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The National Invasive Species Act of 1996: An Assessment of Current Statutes and Potential Changes and Improvements for Future Legislation Regarding Ballast Water Discharge and Prevention of Invasion by Non-Indigenous Species

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THE NATIONAL INVASIVE SPECIES ACT OF 1996: AN ASSESSMENT OF CURRENT STATUTES AND POTENTIAL CHANGES AND IMPROVEMENTS FOR FUTURE LEGISLATION REGARDING BALLAST WATER DISCHARGE AND PREVENTION OF INVASION BY NON-INDIGNEOUS SPECIES

BY

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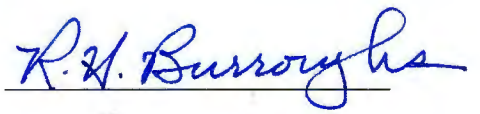
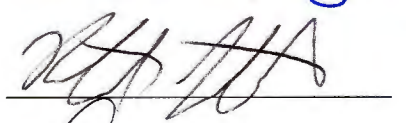
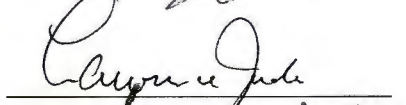
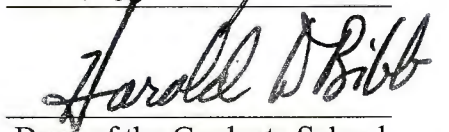
Major Professor 







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ABSTRACT

Ninety-five percent of consumer goods used in the United States reach the markets by way of vessel transport. Each of these vessels carries ballast water, and with it, exotic organisms from ports around the world that can threaten native ecosystems.

A survey (n=10) conducted to gather perceptions on existing ballast water legislation shows that those state and federal agencies who are involved agree on certain aspects of the issue, but there are broad areas of dissent regarding other aspects. Policy actors do feel that this issue must be regulated, however, an agreement on how to reach the goals of ballast water policy cannot be reached. Accordingly, a different model of constructing policy was utilized and a provisional model built using assessed survey data.

The core and periphery model (Majone 1989) structures these findings to reflect those elements of legislation that have been identified by respondents and research as central to the policy itself. The model serves to hold these elements constant throughout the process of devising, implementing and evaluating policy. The periphery is constructed of concentric rings that surround the core. These rings hold the programs and other concrete activities that serve to reinforce and uphold the goals of the overall policy.

Through the articulation of this model, the most important elements of ballast water policy were identified, as well as potential practices to improve the effectiveness of this legislation in the future.

Findings of this research suggest feasible legislative revisions to existing ballast water legislation, the most important of which is the use of the core and periphery model to base future policy development on. Other suggestions for improvement include partnerships among those involved with this issue and cohesive national policy.

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PREFACE

Every day, between three and ten thousand aquatic creatures are transported from their native habitats and introduced into new ecosystems. If conditions of this new habitat happen to be suitable, this new species can establish a population that could ultimately lead to a destruction of certain aspects of the native system. Or, the organism may die as soon as it is released into the new waters. Ballast water discharge is a game of ecological roulette. As such, legislation that will protect the ecosystems, economies and health is vital. However, regulations that pertain to ballast water are not sufficient to stem the tide of invasive species. The upcoming reauthorization of ballast water legislation provides the opportunity to work toward correcting the shortcomings currently troubling this policy.

This project centered those working on this issue in a professional setting; a survey was used to gather their perceptions of current ballast water legislation, as well as potential improvements for the future. Conclusions of this research are offered in hopes of contributing to the process of developing effective legislation to protect the many systems threatened by invasive species.

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Chapter I
Introduction

At the turn of the twenty-first century, human activities ranging from shipping to recreation are moving aquatic species of all kinds from place to place at rates unprecedented in the last tens of millions of years.[1] The ensuing threat of the establishment and spread of non-indigenous species into new areas of the world represent a significant change to the global environment. Many of these introductions have caused substantial environmental and ecological damages that are irreversible, and have resulted in serious economic losses for some communities and water-dependent industries. If the flow of non-indigenous species continues unchecked, these damages and losses will trend toward increasingly homogeneous biota around the world.[2]

The challenge of this issue is presented by the fact that the activity that moves the most species from place to place is also one of the most critical to markets everywhere. The global economy, as well as that of the United States, relies heavily upon the smooth functioning of the shipping industry. It is estimated that more than eighty percent of consumer goods are transported to markets around the world by ship,[3] and that ships carry ninety-five percent of the intercontinental trade of the United States.[4] The globalization of the world trade market has integrated the economies of virtually every corner of the world. However these booming

