LLC, 1999.

[181] From information provided in a March 7, 2000 email communication by Michael Cormier, Assistant Harbor Master, Vancouver Port Authority.

[182] Nield, J., 1999.

monitoring and the monitoring of other types of ship-related pollution,[183] the necessary creation of a state [agency] ballast patrol unit can have spillover effects, helping increase the effectiveness of oil pollution prevention, in addition to reducing ballast transfer risks.

Conclusions

Even though several policy instruments and strategies show potential for use in ballast management, direct state regulation of untreated ballast discharges proves to be the only policy approach that satisfies the prerequisites for a successful ballast control strategy, and at the same time falls within the somewhat limited scope of state jurisdiction over ballast. By making the currently voluntary ballast exchange guidelines mandatory for vessels calling on state waters, and by narrowing the scope of the federal safety exemption, the state can significantly increase the level of bioinvasions prevention in its waters, becoming better prepared for the new transfer risks that will occur with the increase in transoceanic shipping expected to result from port construction and channel dredging. Both CRMC and DEM are suited for the role of a leading ballast management agency, and one of them needs to be selected by the legislature for the purpose; agency implementation, monitoring, and enforcement activities can be supported by a per-vessel fee, while an active pursuit of federal money available for bioinvasions prevention can provide an additional source of funding for biological surveys and related monitoring activities in Narragansett Bay.

[183] Given the number of transoceanic vessels on the bay, even after an expected increase from a new port in Quonset, incoming shipping will still not be numerous enough to keep the patrol unit fully occupied with just ballast inspections (see Chapter one for weekly/yearly [expected] vessel numbers.

# CHAPTER IV:

# CONCLUSIONS AND RECOMMENDATIONS

## Conclusions

The major increases in species introduction risks for Rhode Island will result from channel dredging in Providence and port construction in Quonset. Both projects are expected to increase foreign vessel traffic on Narragansett Bay. Even though the immediate containerport proposals, the last of which involved a medium-sized port facility, were recently rejected by the Rhode Island Economic Development Corporation, a container facility in Quonset still remains in the future of the bay. While the number of vessels projected to use Port of Providence after channel dredging remains undefined, Quonset port construction, if comparable in scale to the latest port plans and guidelines, will, at full development, bring 728 foreign vessels a year, increasing the current average of foreign arrivals by 350%. Such new traffic will in turn translate into a significant increase in the risk of ballast-mediated introductions, due to the species transfer potential of transoceanic ballast.

Precise quantification of the relationship between ship type, likelihood of species introduction, and the risks associated with such introduction is not currently attainable. A large number of factors influence both inoculation potential and the risks of introduction, leading to a complex interplay of multiple combinations of variables. While the resulting uncertainty does not permit any global quantitative statements on the precise relationship between vessel type, inoculation potential, and risk of introductions, knowledge from existing empirical studies allows for local scale analysis of the connection between vessel [traffic] patterns and trends in the likelihood of invasion events.

In the context of Narragansett Bay, containerships, which would constitute the majority of new traffic, are a potentially high-risk vessel category in terms of ballast-mediated species transfer. Contrary to popular beliefs, the fact that many containerships may arrive as NOBOBs (that is, with no *registered* ballast on board) does not eliminate the risk of species introduction. A vessel registered as NOBOB may still carry several hundred tons of sediment laden, species rich ballast, which finds its way into local waters as a result of the complex ballasting and deballasting operations performed during vessel entry into port. Because of their high sediment content, small amounts of residual containership ballast could pose an introduction risk greater than that of larger ballast volumes. The risks presented by residual ballast from NOBOB vessels are discussed in more detail in Chapter I, Section 2.

While the risk of ballast-mediated bioinvasions can be expected to increase with the increase in transoceanic traffic, even under the current state of declining vessel traffic on the bay, such risk remains a reality, reflected in the continuing steady flow of exotics and in the increasing rates of invasion for Rhode Island and the greater New England region. In other words, while planning for port improvement and expansion presents an added motivation to address the problem of ballast-mediated marine bioinvasions at the state level, expected development is not the only reason for concern.

Mandatory U.S. regulations on ballast management, universally applicable, and enforceable at the federal level, are preferable because they can ensure uniformity and efficiency in reducing bioinvasion risks. However, in the absence of adequate federal protection, and in the face of increasing risks of exotic species introductions to

Narragansett Bay, the state has a powerful rationale to control the ballast of transoceanic vessels.

In spite of the complicating factors associated with the federal and developing international controls on ballast, there is both room, and jurisdiction for state ballast controls that aim to prevent untreated ballast releases. NISA, the dedicated federal legislation on ballast and marine invasions, has multiple references to, and provisions for federal-state cooperation on the problem of exotic introductions. The clear lack of federal intention to preempt state ballast controls is directly declared in a NISA anti-preemption clause stating that the federal legislation does not affect state jurisdiction to adopt exotic species control measures. In controlling ballast, the state cannot impose vessel design and equipment requirements, but it can prohibit the discharge of unexchanged ballast within its three-mile territorial waters.

Ballast exchange (i.e. the exchange of coastal ballast with open ocean water) is the most effective control method currently practicable for ships in international trade.[184], Exchange has some safety and efficiency considerations that make it less than universally applicable, but even with such constraints, it is the most popular option in countries and regions that exercise some level of ballast control. This popularity is largely due to the fact that exchange it is the one currently available control alternative that does not require any changes in existing vessel equipment, i.e. vessels can perform exchange without having to make modifications in their design and/or retrofit.

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[184] The effectiveness of exchange in preventing aquatic introductions is due to the fact that there is practically no possibility for reciprocal introductions between open ocean and coastal environments. Open ocean exchange is not practicable for coastal traffic, but the present study is concerned with the management of bioinvasion risks stemming from the ballast of transoceanic shipping.

In order to be successful in the goal of preventing discharges of untreated/unexchanged ballast from transoceanic vessels, state ballast controls need to satisfy several baseline requirements:

- reasonable capacity to prevent (as opposed to penalize after-the-fact) discharges of untreated ballast
- adherence to management/policy options within the scope of state jurisdiction
- flexibility and applicability across the range of vessels calling on state ports
- a reasonable balance between deterring untreated discharges and discouraging shipping to state ports altogether.

Among the highly desirable characteristics of state ballast controls is the potential for transferring the burden of compliance monitoring and verification away from the state and on to the industry.

With ballast control technologies and technical management alternatives, the need for integrated ballast management, relying on multiple approaches to reduce the risk of introduction, is now commonly recognized. An integrated approach is equally important on the policy level. This study's policy analysis of state control options acknowledged the benefits of control strategies, as opposed to individual control instruments applied towards ballast management, but the ultimate choice of a state policy was guided as much by an understanding of the need for integrated approaches, as by the recognition of limitations in the latitude for state action with respect to ballast. A number of viable ballast policy strategies still remain either outside the scope of state jurisdiction, or unsuitable for application at the relatively small scale of the state.

This study reviewed knowledge-based, incentive-based, and regulatory strategies, with the following results:

- State use of risk communication, in the form of ballast exchange guidelines targeting Rhode Island vessel traffic, is unlikely to increase the level of prevention already provided by federal voluntary guidelines on managing ballast. The limited preventive potential of knowledge-based approaches stems from the fact that such approaches cannot provide a sufficient incentive for industry compliance.

- A combination of mandatory ballast exchange regulations and a strict, collective liability system supported by assurance bonding, has great potential to increase bioinvasions prevention and relieve state monitoring efforts. A system which measures compliance in terms of presence or absence of new introductions, and imposes high liability if a new introduction occurs, will greatly increase industry incentives to adhere to the required ballast management practices. It will also push industry to develop alternative monitoring approaches, which will allow solid proof of exchange, and thus make possible a transition from collective to individual liability.[185] A strict, joint liability system, however, is likely to present significant new costs to shipping, and if applied on the state, as opposed to national level, it will likely discourage vessels from calling on state ports: it will suddenly become cheaper to go to Boston or New York, than to face the cost of liability in Rhode Island.

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[185] One such monitoring approach is the development of a "black box" type device, such as a simple flow meter installed in the ballast pipes, beyond crew reach. The "black box" can record ballast flow during intakes and discharges, register the location (through a GPS system), time and amount of such intakes/discharges, and feed this information , as "read only" data, to the ship's computer. The data from the ship's computer can be electronically transmitted to a monitoring agency.

- Therefore, even though several policy instruments and strategies show potential for use in ballast management, direct state regulation of untreated ballast discharges proves to be the only policy approach that satisfies the prerequisites for a successful ballast control strategy, and at the same time falls within the somewhat limited scope of state jurisdiction over ballast.

The most effective ballast control method currently practicable for ships in international trade is ballast exchange, i.e. the exchange of coastal ballast with open ocean water, generally recommended to take place outside the 200 mile exclusive economic zone and in water deeper than 2000 meters. A number of other control alternatives are currently at different stages of development, but incorporating such new methods into any state control framework will entail some technology-oriented regulations, which fall outside the scope of state jurisdiction. Therefore, until such technologies become applicable across vessel types, and commonly used/usable, the technical side of state regulation will be limited to ballast exchange requirements.

**<u>Recommendations</u>**

**1. Draft State ballast legislation calling for mandatory open ocean ballast exchange for transoceanic vessels calling on state waters**

To achieve needed improvements in protection against ballast-mediated species introductions to waters of the state, Rhode Island should take the federal voluntary guidelines on ballast [management], and make them mandatory for vessels calling on state ports after a voyage outside the 200 mile exclusive economic zone (transoceanic vessels).

- State ballast legislation should prohibit any discharges of untreated transoceanic ballast into state waters
- Treatment requirements should call for ballast exchange outside the 200 mile exclusive economic zone and in waters deeper than 2000 meters. An empty-refill exchange, or the exchange of three volumes of the initial ballast if a flow-through exchange is performed, should be specified in the state regulations
- The state should prohibit any conscious discharges of ballast-tank (or ballasted cargo hold) sediment into state waters
- To strengthen the effectiveness of its regulatory program, the state should also encourage the observance of "good housekeeping" practices, including avoidance of ballasting in global "hot spots," near sewage outfalls, in shallow regions where the propeller wash is likely to stir up sediment that will be taken in with the ballast, and if possible – avoidance of ballasting at night
- To monitor and support the state ballast control system, Rhode Island should require [transoceanic] vessels to submit to the state ballast regulatory agency (discussed below) a copy of the mandatory ballast reporting form; the electronic submission of this form to the Smithsonian Environmental Research Center is already required by federal regulation for all transoceanic vessels[186]

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[186] A copy of the form can be downloaded at http://invasions.si.edu/bwform.htm

- To be successful in preventing the discharge of untreated ballast into state waters, state regulations will have to narrow the scope of the federal safety exemption. The state should focus on compiling and monitoring vessel compliance records, and on investigating reasons for repeated non-compliance, which has been [repeatedly] justified on safety grounds by the vessels involved. The state should explore remedial measures, such as receiver vessels for ballast that has not been exchanged 200 miles offshore, or the sealing of ballast tank valves, which would prevent the discharge of unexchanged ballast for vessels with repeated non-compliance.

To address the problem presented by vessels registered as “no ballast on board” (NOBOBs), the state should explore options such as requiring flushing and discharge to receiver vessels and/or requiring partial flushing of unballasted tanks in open ocean (200 miles offshore) prior to any intakes and subsequent discharges in state waters.

To cover costs of monitoring and enforcement for the ballast control program, the state should impose a vessel-voyage fee. The fee, representing an industry contribution towards addressing the bioinvasions problem stemming from shipping operations, should be stipulated by an advisory group including representatives from the state ballast agency and shipping industry. In deciding on the amount of the fee, the advisory group should take into account the following factors, and stipulate the fee accordingly:

- estimated cost of monitoring and enforcement for the first several years of the state’s ballast program

- desired proportion of industry contribution towards ballast control costs[187]

**2. Conduct biological monitoring in the bay**

Conduct a baseline biological study to determine the incidence of and extent to which non-native species have become established in Narragansett Bay. Set a schedule for subsequent periodic monitoring, in accordance with federal legislative goals (33 U.S.C. §1315[188]), CRMC and RI DEM resource monitoring and management mandates (RI GL 46-23-6 and RI GL 42-17-1.9) and goals identified for Narragansett Bay in the Rhode Island State Guide Plan (R.I. State Guide Plan Element 715, p. 3-1.December 1992).[189]The initial baseline biological study will be needed to determine the current invasion status of Narragansett Bay. Periodic biological surveys following the initial invasions inventory will help determine the effectiveness of state regulation in preventing new introductions.