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[1] Marc Miller, "Model Prevention of Harm by Non-indigenous Species Act," 7 November 1995 <http://www.law.emory.edu/~mmiller/nisa1195.html>. Accessed 10 April 2000.
[2] Ibid.
[3] James Carlton, personal communication, 26 October 1999.
[4] Anonymous, "The Port Probe," *Journal of Commerce* (13 September 1999): 5.

economies are threatening to destroy the ecosystems of the world's oceans as non-indigenous species are introduced into new habitats every day by ships' ballast water. Approximately three to ten thousand aquatic species are transferred to new habitats daily.[5] Though most species are not equipped to withstand the transition, a small percentage survive and create severe environmental and public health problems, as well as pose huge amount of money in eradication attempts, which are generally unsuccessful. To date, it has been virtually impossible to predict which species will successfully invade, and where the invasion will take place. It is believed that the establishment of a non-indigenous species in a new habitat is rarely related to only one environmental parameter.[6] Based on this assumption, the best way to mediate the damaging effects of non-indigenous species is to prevent their introduction in the first place.

Effective legislation may be crucial to protecting ecosystems. This research examines the current structure of policy development, implementation, and monitoring within the area of ballast water and non-indigenous species, with an ultimate goal of defining potential improvements in devising guidelines for the future re-authorization of National Invasive Species Act 1996 (NISA 1996). This research identifies the elements that will be crucial to the evolution of the National Invasive Species Act of 1996 as it is re-authorized in coming years. This project provides a forum for the varying opinions on how to best form policy regarding the ballast water/non-indigenous species issue, as well as an objective analysis of those ideas.

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[5] James Carlton, personal communication, 26 October 1999, and Chris Bright, *Life Out of Bounds: Bioinvasion in a Borderless World* (New York: W.W. Norton & Sons, 1998): 157.

The outcome of this project is a set of proposals for specific actions and/or policy goals that might facilitate the evolution of successful ballast water and non-indigenous species prevention and control policy. Specifically stated, the major objective of this project is to identify those elements that are perceived by those dealing with various aspects of the ballast water and non-indigenous species issue to be successful and necessary additions to the reauthorization and restructuring of ballast water legislation.

To this end, a survey was used to gather these opinions and reach a consensus from which to generate conclusions. Subsequent analysis of survey responses has distinguished the areas of broad assent on this issue from the areas of contention. The topics that are agreed upon by all involved parties should be included in the reauthorization of ballast water and non-indigenous species legislation, while the topics that are subject to contention should be addressed prior to the formulation of the reauthorization or new regulations in order to mediate or iron out any basic problems before the policy-making process moves forward. Analysis also provides suggestions for dealing with other aspects of the issue, such as procedures for sediment disposal, monitoring methods, and potential partnerships for successful prevention and control of exotic species invasions. The expected outcome of the survey analysis is as follows:

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[6] James Carlton, "Pattern, Process, and Prediction in Marine Invasion Ecology," Biological Conservation 78 (1996): 98.

HYPOTHESES

H_1: There are no significant differences in perception of the ballast water/ non-indigenous species issue as a serious problem between response groups.

H_2: There are no significant differences in perceptions of the adequacy of allocation of funding for technology development for ballast water treatment between response groups.

H_3: There are significant differences in the perceptions of the adequacy of allocation of funds for ecological impact/risk assessment research between response groups.

H_4: There are no significant differences in the perception of the effectiveness of NISA 1996 between response groups.

H_5: There are significant differences in perception of what would be the most effective means of managing ballast water between groups.

H_6: There is a significant difference in perception of whether the implementation of NISA 1996 would benefit from partnerships among organizations and agencies involved ballast water technology research and development and formation of risk assessments and ecological implications.

H_7: There is a significant difference in perception of the most successful means of monitoring ballast water management methods.

H_8: There is no significant difference in perceived importance of addressing treatment and disposal of sediments from ballast water tanks.

H_9: There no significant difference in the perception of ballast water exchange being a benchmark, and the opinion that development and implementation of new ballast water technology will be challenging.

Affirmation or rejection of these hypotheses will guide the conclusions and recommendations that are the ultimate outcome of this research project.

Chapter II

• Background: Ballast Water Basics

To understand the issue of ballast water and non-indigenous species fully, the utilization and purpose of ballast water must be understood. Ballast, as defined by *The Oxford Companion to Ships and the Sea*, is "the additional weight carried by a ship to give her stability and/or provide a more satisfactory trim."[7] Ballast is used when the vessel is carrying less than its maximum cargo load, either during a transit to pick up a product, or after dropping off a portion of the cargo before continuing on to the next port of call. If a ship is lightened, ballast must be taken aboard in order to reduce the profile of the ship above the water, and to make her easier to maneuver.[8] Ballast may also be taken aboard to stabilize the vessel in heavy weather or rough seas.