**3.Appoint a principal regulatory agency for ballast**

Both CRMC and DEM have some prior experience with regulating vessel-related sources of environmental concern, most prominently with the regulation of ship oil pollution. Neither agency, however, has any experience with monitoring or enforcement of pollution prevention regulations pertaining to vessel-related sources. So far, state

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[187] In stipulating the vessel-voyage fee, the state may find a useful reference point in California's experience with the imposing of such fee (See relevant California State Lands Commission Documents and contacts at http://www.slc.ca.gov/BallastWater/default.asp).

[188] This CWA chapter on water pollution prevention and control, mandates biennial state reports on the quality of navigable waters, to be submitted to the EPA.

[189] CRMC has recently added the investigation of problems associated marine bioinvasions to the duties of a staff person; currently, planning is underway to organize an initial biological [bioinvasions] survey of the Bay; the survey is scheduled for the beginning of August, 2000.

agencies have relied for monitoring and enforcement on the concurrent/dual/overlapping jurisdiction of the USCG. The Coast Guard, however, is a federal agency with a limited mandate, and its current mandate will not allow it to monitor compliance with, or to enforce any state ballast regulations that have requirements over and above the requirements of the voluntary federal ballast guidelines currently applicable to RI. Therefore, as part of the ballast water legislation, the state legislature should appoint one of the two agencies as the principal regulatory agency for ballast. The agency appointed should concentrate its efforts on developing a monitoring and enforcement capacity. A monitoring scheme should consist of ballast salinity checks, to verify exchange, as well as examination of the ship's log (for ballast operations information), and examination of the mandatory ballast water reporting form.[190] The exercise of monitoring and enforcement activities for transoceanic vessels can be supported by funds generated through the vessel-voyage fee, which, as already discussed, should be another provision in the state ballast legislation. Monitoring should be at least initially attempted for all transoceanic vessels, and if this becomes difficult as vessel traffic increases with entry into operation of a new port, it should be done on part of the vessels, selected on a priority basis. Compliance monitoring priorities can be set on the basis of previous compliance records for vessels doing multiple trips to the bay, age of the vessel, and last port-of-call.

**4.Educate the shipping industry about state ballast regulations**

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[190] The 1999 USCG ballast water requirements (enacted pursuant to NISA) currently require that the completed ballast water reporting forms be submitted [electronically, by fax, or by mail] to the Smithsonian Ballast Water Clearinghouse, where [ballast exchange] compliance data will be compiled over the next couple of years.

The state should make a concerted effort to inform shippers, through shipping agents, pilots, and other port personnel that comes in contact with the officers and crew, about the purpose, nature, and requirements of state ballast controls. Shipping industry professionals need to know about, and understand the Rhode Island ballast management requirements, for the state ballast control program to be successfully implemented: since the required ballast exchange has to take place at least 200 miles out to sea, vessels will need to know about thee requirements before they enter the 200 mile Exclusive Economic Zone.

**5. Regional cooperation**

The state should actively explore and pursue opportunities for ballast control cooperation with neighboring states, most prominently, with the state of Massachusetts. Given that the port of Fall River, as the major port facility for Southeastern Massachusetts, is in a location that constitutes an integral part of the Narragansett Bay system, interstate cooperation that will help further the reach of Rhode Island's ballast control program will be critical for the program's success. Given that vessels going to Fall River and the upper part of Mount Hope Bay will be using the channel in the East Passage, and subsequently transiting the bay, such vessels will be subject to Rhode Island ballast regulations during their transit. If, however, the opportunity for untreated discharges remains as the vessels cross into Massachusetts territory in Mount Hope Bay, the preventive value of Rhode Island ballast controls will be seriously weakened. Therefore, to preserve maximum effectiveness for its ballast controls, Rhode Island should seek cooperation with respective Massachusetts agencies/government at the state and/or regional/municipal level, pursuing agreements that will allow an extension of its ballast monitoring to Massachusetts regions where untreated discharges will seriously impact the integrity of Rhode Island's ballast management system.

**6. Promote development of mandatory, technology-based federal regulations on ballast, enforced by USCG, and applicable to all U.S. waters**

Federal government should impose technology-based standards, including requirements for on-board ballast treatment technologies, and requirements for vessel equipment allowing electronic monitoring and [remote] verification of prescribed ballast management procedures. Given the structure and operational characteristics of the shipping industry, as well as the specifics of the ballast transfer problem, on-board technological treatments are the most viable option for successful ballast management in the long term.[191] Addressing the bioinvasions problem [inherent in ships' ballast operations] on-board, while the vessel is underway, will, in the long run, avoid the costly delays that can result from shore-treatment or close-to-shore treatment (e.g. receiver vessels). In addition, the creation of the necessary shore-based infrastructure, even if shore-treatments prove to be as promising in eliminating unwanted organisms as on-board alternatives, is not possible in every port. Therefore, such infrastructure will present only a partial solution to the problem, either restricting the mobility of ballast-carrying vessels, or compromising the quality of treatment for locations that do not have the needed shore-treatment infrastructure, neither of which is acceptable. The selection of on-board treatment technologies should be made from the treatments currently showing potential, such as the filtration, addition of biocides, and thermal treatments reviewed by

[191] Marine Board, 1996; Caroline Karp, personal communication (05.03.00); James T. Carlton, personal communication (05.04.00).

the Committee on Ballast Water.[192] In selecting imposing monitoring requirements, the federal government should take advantage of "black box" type technologies, such as, for example, flow meters registering the time, location, and amount of ballast exchange.[193]

Even though technology-based standards enforced by the Coast Guard will help strengthen the protection of state waters, such standards will not immediately eliminate the state's role in bioinvasions prevention. Technology-based standards, if federally mandated, will apply to newly built vessels, while an entire generation of older vessels will still have to be regulated with traditional monitoring and enforcement procedures, during a technology phase-in period that can take as long as two decades. An existing state regulatory capacity for ballast will therefore be key during the transition period and the state should develop such capacity, as discussed in the recommendations above.

## **Epilogue**

The risk of ballast-mediated introductions to Narragansett Bay and Rhode Island is real. Delaying state response means resigning to, or altogether denying this risk. This is a particularly good time to act for controlling ballast, since a major increase in the species transfer vector is still in the future, presenting the opportunity for preventive action, as well as for incorporating ballast planning into any larger scheme for control and mitigation of the environmental and ecological risks from construction and operation of a new port.

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[192] Marine Board, 1996 (pp. 36, 53-73).

[193] See p. 37, p. 45 for more detail..

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## Appendix 1: Nonindigenous Marine Species and Ballast Water

This appendix provides further illustration of the scope of the phenomenon of exotic marine species transfer, as well as some data on the known distribution of exotics present in Narragansett Bay.

## PART A: EXAMPLES OF EXOTIC MARINE SPECIES INTRODUCTIONS

**Table 1A-1: Number of known nonindigenous aquatic species for selected U.S. estuaries**

| Estuary | NIS known | Source |
|---|---|---|
| Chesapeake Bay (Maryland & Virginia) | 116 | Ruiz et al., 1997, unpublished |
| Coos Bay (Oregon) | 60 | Carlton, unpublished |
| Great Lakes (New York to Minnesota) | 137 | Mills et al., 1993 |
| San Francisco Bay (California) | 234 | Cohen and Carlton, 1998 |

Data from Ruiz et al., 1997; Cohen and Carlton, 1998.

**Table 1A-2: Examples of recent invasions probably mediated by ballast water**

| Higher Taxon | Taxon | Species | Native distribution | Introduced to | Year[194] |
|---|---|---|---|---|---|
| Dinoflagellata | | Alexandrium catanella | Japan | Australia | 1986 |
| | | Alexandrium minutum | Europe? | Australia | 1986 |
| | | Gymnodinium catenatum | Japan | Australia | 1986 |
| | Scyphozoa | Phyllorhiza punctata | Indo-Pacific | California | 1981 |
| | Hydrozoa | Caldonema uchidai | Japan, China | California | 1979 |
| Ctenaphora | | Mnemiopsis leidyi | Western Atlantic | Black Sea | 1987 |
| Annelida | Oligochaeta | Teneridrilus mastix | China | California | 1984 |
| | Polychaeta | Desdemona ornata | South Africa, Australia | Italy | 1986 |
| | | Marenzelleria viridis | US Atlantic | Germany | 1983 |
| Crustacea | Cladocera | Bythotrephes caderstroemi | Europe | Great Lakes | 1984 |
| | Mysidacea | Rhopalophthalamus Tattersallae | Indian Ocean | Kuwait | 1981 |
| | | Neomysis japonica | Japan | Australia | 1977 |
| | | Neomysis americana | US Atlantic | Argentina, Uruguay | 1979 |
| | Cumacea | Nippoleucon hinumenesis | Japan | California Oregon | 1980? |
| | Copepoda | Pseudodiaptomus inopinus | Asia | Columbia River | 1990 |
| | | Pseudodiaptomus marrinus | Japan | California | 1986 |
| | | Pseudodiaptomus forbesi | China | California | 1987 |
| | | Sinocalanus doerrii | China | California | 1978 |
| | | Oithona davisae | Asia | California Chile | 1979 |
| | | Limnoithona sinensis | China | California | 1979 |
| | | Centropages abdominalis | Japan | Chile | 1983 |
| | | Centropages typicus | US Atlantic | Texas | 1985 |

[194] Year introduction was first recognized

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|---|---|---|---|---|---|
| | | Acartia omorii | Japan | Chile | 1983 |
| | Decapoda: Brachyura | Hemigrapsus sanguineus | Asia | New Jersey | 1988 |
| | | Charibdys helleri | Indo-Pacific, Israel | Colombia (Caribbean) | 1987 |
| | Decapoda: Caridea | Salmoneus gracilipes | Japan, Micronesia | California | 1986 |
| | | Hippolyte zostericola | Western Atlantic | Colombia (Atlantic) | 1984 |
| | | Exopalaemon styliferus | Indonesia, India | Iraq, Quwait | 1983 |
| Mollusca | Gastropoda | Tritonia plebeia | Europe | Massachusetts | 1983 |
| | Bivalvia | Potamocorbula amurensis | Asia | California | 1986 |
| | | Dreissena polymorpha | Eurasia | Great Lakes | 1988 |
| | | Dreissena sp. | Eurasia | Great Lakes | 1990 |
| | | Rangea cuneata | Southern US | New York | 1991 |
| | | Theora fragilis | Asia | California | 1982 |
| | | Musculista senhousia | Japan | New Zealand, Australia | 1980 |
| | | Ensis americanus | US Atlantic | Germany | 1979 |
| Ectoprocta | | Membraniphora membranacea | Europe | New Hampshire, Maine | 1987 |
| Pices | | Gymnocephalus cerrnuus | Europe | Great Lakes | 1987 |
| | | Proterorhinus marmoratus | Black Sea | Great Lakes | 1990 |
| | | Negobious melanostomus | Mediterranean | Great Lakes | 1990 |
| | | Butis koilomatodon | Indo-west Pacific | Nigeria, Cameroon | 1983 |
| | | | | Panama Canal | 1972 |
| | | Rhinogobius brunneus | Japan | Arabian Gulf | 1987 |
| | | Mugiligobius sp. | Taiwan, Philippines | Hawaii | 1987 |
| | | Sparidentex hasta | Arabian Sea | Australia | 1985 |
| | | Parablennius thysanius | Philippines, Indian Ocean | Hawaii | 1971 |

Reprinted from Carlton, J.T., and J. B. Geller. 1993. Ecological Roulette: The Global Transport of Nonindigenous Marine Organisms. *Science*, **261**: 78-82.