In early, smaller ships, ballast was any material ranging from stones to iron, and was laid in the hold of the ship. From the 1880's onward, water began to be utilized as ballast aboard ships.[9] It was only after World War II that the use of water as ballast became widespread.[10] At this time, as ships became faster and larger, solid ballast was rendered obsolete. There was always a danger of solid ballast shifting when the vessel was underway, which posed a threat of damage or even loss of the

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[7] Peter Kemp, ed, *The Oxford Companion to Ships and the Sea* (Oxford: Oxford University Press, 1976), 55.

[8] Massachusetts Institute of Technology Exotics Department, "Ballast Water Fact Sheet." Cambridge, MA: Massachusetts Institute of Technology, 1999. Database on-line. Available from http://www.massbay.mit.edu/exoticspecies/ballast/bw-fact-sheet.html. Accessed 28 October 1999.

[9] Committee on Ships' Ballast Operations, Marine Board, Commission on Engineering and Technical Systems of the National Research Council, *Stemming the Tide: Controlling Introductions of Nonindigenous Species by Ships' Ballast Water* (Washington, DC: National Academy Press, 1996): 22.

[10] Carlton, personal communication, 26 October 1999.

vessel. Perhaps more important to the competitive shipping industry than that was the time constraints that followed utilizing solid ballast. Solid ballast required the time and manpower to unload the holds before the cargo could be loaded. In using water as ballast, the loading and unloading times are greatly reduced, thereby reducing the time that a vessel needs to be in port, and decreasing sailing times, as well.[11]

In light of the great advantages to using water as ballast, it became the sole substance utilized by tankers and cargo ships. Ballast water is taken in through one or more intake pumps that are located in the hull of the vessel, below the waterline (see Figure 1).[12] The water passes through a series of pipes until it reaches the ballast tank or floodable cargo hold to be filled. Some of these holds can accommodate more than 150,000 metric tons of water,[13] and are located in different areas, depending on vessel type. The water bound for the ballast tanks should pass through a grate, or strainer, on the way to the tank. However, these strainers or grates are often in a state of disrepair, or even missing completely. There is one case of particular note involving a vessel that was bound for Baltimore Harbor from the eastern Mediterranean. An inspection of the ballast holds of the cargo vessel revealed that there were over fifty "actively swimming individuals" of a mullet

[11] Committee on Ships' Operations, Marine Board, Commission on Engineering and Technical Systems of the National Research Council, *Stemming the Tide: Controlling Introductions of Nonindigenous Species By Ships' Ballast Water*, 2.
[12] Ibid, 29.
[13] Ruiz et al, "Ballast Water and Non-Indigenous Species in US Coastal Waters," in *Ballast Water: Ecological and Fisheries Implications*, 13.

species, each from twelve to fourteen inches long, contained within the ballast water.[14]

The case of mullet in the ballast tank is certainly not an isolated incident of aquatic life being transported by ballast water. To the contrary, nearly every ballast tank aboard any vessel contains a mix of water from various ports, and an even greater diversity of species. The water in these ballast tanks can be from just hours old to months old, and can range in salinity anywhere from zero parts per million to forty parts per million.[15] The sources of ballast water, along with the wide range of salinity, varying temperatures, and nutrients in the water can attribute to a great diversity of aquatic organisms living in the ballast tanks. A study that sampled ballast water from one hundred fifty-nine vessels entering Coos Bay, Oregon found that the organisms contained within the ballast tanks of the vessels represented sixteen animal phyla, three protist phyla, and three plant divisions. All major, and most minor, phyla were represented in this sampling of just one corner of the global shipping routes.[16]

Ballast tanks also contain associated sediments that are taken in with the ballast water.[17] This layer of sediments adds another dimension to the threat that ballast water poses to the marine environment. These sediments will settle out of the ballast water over time, and remain in the tank after the water has been pumped overboard. The sediments are gradually accumulated over time, and form a

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[14] Committee on Ships' Operations, Marine Board, Commission on Engineering and Technical Systems of the National Research Council, *Stemming the Tide: Controlling Introductions of Nonindigenous Species* By *Ships' Ballast Water*, 15.
[15] Carlton, personal communication, 26 October 1999.

relatively stable environment that becomes a haven for species that are able to "hold their osmotic breath"[18] and survive in the ballast tank for an extended period of time. This layer of sediments remains in the tank even after the ballast water has been pumped out because when it is considered that an average ballast tank is about sixty feet deep, even though several inches of water and sediments remain, the tank is, for all practical purposes, considered empty.[19]