## PART B: SOME CONSEQUENCES OF NONINDIGENOUS MARINE SPECIES TRANSFER AND INTRODUCTION

A recent paper[195] looking at the environmental and economic costs of nonindigenous species[196] in the U.S. estimates major environmental damage and the losses caused by the approximately 50 000 nonindigenous species in the U.S. at $ 137 billion per year. This estimate is made with the recognition that assessing the full extent of environmental and economic damage caused by exotic species is difficult, since little is known about many of the existing introductions, in addition to the fact that a number of introductions remain currently unrecognized. The $137 billion/year total damage figure was calculated on the basis of conservative estimates for the impacts of known exotics on agriculture, forestry, and public health. Some of the estimated annual costs relevant to the study of introduced aquatic species include the estimated $ 44 million/year cost of the European green crab (*Carcinus maenas*),[197] the $ 1 billion/year economic losses due to some 40 harmful exotic fish species, and the $ 1 billion/year cost associated with fouling damage from the Asian clam *Corbicula fluminea*.[198] Another pest mollusk is the shipworm, *Teredo navalis*, introduced to San Francisco Bay via wooden ships, and causing, since the early 1990s, wooden dock and ship damage estimated at

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[195] Pimentel et al., 2000.

[196] Includes all known nonindigenous species, terrestrial and aquatic, introduced to the U.S. from outside the country (i.e. the paper does not investigate the costs of species translocation within the U.S., some of which are significant).

[197] *Carcinus*, which was introduced as a food source in the 1800s has been associated with the demise of the softshell clam industry in New England and the maritime provinces of Canada, as well as with the destruction of commercial shellfish beds and with predation on large numbers of native oysters and crabs. (Lafferty and Kuris, 1996).

[198] Pimentel et al., 2000.

$ 200 million/year.[199] As Pimentel et al. note, however, these damage and control costs are low when compared to the extensive environmental damages caused by exotic species. Yet even this understated economic cost clearly indicates that nonindigenous species are exacting a significant toll.[200]

One of the more striking examples of colonization as a result of ballast discharges can be found in the European zebra mussel, *Dreissena polymorpha*, which, since its introduction to the Great Lakes, has turned into the poster child of marine bioinvasions. Discovered in the Great Lakes in 1988, the mussels have caused expensive problems, blocking the pipes that deliver water to cities and factories, and cooling water to nuclear and fossil fuel power plants; attaching in enormous numbers to ship and boat hulls, marine structures and navigational buoys; and covering entire beaches with sharp-edged mussel shells and rotting mussel flesh. The average cost of damages from this invasion has been estimated at $360 000/year for affected cities and industries, and $825 000/year for nuclear power plants, with maximum reported costs through 1995 of $600 000 for one shipping company, $1.5 million for a single factory, $3.7 million for a water treatment facility, and $ 6 million for a power plant. The estimated total costs are $3.1 billion for the power industry, and $ 5 billion overall,[201] where these are numbers for remediation of consequences, since extricating the mussel from the affected regions is not possible.

Paralytic shellfish poisoning (PSP), a human illness with 15% mortality, results from the consumption of shellfish products contaminated with alkaloid toxins produced

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[199] Cohen and Carlton, 1995.

[200] Pimentel et al., 2000.

[201] Cohen, 1998. p. 13; Reeves, 1999.

by some 11 species of plankton dinoflagellates.[202] Toxic dinoflagellates have been transported in ballast sediments and introduced to several countries around the Pacific Ocean, becoming, in some places phenomenally abundant, and causing red tides, which in turn kill fish and invertebrates by clogging their gills.[203] The neurotoxins produced by some dinoflagellate species are the cause of paralytic, amnesiac and diarrheal shellfish poisoning, in humans having consumed contaminated shellfish products.[204] Therefore, red tide causing toxic dinoflagellates have had serious impacts on both human health and aquaculture. In the US, the increase in toxin-producing blooms between 1972 and 1997 can possibly be associated with ballast water transfers.[205] In Australian ports, the incidence of red tides and PSP was circumstantially linked to the advent of Japanese bulk cargo carriers in the 1960s –1970s, and subsequently bolstered when toxic dinoflagellates were found in the ballast of ships arriving from both Korea and Japan.[206] Globally, an increase in the distribution of paralytic shellfish poisoning between 1970 and 1990, is also attributed to dinoflagellate ballast water transfers, among other factors stimulating blooms, once the organisms were introduced to a new location.[207] (See figure 1 below)

Partially linked to red tide algal blooms is another health-related ballast concern – cholera epidemics, caused by plankton-attached *Vibrio cholerae*. As one of the most recent examples, the 1991 South American epidemic of cholera was caused by

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[202] Hallegraeff and Bolch, 1991; Hallegraeff, 1998.

[203] Mlot, 1997.

[204] Culotta, 1992; Epstein et al. 1993; Hallegraeff, 1993; Hallegraeff, 1998.

[205] Mlot, 1997.

[206] Hallegraeff, 1993; Hallegraeff, 1998.

[207] Hallegraeff, 1993.

waterborne Vibrios. In the 1991 epidemic, the deadly bacteria found their way into 20 Latin American countries, sickening more than 1.2 million people, and causing, by 1997, close to 12 000 deaths.[208] In the U.S., in July and September of 1991, the toxigenic *Vibrio cholerae* that caused the Latin American epidemic (*Vibrio cholera*e 01, biotype El Tor, serotype Inaba) were recovered from seafoods collected from oyster beds in Mobile Bay, Alabama, during routine sampling.[209] The epidemic Latin American strain, different from the one normally found in the Gulf of Mexico, appears to have been introduced to the Gulf Coast via ballast water – in 1991 and 1992, toxigenic *Vibrio cholera* e 01, biotype El Tor, serotype Inaba (the Latin American epidemic strain), was recovered from non-potable ballast, bilge and sewage water from five cargo ships docked in ports on the U.S. gulf Coast. Four of these ships had taken on ballast water in cholera infected countries; the fifth took on ballast in a non-infected country.[210] The latent forms of epidemic strains of *Vibrio cholerae*, surviving by coexisting successfully, in their "quiescent" form, with dinoflagellates and other phyto- and zoo- plankton, revert to a culturable, infectious state under favorable nitrogen and phosphorous concentrations, pH, and temperature – or, under the same conditions that are also conducive to red tide algal blooms.[211] Therefore, ballast water transport of organisms can result in compounded

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[208] Dold and Raghu, 1999.

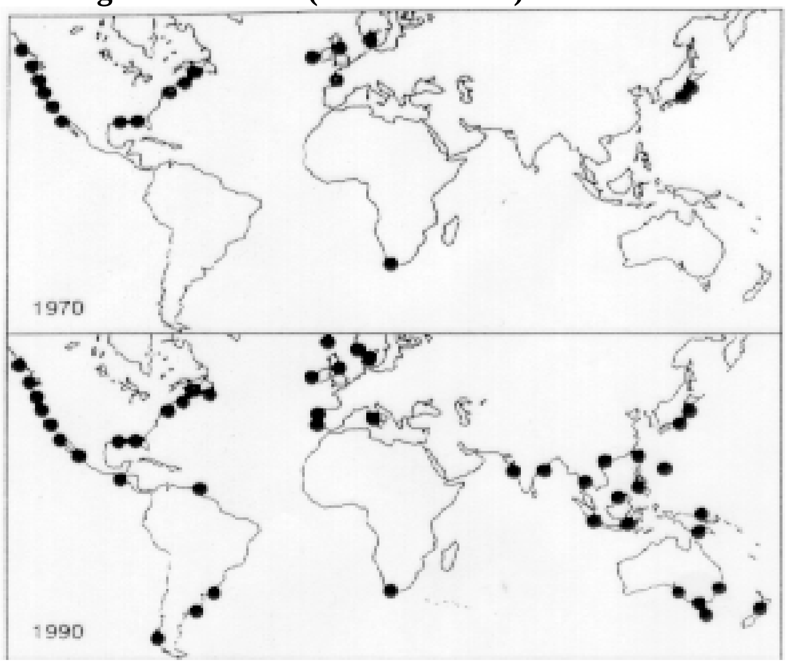
[209] McCarthy et al., 1992.

[210] McCarthy and Khambaty, 1994. On the basis of these findings, the Food and Drug Administration recommended that the US Coast guard issue an advisory to shipping agents and captains requesting that ballast water be exchanged on the high seas before entry of ships into U.S. ports.

[211] Ditchfield, 1993; Epstein et al., 1993; Dold and Raghu, 1999.

risks, such as those of red tide caused shellfish poisoning, and the simultaneously occurring proliferation of epidemic strain *Vibrio cholerae*.

**Figure 1A- 1: Known global distribution of paralytic shellfish poisoning due to toxic dinoflagellate blooms (1970 and 1990)**




From Hallegraeff, G.M. 1998. Transport of toxic dinoflagellates via ships' ballast water: bioeconomic risk assessment and efficacy of possible ballast water management strategies. *Marine Ecology Progress Series*, **168**: 297-309.

It is important to acknowledge that not all releases of exotic species result in invasions, as well as that not all invasions have known negative effects. Many are of unknown consequences, while some are even considered to have had positive economic impacts (for example the accidental introduction of the edible Japanese littleneck clam that arrived in the Pacific Northwest with oysters).

It is also important to note, however, that in addition to the human and economic impacts, which are most often the subject of interest, there is a large number of instances, in the U.S. and worldwide, where introduced species have changed ecosystem dynamics and caused habitat modification or destruction. One of the best examples is San Francisco Bay, where exotics account for more than 90% of the species, individuals, or biomass in several habitats, and where the Asian clam, *Potamocorbula amurensis*, a highly efficient filter-feeder, has severely depleted phytoplankton populations, reducing or altering food available to some of the organisms higher in the food chain. *Potamocorbula* may also be reducing local zooplankton, thus making the ecosystem more vulnerable to invasion by Asian zooplanktonic species.[212]

Granted that not all bioinvasions are immediately harmful, even intentional, and supposedly controlled releases for commercial [aquaculture] purposes can carry ecological risks, such as the introduction of peripheral organisms and parasites, or the potential for takeover of local ecosystems. An illustration of such harmful side effects is provided by the discovery that the feces and digestive tracts of bivalves transferred as shellfish stocks can be loaded with viable toxic dinoflagellate (*Alexandrium catanella*) cells, and sometimes can also contain resistant resting cysts.[213] As another example, the Japanese seaweeds *Sargassum muticum*, *Undaria pinnatifida*, and *Laminaria japonica* are thought to have been introduced into European waters via sporophyte stages contained with introduced Japanese oyster spat.[214]

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[212] Cohen, 1998.

[213] Bricelj et al., 1991.

[214] Hallegraeff, 1993.

PART C: SOME INTRODUCTIONS IN NARRRAGANSETT BAY

**Table 1A-3: Summary of Invasions in New England from 1960 to 1997, By Decade**[215]

| | | |
|---|---|---|
| *Praunus flexuosus* | 1960 | |
| *Haplosporidium nelsoni* | 1967 | (Rhode Island presence) |
| | | |
| *Balanus subalbidus* | 1972 | |
| *Botrylloides diegensis* | 1972 | (Rhode Island presence) |
| *Styela clava* | 1973 | (Rhode Island presence) |
| *Teredo bartschi* | 1975 | |
| | | |
| *Ostrea edulis* | 1982 | (Rhode Island presence) |
| *Ascidiella aspersa* | 1985 | (Rhode Island presence) |
| *Diplosoma listerianum* | 1985 | (Rhode Island presence) |
| *Antithamnion nipponicum* | 1986 | (Rhode Island presence) |
| *Membranipora membranacea* | 1987 | (Rhode Island presence) |
| *Tritonia plebeia* | 1987 | |
| *Rangia cuneata* | 1988 | |
| | | |
| *Perkinsus marinus* | 1990 | (Rhode Island presence) |
| *Bonamia ostrea* | 1991 | (Rhode Island presence) |
| *Dreissena polymorpha* | 1993 | |
| *Hemigrapsus sanguineus* | 1993 | (Rhode Island presence) |
| *Bugula neritina* | 1993 | |
| *Grateloupia doryphora* | 1996 | (Rhode Island presence) |
| *Convoluta convoluta* | 1996 | |
| Palicid crab | 1997 | (Rhode Island presence) |

**from Carlton, J. T. 2000. Marine bioinvasions of the Northwest Atlantic Ocean: Bay of Fundy to Long Island Sound. Monograph in preparation.**

**Table 1A-4: Marine and Estuarine Invasions of New England from 1960 through the 1990s (With common names, and arranged chronologically)**[216]

[215] Entire table from Carlton, 2000b.

| Species | Origin | Vector[217] | First New England Record |
|---|---|---|---|
| *Praunus flexuosus*<br>European opossum shrimp | Europe | BW | 1960, Cape Cod |
| *Haplosporidium nelsoni*<br>Protist: MSX (oyster disease) | Southern U.S. | COM | 1967, Massachusetts |
| *Balanus subalbidus*<br>Barnacle | Southern U.S. ? | BW / SF | 1972, Charles River, Boston MA |
| *Botrylloides diegensis*<br>California Compound Sea Squirt | California | IR | 1972, Cape Cod |
| *Styela clava*<br>Japanese Stalked Sea Squirt<br>(probably introduced from Europe, where it arrived from Asia in the early 1950s) | Japan | BW / SF | 1973, Long Island Sound |
| *Teredo bartschi*<br>Shipworm<br>(likely derived from populations in Southern U.S.) | Indo-Pacific | SF | 1975, Long Island |
| *Ostrea edulis*<br>European flat oyster<br>(IR in Maine in 1940s,but expanding across New England in 1980s-1990s) | Europe | IR? | 1982, Rhode Island |
| *Ascidiella aspersa*<br>European Recumbent Sea Squirt | Europe | BW / SF | 1985, Cape Cod |
| *Diplosoma listerianum*<br>Flat Compound Sea Squirt | Europe? | SF | 1985, Cape Cod |
| *Antithamnion nipponicum*<br>Japanese red alga<br>(probably introduced from Mediterranean, although native to Japan) | Japan | BW / SF | 1986, Long Island Sound |
| *Membranipora membranacea*<br>Kelp Bryozoan | Europe | BW | 1987 Gulf of Maine |
| *Tritonia plebeia*<br>European Nudibranch | Europe | BW | 1987 Gulf of Maine |

[216] Entire table from Carlton, 2000b; cited references: Carlton, J. T. 1993; Carlton, J. T. 1999; Harvey, Alan W. and Christopher B. Boyko. Manuscript; Rivest, Brian, James Coyer and Seth Tyler. 1999.