From a biological standpoint, however, the tank is anything but empty. Investigations have shown that about five percent of the original ballast water and associated sediments remain in the tank after it has been emptied. The water that remains retains approximately twenty-five percent of the original species population.[20] These species may find that the sediment layer provides them with a hospitable environment in which to wait out their stay in the ballast tank. The sediment layer can shelter organisms that will survive the harsh environment of the tank by forming spores or other forms of protection.[21] As conditions in the tank become more favorable, or if the spore is discharged overboard, the organism may again return to its active form and present the possibility of invasion to its new environment.[22] This layer of sediments can also harbor the larvae of organisms that

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[16] James T. Carlton and Jonathan B. Geller, "Ecological Roulette: The Global Transport of Non-Indigenous Marine Organisms." *Science* 261 (2 July 1993): 80.
[17] Note that hereafter, ballast water includes the associated sediments.
[18] Carlton, personal communication, 26 October 1999.
[19] James Carlton, "Exotic Species Update: Are Ballast Water Regulations Working?," *Focus* 20, no.1 (March/April 1995). Available from the International Joint Commission on-line http://www.icj.org/focus/v20i1/feat04.html. Accessed 1 November 1999.
[20] Igor Vodyanoy, "Testing Monitoring Systems for Risk Assessment of Harmful Introductions by Ships to European Waters," *Biophysics Newsletter* 44 (9 December 1998): 2. Available from http://www.ehis.navy.mil/ivnews/ivnews44.htm. Accessed 2 November 1999.
[21] Massachusetts Institute of Technology Exotics Department, "Ballast Water Fact Sheet," 1999: 2.
[22] Ibid.

have mated in the waters of the ballast tank. When new water is taken aboard, the larvae may be re-suspended in the ballast tank, and potentially pumped overboard in the next port. If the larvae remain in the tank and begin to develop in the residual inches of water, these organisms can continually replenish the water of the ballast tank with new larvae or organisms to be introduced into multiple environments.[23]

The sediments can also preserve resting cysts of toxic dinoflagellates;[24] these cysts have the potential to be re-suspended and pumped overboard in many different ports.

Given that the salinity, temperature, and nutrient availability is different from what a non-indigenous species is accustomed to, only about one to three percent of the three thousand species that are transported around the globe daily survive the multiple transitions to be able to establish a population.[25] It appears that one of the biggest challenges that exotic species pose to researchers is their unpredictability.[26] Science can only speculate why and where invasions occur when they do, and why the species that invade can survive. "A vessel may move a species between two ports for a hundred years, and then the species 'takes' in the hundred and first year."[27] There are several hypotheses that have been formed to suggest why certain species invade, as well as when and where they do. It has been suggested that

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[23] Ibid.
[24] Gustaaf M. Hallegraeff, "Transport of toxic dinoflagellates via ships' ballast water: an interim review," in *Ballast Water: Ecological and Fisheries Implications*, 74.
[25] Carlton, personal communication, 26 October 1999.
[26] Radika Bahaskar and Judith Pederson, "Exotic Species: an ecological roulette with nature," Cambridge, MA: Massachusetts Institute of Technology, 1999. Database on-line. Available from http://www.massbay.mit.edu/exoticspecies/invaders/factsheet.html. Accessed 28 October 1999.
[27] James Carlton, "Marine Bioinvasions: The Alteration of Marine Ecosystems by Non-Indigenous Species," *Oceanography* 9, no.1 (1996): 39.

dredging can alter the otherwise stable environment in a river or coastal area,[28] thus making the area more susceptible to organisms that will exploit the unbalance of the system to establish their own populations.

Along this same line, it has been suggested that any change in the recipient region may make that area more susceptible to invasions.[29] These changes include, but are not limited to: 1) a region (either the donor or the recipient region) becoming less polluted, thereby making the region more hospitable to invasions by species that previously could not establish a population due to water quality, or 2) a region (either the donor or the recipient region) becoming more polluted, thus making it more susceptible to invasions of species that are more tolerant to higher pollution levels.[30]

Another factor suggested involves a change in the donor region that would involve a pre-existing population increasing in numbers in that native habitat, but enough so that it would be a large enough population to reach into the path of a port where it could potentially be transported to a new area.[31]

Research also suggests that the formation of new donor regions may be a factor in an introduced species being able to establish a population in a new environment.[32] As long-standing political barriers fall in various parts of the world and new shipping lanes are established in these areas, new vectors of transportation are formed for the species from these areas. One factor of note is that these species may have just a slight genetic variation from similar species that have already been

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[28] Vodyanoy, "Testing Monitoring Systems for Risk Assessment of Harmful Introductions by Ships' to European Waters", 2.
[29] James Carlton, "Pattern, Process, and Prediction in Marine Invasion Ecology," *Biological Conservation* 78 (1996): 98.
[30] Ibid., 99.

introduced to waters around the world, but it could be that slight difference that would allow this species to successfully invade.[33]