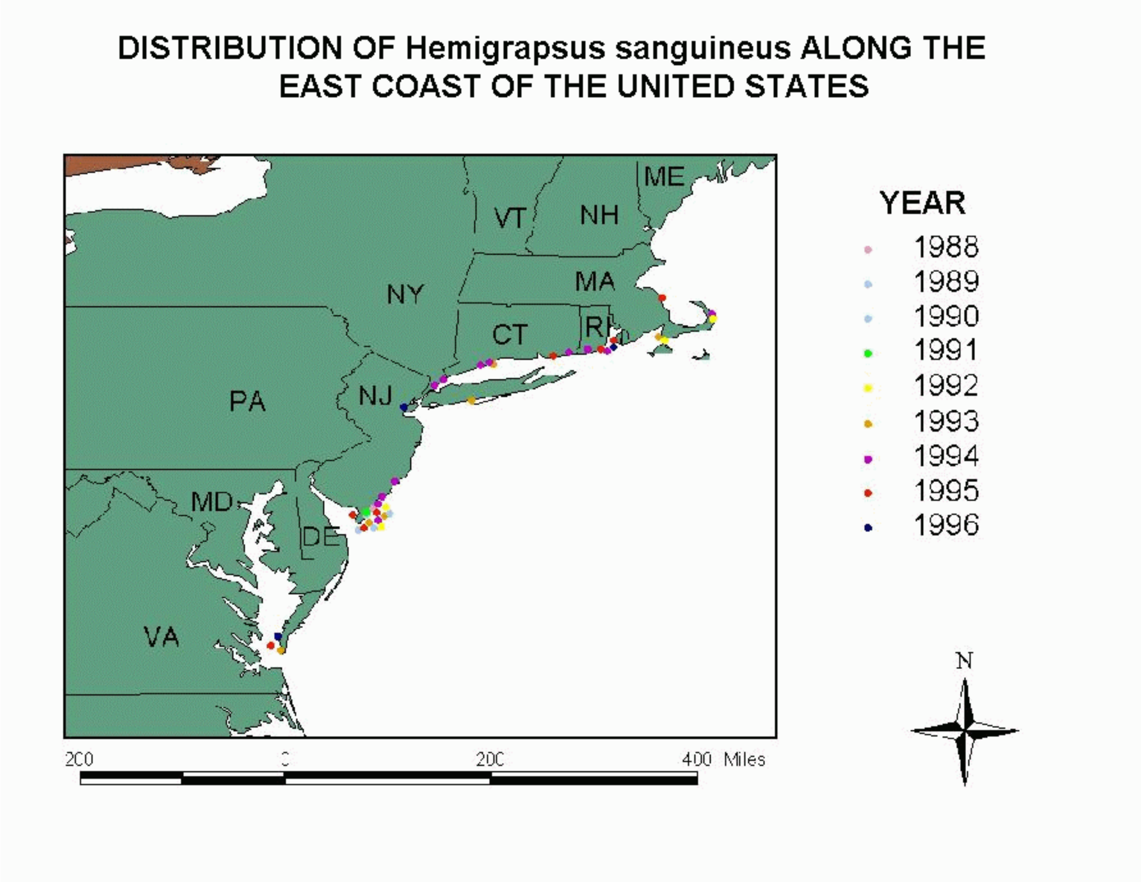
[217] **Vectors**

BW = ballast water
SF = ship fouling
IR = intentional release
COM = commercial shellfish movements

| | | | |
|---|---|---|---|
| *Rangia cuneata*<br>Atlantic Rangia | South U.S. | BW | 1988, Hudson River |
| *Perkinsus marinus*<br>Protist: DERMO<br>(oyster disease) | Southern U.S. | COM | 1990, Mass. |
| *Bonamia ostrea*<br>Protist: BONAMIA<br>(oyster disease) | Southern U.S. | COM | 1991, Maine |
| *Dreissena polymorpha*<br>Zebra mussel<br>(in oligohaline waters, arriving by dispersal down the Hudson River from the Great Lakes, to where it was introduced by BW in the mid 1980s) | Eurasia | BW | 1992, Hudson River |
| *Hemigrapsus sanguineus*<br>Japanese Shore Crab<br>(probably by natural larval dispersal from New Jersey, where it was first found in 1988) | Japan | BW | 1993, Long Island Sound |
| *Bugula neritina*<br>Purple Bryozoan | Europe? | BW / SF | 1993, Long Island Sound |
| *Grateloupia doryphora*<br>Red Alga | Europe? | BW / SF | 1996, Narragansett Bay |
| *Convoluta convoluta*<br>European flatworm | Europe | BW | 1996,Gulf of Maine |
| Palicid crab<br>Indo-Pacific crab<br>(established?) | Indo-Pacific | BW | 1997, Newport, Rhode Island |

From Carlton, J. T. 2000b. Marine bioinvasions of the Northwest Atlantic Ocean: Bay of Fundy to Long Island Sound. Monograph in preparation.

**Figure 1A-2:**




Even though the ecological and economic effects of *Hemigrapsus* have not been fully investigated and/or quantified, a recent study on predation shows that the species feeds on bivalve prey, with strong preference for soft shell clams.[218] In spite of the fact that further studies will be necessary to determine the significance of the laboratory results for New England ecosystems, the implications of these findings can be significant for both aquaculture and shell fisheries.

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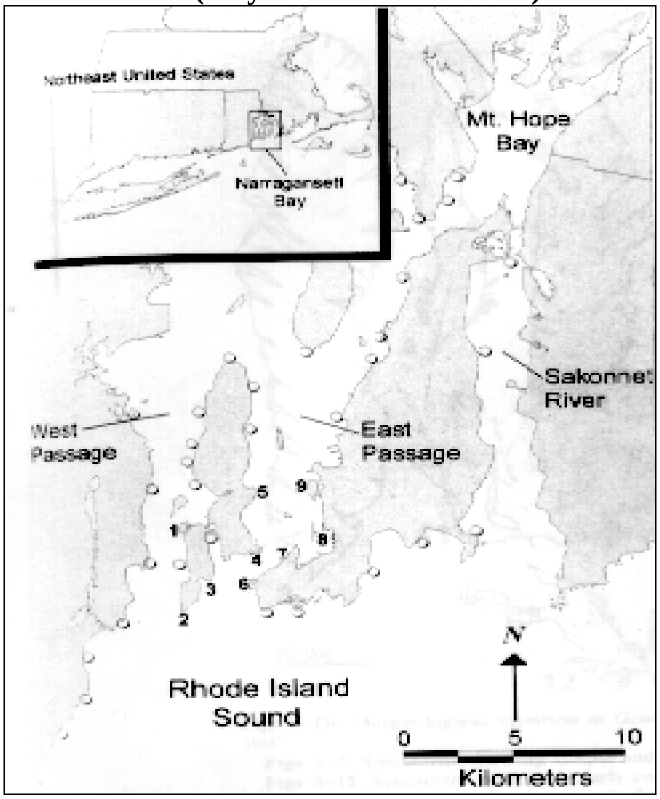
[218] Brousseau et al., Presentation at the 20th Milford Aquaculture Seminar, February – March 2000.

**Figure1A-3: Locations of *Grateloupia doryphora* populations in Narragansett Bay, Rhode Island (July 1996 – March 1997)**




From Villalard-Bohnsack, M., and M. Harlin. 1997. The appearance of *Grateloupia doryphora* (Halymeniaceae, Rhodophyta) on the northeast coast of North America. *Phycologia*, **36**: 324-328.

**Locations:**
Fort Getty (1), Beaver Tail Park (2), Hull Cove (3), Fort Wetherill (4), Taylor Point (5), Castle Hill (6), Fort Adams (7), Goat Island and Newport Harbor (8), Coasters Harbor Island (9);

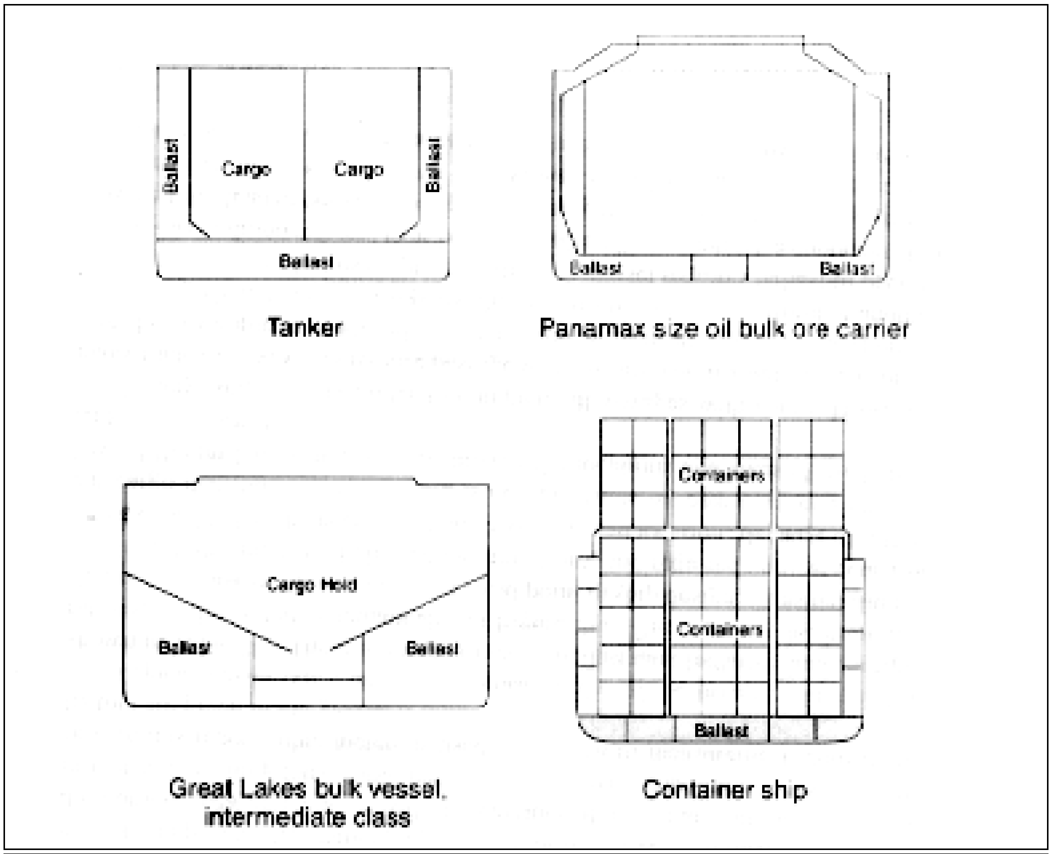
Open circles represent stations with suitable substrata at which *Grateloupia doryphora* was not found.