It is also suggested that "invasion windows" may open in an environment when the right combination of physical, biological, and ecological variables add up to create a hospitable environment for the invading species.[34] Simply put, "good timing is vital in all invasions."[35]

The number of a specific species introduced into an ecosystem is thought to have a large influence on the success rate of the invasion. When a large number of individuals are released into a habitat, there is a potentially higher success rate, because even if some of the individuals die, enough can still be present in the environment to propagate the species.[36]

A final possibility for the success of the invading species involves the means of transporting the ballast water and associated sediments. Following the idea that a larger inoculant pool will be more successful, it is thought that larger ships that will hold more ballast water may be responsible for introducing larger numbers of individuals, as well as a greater diversity of species into a given ecosystem.[37] This theory is supported by the observation that "intense new pulses of shipping activity appear on occasion to have led to new introductions."[38] It is also hypothesized that faster ships and the utilization of segregated ballast tanks aboard tankers may be vital

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[31] Ibid., 98.
[32] Ibid., 99.
[33] Ibid.
[34] Ibid., 100.
[35] Ibid.
[36] Ibid.
[37] Ibid.
[38] Ibid.

in keeping the myriad species alive in the ballast tanks over the course of the voyage.[39] The fact that ballast water is no longer, for the most part, in direct contact with petroleum products that could poison the life in ballast water, coupled with a shorter residence time in the ballast tank, more critters are arriving in a new port alive and ready to start a new population.

Comprehending the factors that play into an exotic species establishing itself in a new habitat will hopefully be the first step in understanding the patterns of invasions. From there, it may become possible to predict and prevent future invasions of non-indigenous species.

In light of all of these circumstances that allow for successful invasions, it is believed that "the successful establishment of a species…is rarely related to any one environmental parameter".[40] Whatever the determinant that allows these non-indigenous species to invade an ecosystem and fix a population within it, each species that is successful carries its own ecological, economic, and social impact.

The ecological impacts of a non-native species that establishes itself in a new habitat are great. One of the most critical issues under impacts to the environment revolves around the fact that in the absence of their natural predators, the populations of introduced species will grow expeditiously.[41] The increasing numbers of the introduced species can successfully compete with the indigenous species for food and habitat space, or may prey on native species, resulting in the decimation of a

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[39] Ibid.
[40] Ibid., 98.
[41] Laura Tangley, "Unwelcome sea voyagers: Marine stowaways take advantage of increased global trade and travel,"*U.S. News*, 26 October 1998. Available from http://www.usnews.com/usnews/issue/981026/26alie.htm. Accessed 1 November 1999.

population that has inhabited an ecosystem for centuries.[42] No matter if the native species are preyed upon or simply out-competed, non-indigenous species will have a significant impact on the trophic levels of an established native ecosystem. A thriving exotic species has the potential to squeeze the endemic species out of its niche, resulting in a decline of the native population to a level that it may not recover from. Over time, this could result in a lowering of the biodiversity of the habitat.

Native species may also be killed off in substantial numbers by the parasites carried by non-native species.[43] The introduced species will be resistant to the adverse effects of the parasite, as it will have encountered the parasite before in its natural habitat. However, when the non-indigenous species is able to establish a population and transmit the parasite to the endemic species of the area, they may not be able to mediate the damaging effects of this new invader. If the parasite gets the better of the native populations, again we may see a resulting decline in the biodiversity of the area, which in turn may leave the ailing ecosystem open to further invasions or opportunistic parasites.[44]

An invading species may also alter the environment by changing the gene pool of the ecosystem. Non-indigenous species can mate with endemic species to produce hybrids of the two.[45] This results in not only an alteration of the gene pool,

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[42] Enserink, "Biological Invaders Sweep In," 1834.
[43] Committee on Ships Operations, Marine Board, Commission on Engineering and Technical Systems of the National Research Council, *Stemming the Tide: Controlling Introductions of Nonindigenous Species by Ships' Ballast Water*, 15.
[44] Bahakar and Pederson, "Exotic Species: an ecological roulette with nature," 1999: 2.
[45] Ibid.

but in a simplifying of the ecosystem, which in turn, will likely cause a reduction of biodiversity.[46]

As is evident, invading species can have tremendous negative effects on native creatures and ecosystems. Perhaps the greatest, and most dire, of these adverse effects is the loss of biodiversity. It has been noted that "because the makeup of communities is not always studied, when biodiversity decreases, it is not noticed."[47] Even though loss of biodiversity may not be acknowledged as it is occurring, biological invasions are recognized as being the "second biggest cause of biodiversity loss in the Unites States, after habitat destruction."[48] This factor alone should command the attention of lawmakers, mariners, and the public worldwide.