# Appendix 2: Ballast Water

The purpose of this appendix is to provide further background on ships' ballast water, vessel ballast capacities, and ballast treatment and control options. It is meant to further illustrate the Chapter I discussion of ship-related risks of ballast-mediated species introductions.

## PART A: BALLAST SYSTEMS AND BALLAST CAPACITIES

**Figure 2A-1: Typical ballast tank arrangements for four major types of commercial vessels**

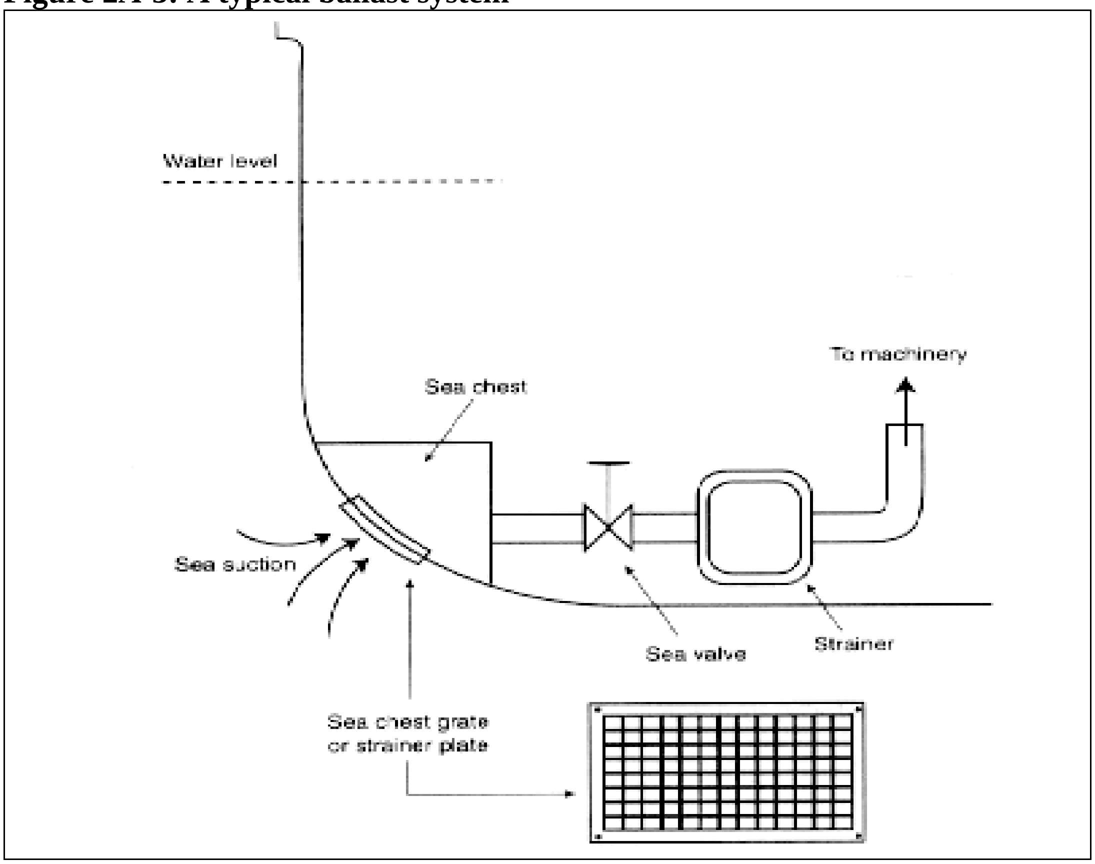



From Marine Board, 1996. Stemming the tide: controlling introductions of nonindigenous species by ships' ballast water. National Academy Press, Washington, DC. p. 25.

**Figure 2A-2: Ballast water (in white) of various oceangoing vessels**

From a slide provided by J.T. Carlton

**Figure 2A-3: A typical ballast system**[219]



From Marine Board, 1996. Stemming the tide: controlling introductions of nonindigenous species by ships' ballast water. National Academy Press, Washington, DC. p. 30.

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[219] Note the sea chest, which has become a source of increasing concern re: its potential to retain and transport aquatic organisms.

## Table 2A-1: Ballast water and containerships: examples of ballast water movement patterns

| Containership # 1<br><br>Registry: Liberia<br>SDWT: 44 477 MT[220]<br>BWCAP: 10 453 MT | <br><br>LPOC: Oakland<br>PPOC: Long Beach<br>NPOC: Hong Kong | | |
|---|---|---|---|
| **Date (1992)** | **Location** | **Ballast on Board** | **Ballast +/-** |
| _ _ _ | Long Beach | _ _ _ | _ _ _ |
| 13-May | Hong Kong | 6032 | _ _ _ |
| 14 | Hong Kong | 6350 | +318 |
| 17 | Singapore | 6518 | +168 |
| 18 | Singapore | 6477 | -41 |
| 18 | Port Kelang | 6477 | |
| 19 | Port Kelang | 5280 | -1197 |
| 20 | Singapore | 5280 | |
| 20 | Singapore | 4614 | -666 |
| 24 | Hong Kong | 4614 | |
| 25 | Hong Kong | 5324 | +710 |
| 5-Jun | Oakland | 5378 | +54 |
| 6-Jun | Oakland | 5234 | -144 |
| 7-Jun | Long Beach | 5225 | -9 |
| 9-Jun | Long Beach | 4125 | -1100 |

| Containership # 2<br><br>Registry: Taiwan<br>SDWT: 53 274 MT<br>BWCAP: 19 240 MT | <br><br>LPOC: Jamaica<br>PPOC: Los Angeles<br>NPOC: Tokyo | | |
|---|---|---|---|
| **Date (1992)** | **Location** | **Ballast on Board** | **Ballast +/-** |
| 24-Mar | Los Angeles | 6565 | _ _ _ |
| 27 | ocean | 6585 | +20 |
| 7-Apr | Tokyo | 6110 | -475 |
| 8 | Osaka | 5060 | +1050 |
| 10 | Pusan | 5020 | -40 |
| 13 | Keelung | 6701 | +1681 |
| 15 | Kaohsiung | 6701 | |

[220] LPOC Last Port of Call — SDWT Summer Deadweight Tonnage
PPOC Present Port of Call — BWCAP Ballast Water Capacity
NPOC Next Port of Call — MT Metric Tons

| | | | |
|---|---|---|---|
| 17 | Hong Kong | 6350 | -351 |
| 21 | Singapore | 6300 | -50 |
| 24 | Colombo | 3200 | -3100 |
| 12-May | Hamburg | 5350 | +2150 |
| 13 | Thamespoort | 5350 | |
| 15 | Rotterdam | 5350 | |
| 16 | Antwerp | 8580 | +3230 |
| 26 | New York | 11 970 | +3390 |
| 27 | Norfolk | 10 686 | -1284 |
| 29 | Charleston | 5460 | -5226 |
| 1-Jun | Jamaica | 5460 | |
| 11 | Los Angeles | 8170 | +2710 |

From Carlton, J.T., D.Reid, and H. van Leeuwen. 1995. The role of shipping in the introduction of nonindigenous aquatic organisms to the coastal waters of the United States (other than the Great Lakes) and an analysis of control options. Report to U.S. Coast Guard, Marine Environment Protection Division, Washington, DC.

**Table 2A-2: Average ballast capacities, and residual (unpumpable) ballast for vessels grouped by major vessel types**

| **Ship type** | **Average Ballast Capacity** | **Ballast Range** | **Unpumpable Ballast (Average)** |
|---|---|---|---|
| Bulk carriers | **19 100** MT**/**<br>**5 060 000** gallons | **211** MT - **47 000** MT/<br>**56 000** - **12 400 000** gallons | **68** MT**/**<br>**18 000** gallons |
| Tankers | **13 500** MT/<br>**3 575 000** gallons | **1500** MT - **28 000** MT/<br>**396 000** - **7 450 000** gallons | **86** MT**/**<br>**22 700** gallons |
| Container ships | **10 600** MT/<br>**2 800 000** gallons | **3900** MT- **22 200** MT/<br>**1 020 000** - **5 865 000** gallons | **145** MT**/**<br>**38 000** gallons |

Note: All data is from Carlton, J.T., D.Reid, and H. van Leeuwen. 1995. The role of shipping in the introduction of nonindigenous aquatic organisms to the coastal waters of the United States (other than the Great Lakes) and an analysis of control options. Report to U.S. Coast Guard, Marine Environment Protection Division, Washington, DC. The numbers in this table were compiled by the researchers in the study on the basis of datasets generated from information collected during boarding 95 vessels at different US locations.

Given these approximate averages for ballast capacity of vessels classified in three main types (bulk carriers, tankers, and containerships), average times for ballast exchange (both flow-through and empty-refill) can be calculated with knowledge of the pumping rates of ballast pumps for the different vessel types. Understanding the time required for ballast exchange is a helpful reference point for both ballast management itself, and for ballast control policy analysis, since it provides a sense of the approximate amount of burden presented to shippers by open ocean exchange requirements. Knowledge of pumping times is helpful in gauging not only operational burden, but also the cost of exchange, which is usually the cost of fuel for running the pumps; therefore ballast capacity, pumping rates, and [ballast] pump fuel efficiency can be used to make an interval estimate of the cost of exchange for major vessel types. Pumping rates for ballast pumps of different vessel types are presented in Table 2, which uses the data from the Marine Board (1996) study.

**Table 2A-3: Typical Vessel Types, Ballast Needs, and Pumping Rates**

| Ballast Needs[221] ($m^3/h$) | Vessel Types | Typical pumping rates |
|---|---|---|
| **Ballast replaces cargo** | Dry bulk carriers | 5000 - 10 000 |
| Ballast required in large | Ore carriers | 10 000 |
| quantities, primarily for | Tankers | 5000 - 20 000 |
| return voyage | Liquefied gas carriers | 5000 - 10 000 |
| | Oil bulk carriers | 10 000 – 15 000 |
| **Ballast for vessel control** | ***Container ships*** | 1000 – 2000 |
| Ballast required in almost all | Ferries | 200 - 500 |
| loading conditions to control | General cargo vessels | 1000 - 2000 |
| stability, trim, and heel | Passenger vessels | 200 – 500 |
| | Roll-on, Roll-off vessels | 1000 – 2000 |
| | Fishing vessels | 50 |
| | Fish factory vessels | 500 |
| | Military vessels | 50 – 100 |
| **Ballast for loading and unloading operations** | Float-on, Float-off vessels | 10 000 – 15 000 |
| Ballast taken on locally in | Heavy lift vessels | 5000 |
| large volumes and discharged | Military amphibious assault vessels | 5000 |
| in same location | Barge-carrying cargo vessels | 1000 - 2000 |

From Marine Board, 1996. Stemming the tide: controlling introductions of nonindigenous species by ships' ballast water. National Academy Press, Washington, DC.

[221] The three categories of ballast needs are not mutually exclusive, i.e. a vessel in which ballast replaces cargo may also require ballast to control stability.

Based on tables 1 and 2, we can, for example, see that an approximate average of pumping time for an empty-refill exchange of a containership is between 10.6 and 21.2 hours for both emptying and refill, e.g. [(10 600MT)/(1000MT/hr)]x2 = 21.2 hrs for emptying and subsequent refill, at pumping rates of 1000MT/hr, assuming that the same ballast pumps do both the emptying and refill. Respectively,

[(10 600MT)/(2000MT/hr)]x2 = 10.6 hrs for emptying and subsequent refill at pumpiing rates of 2000MT/hr, assuming the same pumps do both the emptying and refill.

## PART B: BALLAST CONTROL OPTIONS

As an expansion of the voyage approach classification of ballast management options (See Chapter 1), one of the most useful reviews of management alternatives, by Carlton et al.,[222] examines 32 control options, grouped in 5 categories according to the voyage stage/time at which they occur. Among the pre-voyage control measures [as listed in the study] are "good housekeeping" practices such as avoiding "global hot spots,[223]" avoiding ballasting in water with high sediment loads or in areas of sewage discharge, as well as mechanic filtration, optical (UV) and acoustics (ultrasonic) treatments. En route options as reviewed by the Coast Guard commissioned study include active disinfection (tank wall coatings, chemical biocides, ozonation, thermal treatment etc.), and passive disinfection (ballast exchange, increased voyage length, sediment removal and sea disposal). Given [a vessel's] inability to perform any of the pre-voyage and/or en route

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[222] Carlton et al., 1995.