In addition to the immense problems that non-indigenous species present to the ecosystems they invade, exotics also pose a serious threat to the economy of coastal areas. Take, for example, the tiny zebra mussel (*Dreissena polymorpha*), which has clogged water pipes and water treatment systems in the Great Lakes area.[49] Because these mussels reproduce and spread so rapidly, they have been virtually impossible to contain and prevent from fouling the systems that are necessary to sustain the communities along the Great Lakes. The zebra mussel has already cost millions of dollars in efforts to stop its rapid and irrepressible spread, and it seems that a solution is not yet in sight.

Exotic species also inflict damage on the fisheries of coastal communities. One of the better known examples is that of the American comb jellyfish

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[46] Ibid.
[47] Ibid.
[48] Enserink, "Biological Invaders Sweep In," 1834.

(*Mnemiopsis leidyi*), which was introduced into the Black and Azov Seas from New England.[50] The comb jelly is a voracious predator with no satiation response, and as a result of its unchecked growth in these areas, the biomass of plankton was drastically reduced, ultimately leading to a collapse of the anchovy fisheries in Russia and Turkey.[51]

Another invasion of note is that of the rappa whelk, a shellfish-eating snail. This snail is currently threatening the recovering shellfish industry in the Chesapeake Bay.[52] With no natural predators in these waters, these snails have the potential to reproduce unchecked, and once again sink the shellfish industry in this area.

An added threat to the shellfish industry is taking place on the opposite coast of the United States. The green crab (*Carcinus maenas*), which marred the soft-shell clam industry in New England in the 1960's, has found its way to the shores of Washington state.[53] The green crab is an adaptable animal that feeds on clams and oysters, among other things, and now threatens to decimate the shellfish-growing industry in the waters off of Washington, which have a value of seventy-five million dollars per year.[54] With no known way to control these tolerant and hardy creatures, the invasion could worsen over time, and gradually deteriorate the Washington shellfish industry, much like the fisheries in other areas of the world.

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[49] Bahakar and Pederson, " Exotic Species: an ecological roulette with nature," 1999: 3.
[50] James Carlton and Janet Kelly, foreword to *Ballast Water: Ecological and Fisheries Implications*, 1.
[51] Carlton, personal communication, 26 October 1999.
[52] Ibid..
[53] Tangley, "Unwelcome sea voyagers: Marine stowaways take advantage of increased global travel and trade," 2.
[54] Ibid.

In addition to the economic blows that effect humans, exotic species can often have an even more direct effect on our own population. Non-indigenous species are not only limited to animal life; they can include various types of dinoflagellates that can cause harmful algae blooms and present toxins into the food chain of which we are a part. The cysts of dinoflagellates that are harbored in the sediments in ballast tanks can become active when re-suspended and pumped overboard. These toxic dinoflagellates can find their way into shellfish stocks, and when the shellfish is consumed, result in paralytic shellfish poisoning in humans.[55] The fundamental issue at hand, however, is not the presence of paralytic shellfish poisoning; the problem becomes evident when the pattern of outbreaks is looked at. Until the 1970's, paralytic shellfish poisoning was contained within the waters of Europe, North America, and Japan.[56] However, by 1990, occurrences of paralytic shellfish poisoning outbreaks were recorded all through the Southern Hemisphere.[57] "Unambiguous evidence for the presence of viable toxic dinoflagellate cysts in ships' ballast water" suggests that these outbreaks were caused by the "translocation of non-indigenous estuarine dinoflagellate species across oceanic boundaries."[58]

Another threat to human health is presented by ballast water. This time it is not the animals or the plants contained within; it is the bacteria. The Western Hemisphere's only cholera outbreak of epidemic proportion is blamed on ballast

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[55] Hallegraeff, "Transport of toxic dinoflagellates via ships' ballast water," in *Ballast Water: Ecological and Fisheries Implications*, 74.
[56] Ibid.
[57] Ibid.
[58] Ibid.

water from an Asian ship that was discharged off the coast of Peru.[59] This outbreak was said to have infected several million people since the beginning of 1991.[60]

Given the range and the gravity of all of these issues, as well as the uncertainty of knowing what the next invader will be and the effect it will have on the economy and ecosystem, it is imperative that regulatory action be taken in order to prevent a "kind of hyper-Pangea from emerging."[61]

[59] Carlton, personal communication, 26 October 1999.
[60] Tangley, "Unwelcome sea voyagers: Marine stowaways take advantage of increased global travel and trade," 1.
[61] Bright, *Life Out of Bounds: Bioinvasion in a Borderless World*, 18.

Chapter III
Background: Past Legislative Action Against Invasive Species

It was the case of the thumbnail-sized zebra mussel in the Great Lakes that spurred on the first major federal act on the subject of non-indigenous species.[62] Although it was concern over the Eurasian ruffe invading the Great Lakes that brought attention to this issue, the rapid and destructive spread of the zebra mussels put pressure on lawmakers to push ballast water regulations through in a timely manner.[63] The piece of legislation that was created was the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA), and was brought into effect by Congress on 29 November 1990.[64]

NANPCA called for research in various areas of non-indigenous species: how they are transported around the globe, what species invade, what species survive, and monitoring the populations of invaders that had already established themselves in the waters of the Unites States, all with the goal of preventing future incursions.[65] NANPCA also mandated the formation of the Aquatic Nuisance Species Task Force (ANS Task Force) to develop and oversee the ballast water research and management program, as well as an ANS Panel to work specifically in the Great Lakes area to coordinate federal, state, and local efforts geared toward

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[62] Carlton, personal communication, 26 October 1999.
[63] Allegra Cangelosi, "Biological Invasions: Congress Takes a Second Look," Seaway Review, September 1995: 2. Available from http://www.nemw.org/bioinvad2dlook.htm. Accessed 2 November 1999.
[64] Carlton, personal communication, 26 October 1999.
[65] Cangelosi, "Biological Invasions: Congress Takes a Second Look,": 2.

cleaning up invasions, like the zebra mussel, and preventing new ones from taking place.[66]

One of the most vital components of NANPCA was designation of the Coast Guard as the executive branch agency to create guidelines and regulations to be applied to commercial vessels entering ports of the United States.[67] The United States Coast Guard, working in conjunction with the Canadian Coast Guard, created voluntary guidelines that would apply to ships entering the St. Lawrence seaway. The guidelines requested that all vessels entering the Seaway from a foreign port exchange their ballast water out in the open ocean, and provide documentation of this exchange, as well.[68] The Coast Guard noted outstanding compliance with these guidelines, and estimated that eighty-five to ninety percent of vessels were in compliance,[69] at least on paper. The Coast Guard also established an education program on introduced species and the implications of invasions that they believe contributed to the success of the guidelines.[70]

An additional resource that the Coast Guard implemented in 1992 was a "Marine Safety Detachment" at Massena, New York.[71] Massena was chosen because it is the first United States port on the St. Lawrence seaway. This checkpoint was used to stop vessels that were proceeding to the Great Lakes and to

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[66] Ibid.
[67] Ibid.
[68] U.S. Congress, House, Committee on Merchant Marine and Fisheries, Subcommittees on Merchant Marine Fisheries Management and Coast Guard and Navigation, *The Ballast Water Control Act: Hearing Before the Subcommittees on Merchant Marine Fisheries Management, Coast Guard, and Navigation of the Committee on Merchant Marine and Fisheries*, 103rd Cong.,1st sess., 27 October 1993, 85.
[69] Ibid.
[70] Ibid., 86.
[71] Ibid.

check the salinity of the water in ballast tanks to ensure that it was high enough to prevent the survival of organisms released into the Great Lakes. In May of 1993, these guidelines were mandated,[72] and any vessel proceeding on to the Great Lakes had to have a ballast water salinity of thirty parts per thousand or greater to be in compliance with United States law.[73] By November of 1993, the regulations had reached farther south, effecting all vessels seeking passage north of the George Washington Bridge on the Hudson River.[74]

NANPCA underwent some changes as time went on. Understandably, Congress focused the efforts of the act on the Great Lakes. However, as the findings from the research the NANPCA had mandated trickled in, it was becoming clear that NANPCA needed to undergo further changes to have the potential to continue to be an effective piece of legislation. Testimony of the research findings was given on 27 October 1993 before the House Subcommittees on Merchant Marine Fisheries Management, Coast Guard, and Navigation, and published in the Ballast Water Control Act of 1993. This act outlined the importance of more research into alternatives to ballast water exchange and wider ranging regulations. From here, the development of the re-authorization of NANPCA began to develop.

The re-authorization of NANPCA was titled the National Invasive Species Act of 1996 (NISA). NISA included the creation of a ballast water management program that includes all coastal regions of the United States, required reporting of

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[72] Ibid.
[73] Carlton, personal communication, 26 October 1999.
[74] U.S. Congress, House, Committee on Merchant Marine and Fisheries, Subcommittees on Merchant Marine Fisheries Management and Coast Guard and Navigation, *The Ballast Water Control Act: Hearing Before the Subcommittees on Merchant Marine Fisheries Management, Coast Guard, and*

ballast water exchange, and authorization and funding for a variety of programs, including a Ballast Technology Development Program, seeking to find a suitable alternative to ballast water exchange as a means of reducing the risk of invasions.[75] NISA held a lot of promise for the development of guidelines for the international shipping arena as well, because the International Maritime Organization (IMO) became involved in creating guidelines. With major players on board, the ballast water issue came to the forefront.[76] Though the issue was getting more attention from policy makers, there was still dissention among those involved about what should be done and how to do it. This disagreement is still carried to the ballast water issue today.