[223] Areas with [known] high concentrations of known harmful organisms, such as the red tide causing toxic dinoflagellates (that is, for example, avoiding ballast intakes in areas experiencing algal blooms).

options, ballast management steps such as performing ballast exchange in designated back up zones (which are near the port of destination, but far enough offshore to prevent return of released ballast organisms with local currents, etc) are considered as another possible option.[224]

**Table 2A-4: Ballast Water Control Alternatives Classified Based on the "Voyage" Approach[225]**

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**<u>I. ON OR BEFORE DEPARTURE FROM PORT-OF-BALLAST-WATER ORIGIN</u>**

<u>Water Supply: Uptake</u>
1. Specialized shore facility provides treated salt or fresh water
2.Port provides city fresh water

<u>Prevention of organism intake: ballasting micromanagement</u>

| | |
|---|---|
| 3. Site: | Do not ballast in "global hot spots" |
| 4. Site: | Do not ballast in water with high sediment loads |
| 5. Site: | Do not ballast in areas of sewage discharge or known disease incidents |
| 6. Site/Time | Do not ballast at certain sites at certain times of year[226] |
| 7. Site/Time | Do not ballast at night |

<u>Prevention of organism intake: mechanical</u>
8. Filtration

<u>Extermination of organisms upon ballasting (ballast treatment)</u>
9. Mechanical agitation
  a)water velocity
  b)water agitation mechanisms
10. Altering water salinity
  a)Add fresh water to salt water
  b) Add salt water to fresh water
11. Optical: Ultraviolet treatment
12. Acoustics (Sonic): Ultrasonics treatment

**II. ON DEPARTURE AND/OR WHILE UNDERWAY (EN ROUTE)**

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[224] Ibid. Carlton et al., 1995.

[225] The "voyage" approach divides ballast control options depending on the stage in a vessel voyage at which they occur – on or before departure, en route, or on arrival.

[226] E.g. do not ballast during bloom season in areas where toxic dinoflagellates are present

Extermination of organisms after ballasting
(while at port of origin or while underway, but before arrival at destination port)

Active disinfection (ballast treatment)
13. Tank wall coatings
14. Chemical biocides
15. Ozonation
16. Thermal treatment
17. Electrical treatment
18. Oxygen deprivation
19. Filtration/ultraviolet/ultrasonics underway
20. Altering water salinity: partial exchange

Passive disinfection
21. Increase length of voyage
22. Exchange (deballast/reballast)
23. Sediment removal and at-sea disposal

Deballasting only
24. Deballast/no reballasting

## III. BACK UP ZONES

25. Exchange or deballast

## IV. ON ARRIVAL AT BALLAST DISCHARGE DESTINATION PORT

Water supply: discharge
26. Shore facility receives treated and untreated water

Prevention of discharge to environment
27. Discharge to existing sewage treatment facilities
28. Discharge to reception vessel
29. Sediment removal and onshore disposal
30. *In situ* extermination of organisms upon arrival (options 8, 11, 14)

Non-discharge
31. Non-discharge of ballast water

## V. RETURN TO SEA: EXCHANGE WATER

32. Vessel returns to sea and undertakes exchange

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From Carlton, J.T., D.Reid, and H. van Leeuwen. 1995. The role of shipping in the introduction of nonindigenous aquatic organisms to the coastal waters of the United States (other than the Great Lakes) and an analysis of control options. Report to U.S. Coast Guard, Marine Environment Protection Division, Washington, DC.

Another way of representing the temporal sequence in the voyage approach to ballast management,  and of looking at this approach within the context of a quarantine system is reflected in Table 4 below.

**Table 2A-5: Voyage approach to managing ballast water (italics indicate future options)**

| **Before Departure** → | **En route** → | **On arrival** |
|---|---|---|
| **Key factors of importance to master** | | |
| • water temperature/salinity<br>• depth at berth<br>• high sediment loads<br>• sewage discharge, known disease incidence<br>• acceptable light ballast conndition<br>• no ballasting when target organisms present<br>• no ballasting at night<br>• *port baseline survey* | - open ocean<br>- coastal water<br>- fresh water | - water temperature/salinity<br>- contingency plans<br>- *port baseline survey* |
| → **Proactive** → | → | → **Reactive** → |
| **Loading port options** | **At sea options** | **In port options** |
| • no loading of ballast water<br>• freshwater ballast from city main<br>• *treated ballast water from shore reception facilities sampling of water column,*<br>• *chemical, physical, mechanical, or biological treatment* | - deballast/reballast<br>- flushing<br>- *onboard treatment (chemical, physical, mechanical, biological)* | - *transfer onshore*<br>- *depart port – at sea options*<br>- *on board treatment (chemical, physical, mechanical, biological)* |

From Marine Board, 1996. Stemming the tide: controlling introductions of nonindigenous species by ships' ballast water. National Academy Press, Washington, DC.

Another way of classifying ballast management options is by looking at the ones that are currently available, versus the short and long-term management alternatives.

**Table 2A-6: Ballast Management Techniques Classified by Availability .**

| | Current Options | Short-Term Alternatives | Long-Term Alternatives |
|---|---|---|---|
| **Operational Management** | * Exchange<br>* Retention<br>* Avoiding hot spots, other risk factors<br>Partial exchange on NOBOBs | * Loading treated water<br>* Discharge to shore<br>* Avoiding cross-transfer | |
| **Treatment Technologies** | * Sedimentation<br>* pH treatment<br>* Salinity | * Filtration<br>* Loading from a specialized facility<br>* Reception vessels<br>* Chemical Biocides | * Filtration<br>* Ultraviolet light<br>* Heat<br>* Acoustics<br>* Cy/Ag ions<br>* $O_2$deprivation<br>* Reception vessels |
| **Retrofitting or Redesign** | | * Flushing tanks | * Redesign of tanks<br>* Supporting ship and tank redesign |

Reprinted from Reeves, E. *Protection of the Great Lakes From Infection by Exotic Organisms in Ballast Water* , presented to the sixth annual zebra mussel conference, Dearborn, Michigan, March 5, 1996

A number of important studies emphasize shipboard treatment methods as the control methods as the methods with greatest flexibility, and therefore greatest potential in the future.[227] Filtration, addition of biocides (except ozone), and thermal treatment are among the most promising/mature technologies, as ranked by the Committee on Ballast Water, a ranking based on criteria of safety, effectiveness, power consumption,

[227] One of the influential studies ranking shipboard treatment options highest, because they are most flexible, is the Marine Board's Committee on Ballast Water study. (Marine Board, 1996)

installation and operational costs, maintenance requirements, environmental safety (amount etc. of chemical residuals), and availability of existing commercial treatment systems and the potential for adaptation of such systems to shipping industry needs.[228]

# Appendix 3: Vessel traffic data for Narragansett Bay

This appendix provides further details on vessel traffic numbers used in the analysis of current and future commercial shipping-related ballast risks for Narragansett Bay (Chapter I).

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**Table 3A-1: Annual commercial vessel trips on Narragansett Bay, 1985-1996.**

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Freighters | 1026 | 1129 | 914 | 828 | 765 | 643 | 1742 | 304 | 349 | 349 | 1214 | 557 |
| Tankers | 627 | 729 | 690 | 684 | 661 | 659 | 556 | 522 | 492 | 410 | 380 | 401 |
| Towing vessels (TV) | 3493 | 4051 | 3353 | 3081 | 3338 | 3156 | 2613 | 2296 | 1884 | 2087 | 2147 | 1578 |
| Dry Cargo Barges (DCB) | 215 | 259 | 182 | 133 | 868 | 122 | 142 | 169 | 233 | 189 | 151 | 143 |
| Tank Barges (TB) | 1753 | 1653 | 1359 | 1071 | 1274 | 1233 | 909 | 753 | 873 | 791 | 774 | 683 |
| **TOTAL** (all vessel trips) | 7114 | 7821 | 6498 | 5797 | 6906 | 5813 | 5962 | 4044 | 3831 | 3826 | 4666 | 3362 |

From Nield, J.A. 1999. What are the ship-related environmental risks of increased commercial shipping traffic in Narragansett Bay due to proposed port expansion in Providence and Quonset/Davisville? Master's thesis, Brown University Center for Environmental Studies, Providence, RI. Original data from United States Army Corps of Engineers. Annual. *Waterborne Commerce of the U.S. (WCUS) – Vessel Tables.* Navigation Data Center, ACOE. New Orleans, LA.

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[228] Marine Board, 1996, pp. 55-60.

**Table 3A-2: Towing vessels, dry cargo barges, and tank barges as a percentage of all vessel trips on Narragansett Bay for the period 1985-1996.**

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Towing vessels (TV) | 3493 | 4051 | 3353 | 3081 | 3338 | 3156 | 2613 | 2296 | 1884 | 2087 | 2147 | 1578 |
| Dry Cargo Barges (DCB) | 215 | 259 | 182 | 133 | 868 | 122 | 142 | 169 | 233 | 189 | 151 | 143 |
| Tank Barges (TB) | 1753 | 1653 | 1359 | 1071 | 1274 | 1233 | 909 | 753 | 873 | 791 | 774 | 683 |
| **TV+DCB+TB total** | 5461 | 5963 | 4894 | 4285 | 5480 | 4511 | 3664 | 3218 | 2990 | 3067 | 3072 | 2404 |
| All vessel trips - TOTAL | 7114 | 7821 | 6498 | 5797 | 6906 | 5813 | 5962 | 4044 | 3831 | 3826 | 4666 | 3362 |
| TV+DCB+TB as % of all vessel trips/yr | **77%** | **76%** | **75%** | **74%** | **78%** | **78%** | **61%** | **80%** | **78%** | **80%** | **66%** | **72%** |

From Nield, J.A. 1999. What are the ship-related environmental risks of increased commercial shipping traffic in Narragansett Bay due to proposed port expansion in Providence and Quonset/Davisville? Master's thesis, Brown University Center for Environmental Studies, Providence, RI. Original data from United States Army Corps of Engineers. Annual. *Waterborne Commerce of the U.S. (WCUS) – Vessel Tables.* Navigation Data Center, ACOE. New Orleans, LA.

The large percentage of tugs and barges as a proportion of total vessel traffic is important for gauging the ballast context in the bay, since these vessel categories do not represent any risk of ballast-mediated introductions. They either carry no ballast, as in the case of tugs and barges, or carry strictly local ballast (as in the case of ballast-carrying barges).

**Table 3A-3: Number of foreign and domestic vessel arrivals in Narragansett Bay, 1995-1999**

| | **1995** | **1996** | **1997** | **1998** | **1999** |
|---|---|---|---|---|---|
| # foreign vessel arrivals | 185 | 243 | 222 | 202 | 189 |
| # domestic vessel arrivals | 99 | 127 | 160 | 123 | 94 |
| TOTAL | 284 | 370 | 382 | 325 | 283 |

Data from MARAD database, data on vessel arrivals to ports in Narragansett Bay, including Fall River; data provided by Whitman Miller, SERC Ballast Water Clearinghouse on April 4, 2000.

Table 3A-4: Quonset Point Vessel projections, for the 20 year period from start of new port operation until port expansion is completed (2005-2025)

| | 2005 | 2007 | 2015 | 2025 |
|---|---|---|---|---|
| # vessels per week | 5 | 5 | 9 | 14 |
| **Total # vessels per year** | **260** | **260** | **468** | **728** |

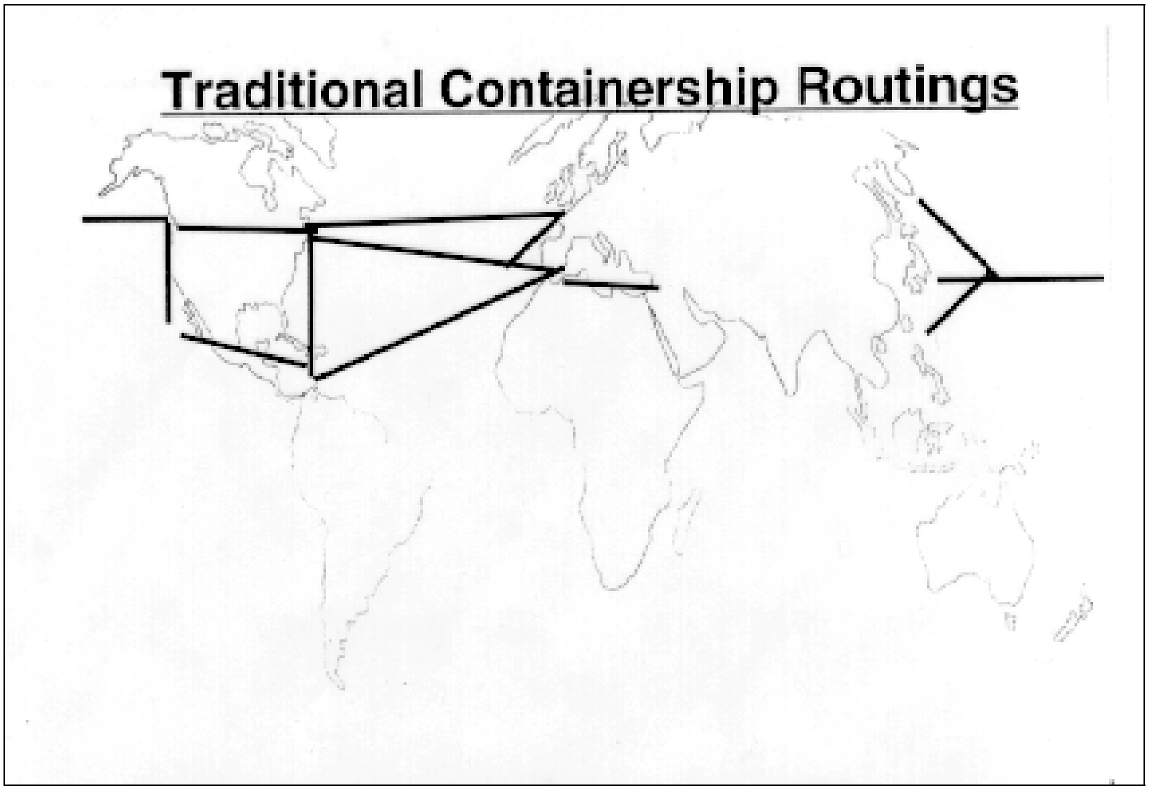
**Data from Quonset Point Partners LLC, Port development Plan, June 30, 1999.**

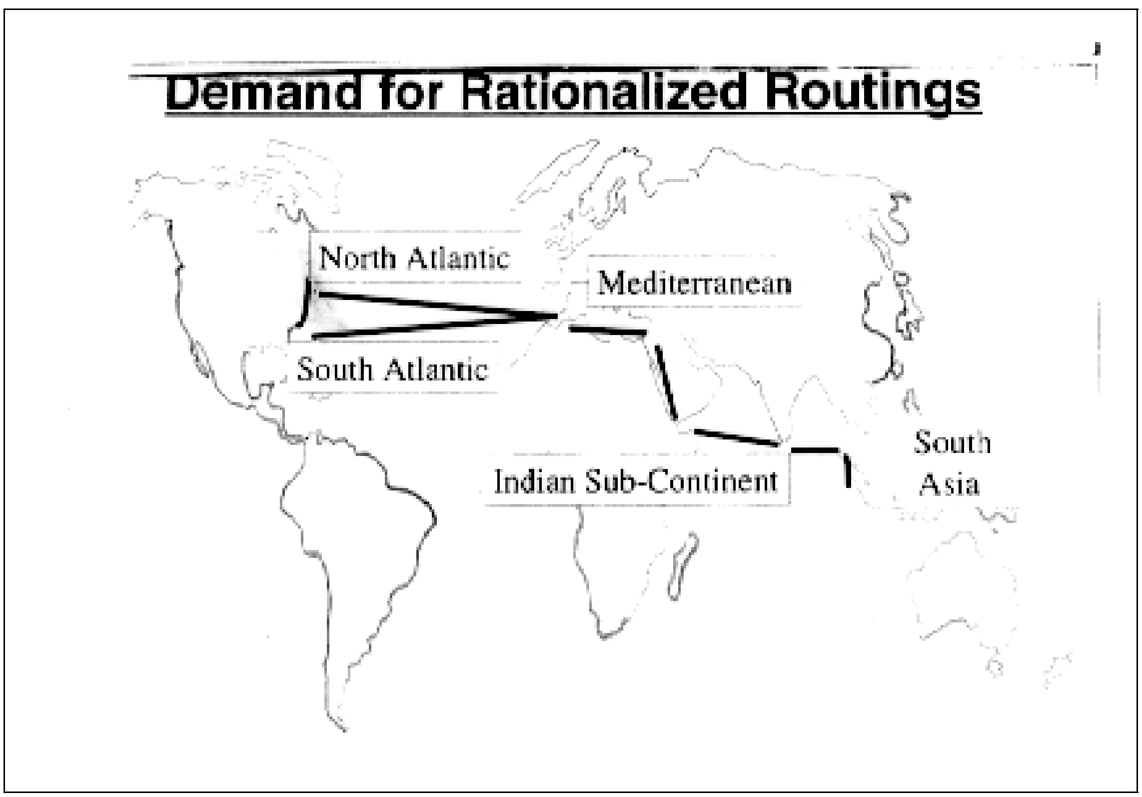
**Table 3A-5: Quonset Point Vessel and Cargo Projections**

| | | | | **Estimated Vessel Mix** | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | TEU | Barges | 1000-1500 TEU | 2000-3000 TEU | 3500-4500 TEU | 4500+ TEU | Total ship calls/wk | Total Vessels/wk |
| 2005 | 300 000 | 1 | 1 | 2 | 2 | 0 | 5 | 6 |
| 2007 | 330 000 | 1 | 1 | 2 | 1 | 1 | 5 | 6 |
| 2015 | 640 000 | 2 | 2 | 3 | 2 | 2 | 9 | 11 |
| 2025 | 1 000 000 | 3 | 3 | 4 | 4 | 3 | 14 | 17 |

Data from Quonset Point Partners LLC, Port development Plan, June 30, 1999.

**Figure 3A-1: Traditional and projected [future] rationalized containership routings**




From QPP presentation to stakeholders, October 1998. (Title of the presentation: Container terminal development project)

**Effects of port downsizing on ballast-related introduction risks**

The plans for sizing and location of the initially proposed mega-containerport were adjusted several times in favor of downscaling. These adjustments were a result of the stakeholders process[229] which led to recommendations for size and location minimizing environmental impacts of the facility and its operation. The initial plan included a much larger terminal area, amounts of dredge and fill, channel depth, and, respectively, cost, than the subsequent alternatives. The amount and extent of downscaling from the original proposal to the 3 final [two-phase] alternatives, is reflected in Tables 6 and 7. Amount and extent of downscaling are expressed in terms of several key indicator quantities, which are also of immediate relevance to the expected environmental impacts of port construction and operation; these quantities are total terminal area, amount of dredge and fill, and channel depth. Cost is also included for comparison.

Table 3A-6: The six alternatives of the Quonset-Davisville initial port proposal (1998)

| | Total Terminal area (acres) | Dredge Materials (mcy) | Created Land (acres) | Cost of Development ($ million) | Channel depth (feet) |
|---|---|---|---|---|---|
| Alternative I | 657 | 12.6 | 383 | 607.7 | 52 |
| Alternative II | 652 | 16.3 | 252 | 666.1 | " |
| Alternative III | 644 | 14.6 | 108 | 761.6 | " |
| Alternative IV | 753 | 14.8 | 61 | 786.7 | " |
| Alternative V | 739 | 9.4 | 301 | 829.5 | " |

[229] In mid-May, 1998 Governor Lincoln Almond, with the concurrence of Rhode Island and regional environmental, business and labor leaders, called for the creation of a Stakeholders process to develop consensus on a proposed port for the Quonset Point-Davisville site. The Stakeholders determined their own membership, decided the purpose of their endeavor, set their own agendas, organized their own committees and directed the collection of data. When they were concerned about the possible bias of consulting scientists, hired by the developer, they proposed and obtained independent peer review of the consultants' work. (Final Stakeholders Report to Governor Lincoln Almond, http://www.riedc.com/stakeholders/finalqpdreport.pdf (retrieved 04.08.00).

| | | | | | |
|---|---|---|---|---|---|
| Alternative VI | 694 | 10.1 | 372 | 777.8 | " |
| | **As translated into traffic and cargo volumes…** | | | | |
| Year of port expansion | TEU/year | vessels/day | vessels/wk | vessels/year | |
| Year 1 (2005) | 800 000 | 1 | 7 | **364** | |
| Year 2 (2025) | 3 400 000 | 2 | 14 | **728** | |

**Data Source: Quonset Point Partners LLC.** ***Quonset/Davisville Port and Commerce Park – Container Terminal Development Project. 1998.***

**Table 3A-7: The new proposal, after initial plans are modified to fit stakeholders principles (1999) (3 alternatives, 2 phases for each alternative)**

| | Total Terminal area (acres) | Dredge Material (mcy) | Created Land (acres) | Cost of Development ($ million) | Channel depth (feet) |
|---|---|---|---|---|---|
| **1. Davisville** | | | | | |
| Phase I | 213 | 8.9 | 68.4 | 352.8 | 45 |
| Phase II additions | 137.7 | 4.25 | 69.3 | 215.3 | " |
| **Total** | **350.7** | **13.15** | **137.7** | **568.1** | " |
| 2. Quonset North | | | | | |
| Phase I | 202 | 10.25 | 126.2 | 430 | 45 |
| Phase II additions | 88 | _ | _ | 91 | " |
| **Total** | **290** | **10.25** | **126.2** | **521** | " |
| 3. Quonset Altern. | | | | | |
| Phase I | 250 | 9.17 | 204.5 | 318.4 | 45 |
| Phase II additions | 140 | _ | _ | 99.3 | " |
| **Total** | **390** | **9.17** | **204.5** | **417.7** | " |
| | **As translated into traffic and cargo volumes…** | | | | |
| | TEU/year | vessels/day | vessels/week | vessels/year | |
| Year 1 (2005) | 510 000 | | 5 | 260 | |
| Year 3 (2007) | 561 000 | | 5 | 260 | |

| | | | | | |
|---|---|---|---|---|---|
| Year 10 (2015) | 1 088 000 | | 9 | 468 | |
| Year 25 (2025) | 1 700 000 | 2 | 14 | **728** | |

Data Source: Quonset Point Partners LLC. *Port Development Plan.* June 30, 1999.

Appendix 4: Policy Response to the Problem of Ballast-Mediated Species Transfer

This appendix provides information and chronology of some of the policy and regulatory steps taken in response to the ballast transfer problem, both internationally and in the U.S.

**Table 4A-1: A chronology of political and legal actions on exotics in ballast water**

| | |
|---|---|
| AUG 1988 | In response to the detection of the ruffe and the zebra mussel in the Great Lakes, the Great Lakes Fishery Commission and the International Joint Commission request that the Governments of the United States and Canada require the exchange of ballast water for ships entering the Great Lakes. |
| MAY 1989 | The Canadian Coast Guard issues Voluntary Guidelines for the Control of Ballast Water Discharges from Ships, recommending use of exchange. |
| FEB 1990 | In response to outbreaks in toxic dinoflagellates, the Australian Quarantine and Inspection Service (AQIS) issues Voluntary Guidelines for Ballast Water and Sediment Discharge from Overseas Vessels Entering Australian Waters. |
| SEP 1990 | The International Joint Commission and the Great Lakes Fishery Commission issue a joint report recommending that the Governments of the United States and Canada require the exchange of ballast water on ships entering the Great Lakes, coordinate their programs, promote international standards, and develop a long-term research strategy, including study of redesign and retrofitting of vessels to maximize safe and effective ballast exchange. |
| NOV 1990 | The United States Enacts the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA 1990), which applies only to the Great Lakes and connected waters, |

| | |
|---|---|
| | mandating the US Coast Guard to issue voluntary guidelines 6 months after the act and mandatory regulations two years after the act.[230] |
| JUL 1991 | The Marine Environment Protection Committee (MEPC) of the International maritime Organization (IMO) issues draft International Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ships' Ballast Water and Sediment Discharges, recommending ballast exchange. |
| DEC 1991 | The Canadian Great Lakes laboratory for Fisheries and Aquatic Sciences issues a report on the effectiveness of ballast exchange in the Great Lakes under the 1988 Canadian Guidelines. |
| APR 1993 | The US Coast Guard Issues mandatory regulations under NANPCA 1990, requiring exchange or alternative measures on all vessels entering the Great Lakes in ballast (applicable to vessels headed for both US and Canadian ports in the Great Lakes). |
| JUL 1993 | At the urging of Australia, with support from New Zealand, Canada, and the United States, MEPC (IMO) forms a Ballast Water Working Group (BWWG). |
| NOV 1993 | The IMO General Assembly adopts Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ships' Ballast Water and Sediment Discharges, recommending ballast exchange. |
| MAY 1994 | The Australian Quarantine and Inspection Service (AQIS) develops a draft Australian Ballast Water Strategy for a comprehensive program of research on control measures. |
| OCT 1996 | The United States enacts the National Invasive Species Act (NISA 1996), mandating the US Coast Guard to issue national voluntary guidelines one year after the act, and national mandatory regulations three years after the issuance of the guidelines, if the voluntary guidelines are found to be ineffective. |
| OCT 1997 | The Canadian Department of Fisheries and Oceans (DFO), the Canadian Department of Transport (Transport Canada), and the US Coast Guard adopt a Binational Ballast Water Research Strategy to support critical changes in the Great lakes regime. |
| APR 1998 | The US Coast Guard proposes voluntary guidelines under NISA 1996, along with revisions to the existing great Lakes Mandatory regulations. |
| OCT 1998 | Canada enact an Amendment to the Shipping Act authorizing the government to issue mandatory regulations for the management of ballast water throughout Canada. |
| MAY 1999 | The US Coast Guard issues the National Voluntary Guidelines under NISA 1996, which guidelines also contain some amendments to the Great lakes regime (whose content remains essentially the same) |
| JUL 1999 | The mandatory ballast reporting requirement, promulgated through the May 17 national ballast management guidelines issued by the US Coast Guard pursuant to NISA 1996, enters into force. |

Source: Eric Reeves, Analysis of Laws and Policies Concerning Exotic Invasions of the Great Lakes. A report commissioned by the Office of the Great Lakes, Michigan DEQ, March 15, 1999.

[230] NANPCA 1990, US Public Law 101-646 (November 1990), codified in 16 USC §§ 4701 *et seq.* , later amended by NISA 1996, National Invasive Species Act of 1996, Public Law 104-332, 110 Stat. 4073 (Oct. 26, 1996) which currently appears in 16 USCS §§ 4701 *et seq.*

**International legal framework: compliance and enforcement difficulties**

Adding to the detection and liability proof difficulties, in vessel pollution control on international level, enforcement and punishment of violators also present significant challenges, because of the separation of authority among flag, coastal and port states.

Three types of jurisdiction apply to oceangoing vessels: flag, coastal, and port state jurisdiction. This division means that the separate authorities to detect a violation (prescriptive jurisdiction), sue the accused (adjudicative jurisdiction), and punish the offender (enforcement jurisdiction), while combined together in national legal systems, are not vested in the same state under UNCLOS[231] and MARPOL.[232] Upon finding a violation, the port or coastal authority is required to pass its findings to the flag state for enforcement proceedings, unless the violation occurs within the territorial waters of the coastal state.[233]

This jurisdictional requirement can have a particular result in the case of ballast water. Within an international framework of ballast control, a ship, consciously avoiding coastal country enforcement action, may discharge untreated ballast right outside the territorial sea of a coastal country, posing essentially similar risks as a discharge in territorial waters.  Provided that the unauthorized discharge is detected, the violating vessel, having [potentially] damaged the coastal state, will still be subject to the enforcement jurisdiction of its flag state. Such jurisdiction is questionable as to its

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[231] United Nations Convention on the Law of the Sea (UNCLOS), negotiated1982, entered into force1994 with the filing of its 60th instrument of ratification.

[232] Hunter et al., 1998.

[233] Ibid. 8.

adequacy: since pollution on the high seas and in other coastal waters does not normally affect the flag state, flag state has little incentive to prescribe environmental standards or take adequate enforcement measures.[234] Such lack of incentives to uphold environmental standards has been amply illustrated by the widespread phenomenon of flags of convenience, where flag states are specifically chosen by commercial shippers for the low level of [among other] environmental standards and enforcement.

Generally, even if violation occurred outside the flag state's waters, unless the violation was in the territorial waters of a coastal state, enforcement proceedings in the flag state preempt and suspend enforcement proceedings commenced in the port or coastal state.[235] Only two exceptions to the practice of flag state enforcement are stipulated by UNCLOS: if the discharge, even when committed outside territorial waters, causes major damage to the coastal state, or if the flag state has a history of non-enforcement.[236] History of non-enforcement has proven difficult to establish. As to the "major damage to coastal state" provision, in the case of ballast discharges, damage will be even more difficult, and often impossible to establish and attribute to a particular vessel.

**Table 4A-2: The key U.S. requirements and guidelines on ballast from foreign shipping, as mandated by USCG regulations issued pursuant to NISA 1996[237]**

[234] Ibid. 8.

[235] Ibid. 8.

[236] UNCLOS 1982, Article 228(1).

[237] From the May 17, 1999 Coast Guard Rule Implementing the provisions of the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA) (16 U.S.C. 4701-4751), as amended by the National Invasive Species Act of 1996 (NISA). (the Amendments to 33 CFR Part 151 or Fed. Reg. 64(94) 26672-16690.)

## A. Mandatory regulations

**1. Great Lakes and Hudson River Only**[238]

Ballast management requirements:

All vessels bound for the Great Lakes or Hudson River, and which have operated beyond the EEZ during any part of their voyage (regardless of intermediate ports of call within the waters of the United States or Canada) must perform the following ballast management procedures (as well as all of the reporting procedures detailed in 2 below):

- Exchange of ballast (prior to entry into the Snell Lock, at Massena, New York, or prior to navigating on the Hudson River, north of the George Washington Bridge) in waters beyond the EEZ line, and in a depth exceeding 2000 meters, where the exchange needs to result in salinity of at least 30 ppt.

OR

- Retain the vessel's ballast water on board the vessel[239]

OR

- Use an alternative environmentally sound method of ballast water management that has been submitted to, and approved by, the Commandant prior to the vessel's voyage.

Safety exemption and ballast management alternatives in extraordinary circumstances:

Open ocean ballast water exchange (as required for Great Lakes and Hudson River Vessels) should not jeopardize the safety of the ship and the crew, so it should not be performed under conditions that will put the vessel and its crew in danger.[240] However, if [the master of] any vessel subject to the mandatory ballast management requirements above is unable to effect a ballast water exchange before entering the EEZ, due to weather, equipment failure, or other extraordinary conditions, such vessel still needs to employ an approved alternative method of ballast water management, or to exchange ballast within a “backup” exchange zone in the area, where the “backup” exchange zone has to be agreed to by the COTP (Captain of the Port) at the time of the request.[241]

**2.All US waters**[242]

All vessels[243] carrying ballast water into the waters of the United States after operating beyond the EEZ are required to maintain a record of and submit (to NBIC or COTP) a report on their total ballast, the number of ballast tanks and the ballast content of each tank in the vessel, and the number and type of ballast operations during the vessel’s US bound voyage. Vessels are also required to provide exact information on the intended amount of ballast discharge in US waters, a report of whether or not the ballast discharged in US waters had undergone ballast exchange or any alternative treatment, and a description of the type of alternative treatment or the vessel/sea conditions during the exchange. Any intended sediment discharge

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[238] 33 CFR Sect. 151.1510.

[239] If this method of ballast water management is employed, the COTP (Captain of the Port) may seal any tank or hold containing ballast water on board the vessel for the duration of the voyage within the waters of the Great Lakes or the Hudson River, north of the George Washington Bridge.

[240] 33 CFR Sect. 151.1512.

[241] 33 CFR Sect. 151.1514.

[242] 33 CFR Part 151: Sect.-s 151.2040 & 151.2045.

[243] Except for crude oil tankers engaged in the coastwise trade, passenger vessels equipped with a functioning treatment system designed to kill aquatic organisms in the ballast water, Department of Defense, Coast Guard or Armed Forces Vessels (who are subject to requirements under different sections of relevant statutes), vessels that will discharge ballast water or sediments only at the same location where the ballast water or sediments originated, and vessels in innocent passage (who are not discharging ballast) which are exempt from the mandatory reporting requirements in Secs. 151.2040 and 151.2045. (Sections 151.2010 & 151.2015).

and the location of the [legally approved] disposal facility also needs to be reported. These, and some other vessel specification and voyage/crew related information is to be submitted electronically or on paper in the format of the Ballast Water Reporting Form developed by the National Ballast water Clearinghouse at the Smithsonian Environmental Research Center in Edgewater, MD.[244]
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## B.Voluntary guidelines

**1. All US waters except Great Lakes and Hudson River[245]**

**Requested practices**
All vessels carrying ballast water into the waters of the United States after operating beyond the EEZ are requested to perform one of the following ballast management practices:
- Exchange ballast water beyond the EEZ, from an area no less than 200 nautical miles from any shore, and in waters more than 2,000 meters (6,560 feet, 1,093 fathoms) deep, before entering waters of the United States.
OR
- Retain the ballast water on board the vessel
OR
- Use an alternative environmentally sound method of ballast water management that has been approved by the Coast Guard before the vessel begins the voyage
OR
- Discharge ballast water to an approved reception facility.
- Under extraordinary conditions, conduct a ballast water exchange within an area agreed to by the COTP at the time of the request.

**Safety exemption**
The safety exemption under the guidelines concerning all US waters besides the Great Lakes and the Hudson River is much broader and more sweeping than the safety exemption stipulated for the latter two regions. *This greater latitude of the safety exemption would have an impact on the efficiency of ballast management in the future, should the voluntary guidelines become mandatory (in 3 years0 while preserving their current content* (see discussion later in chapter. For all US waters other than the Great lakes and the Hudson River

As in the case of the Great Lakes and Hudson River, for the rest of US waters the master, operator, or person-in-charge of a vessel is not required to conduct a ballast water management practice (including exchange), if they decide that the practice would threaten the safety of the vessel, its crew, or its passengers because of adverse weather, vessel design limitations, equipment failure, or any other extraordinary conditions. **However,** in the case of no exchange due to safety concerns, vessels on a voyage to any port other than the Great Lakes or Hudson River, are not required to perform a substitute ballast water management practice.[246]

**2.All US waters**

[244] Completion of the ``Ballast Water Reporting Form'' contained in the IMO Guidelines or of the ballast water information section of the required St. Lawrence Seaway ``Pre-entry Information Flagged Vessels Form,'' is also considered as compliance with the requirements in the sections of the Coast Guard regulations stipulating mandatory reporting.

[245] Vessels in those two regions are bound by MANDATORY ballast management requirements, as detailed above, in part A 1) of this table.

[246] 33 CFR Sect. 151.2030.

| |
|---|
| **Voluntary precautions [to minimize the uptake and the release of harmful aquatic organisms, pathogens, and sediments]:**[247]<br>- Avoid the discharge or uptake of ballast water in areas within marine sanctuaries, preserves, or coral reefs<br>- Minimize or avoid uptake of ballast water in areas known to have infestations or populations of harmful organisms and pathogens (e.g., toxic algal blooms), areas where propellers may stir up the sediment, areas near sewage outfalls, areas near dredging operations, areas where tidal flushing is known to be poor, as well as in darkness when bottom-dwelling organisms may rise up in the water column.<br>- Clean the ballast tanks regularly (in mid-ocean or under controlled arrangements in port, or at dry dock) to remove sediments<br>- Discharge only the minimal amount of ballast water essential for vessel operations while in the waters of the United States<br>- Rinse anchors and anchor chains when you retrieve the anchor to remove organisms and sediments at their place of origin and remove fouling organisms from hull, piping, and tanks on a regular basis (disposing of any removed substances in accordance with local, State and Federal regulations)<br>- Maintain a ballast water management plan that was developed specifically for the vessel |

Compiled on the basis of the US Coast Guard Rules, 33 CFR 151.

For Table 4A-3, the statutes in the shaded areas represent federal legislation that is applicable to the problem of ballast mediated marine bioinvasions, but has not been used to address the problem, to date.

[247] 33 CFR Sect. 151.2035(a).