Mandatory ballast water exchange should have gone into effect no later than one year after enactment of the legislation. Following a window of compliance that was twice as long as intended all ships entering waters of the United States from outside of the exclusive economic zone were not required to exchange their ballast water on the open ocean until March 1998.[77] The exemptions from ballast water exchange have been a point of contention for policy analysts as well as environmentalists. If the weather conditions are not conducive to a safe exchange operation, then the vessel is exempt from the requirement, and is permitted to discharge ballast as needed when entering a harbor.[78] This is viewed as a loophole

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Navigation of the Committee on Merchant Marine and Fisheries, 103rd Cong.,1st sess., 27 October 1993, 87.

[75] Cangelosi, "NISA Passes!,"17 August 1999. Northeast-Midwest Institute On-line. Available from http://www.nemw.org/nisapasses.htm. Accessed 2 November 1999.

[76] Carlton, personal communication, 26 October 1999.

[77] Ibid.

[78] John LaRese, personal communication, 16 November 1999.

that undermines the effectiveness of NISA 1996.[79] The lack of available alternatives to ballast water exchange is seen as the underlying cause of this loophole; this exemption that can threaten ecosystems serves to reinforce the call for effective and implementable policy that will encourage the development of treatment technologies, and ultimately reduce the number of invasions into the waters of the United States.

Another problem area that has been identified is the reporting form that is used to record ballast water exchanges. Currently, this slip of paper is the only assurance that the vessels entering our waters have complied with ballast water exchange regulations.[80] It is conceivable, then, that in the interest of maintaining a schedule and still appearing to be in compliance, these forms may at times be falsified. Under the present policy structure, there is no way to be certain of true compliance.

Though no formal evaluation of existing programs has been executed, legislation continues to layer new plans and calls for action on top of existing ones. President Clinton issued an executive order on February 3, 1999 establishing an Invasive Species Council to develop management plans for invasive species, and also to work with local, state, and federal organizations to achieve the goals of the plans set forth by the committee. This pile-up of stagnant plans and lack of technological development demands that the process of policy development be revisited.

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[79] David P. Eldridge, "Leviathan Lurks: Might the Non-indigenous Species Act of 1996 Actually Authorize Invasion by Proscribed Species?," South Carolina Environmental Law Journal, (Summer 1997).

[80] John LaRese, personal communication, 16 November 1999.

Although ballast water and non-indigenous species are receiving the attention that they need, existing policy appears merely to be a paper tiger, and successful development of policy on this issue seems to be at a stalemate. Aside from the perceived flaws in existing legislation, there is dissent among those involved with development as to the best way to manage and monitor ballast water and prevent non-indigenous species transfer. At the public meeting of the United States delegation to the Marine and Environmental Protection Committee (MEPC) of the International Maritime Organization in February 2000, the development of policy was described as being in a state of chaos. There is palpable tension between those who represent the interests of the shipping industry, and those who are advocating environmental protection, specifically the NGOs. The federal government appears as though it is stuck in the middle, trying to appease the interests of the environmental groups, while recognizing the importance of a smooth-running shipping industry to the economy of the United States.

At this point in time, one of the biggest concerns is that the call for an alternative to ballast water exchange has gone unfulfilled, and it appears that a solution will not come any time in the immediate future. Representatives of the shipping industry have expressed concern over the fact that exchange as a means of treating ballast water is a benchmark, and the development and implementation of any new technology will be extremely difficult.[81] A statement on ballast water management put forth by the United States Coast Guard acknowledges the fact that

[81] Kathy Metcalf, American Bureau of Shipping, testimony given at a public hearing in preparation for MEPC 44, 29 February 2000.

"ballast water exchange is viewed as an interim solution, [and] technology has yet to catch up with the problem."[82]

It is also evident from the testimony given at the public hearing in preparation for the MEPC 44 meeting that there is some tension among the agencies and organizations involved with this issue. The shipping industry has the stance that it cannot lose any time in the application and implementation of whatever standards of treatment are eventually created. Kathy Metcalf, a representative for the American Bureau of Shipping suggested that new regulations could easily have an adverse impact on the industry. For example, if a million dollars worth of technology is installed in a vessel, and then the next year the regulations are cinched down again, the industry would be required to invest more money in each vessel to keep up with morphing technology and regulations.[83] Given the likelihood of technology to change fairly rapidly, this could amount to a substantial loss for the shipping industry in just a few years. Ms. Metcalf also brought up the fact that policy being developed must take into account the fact that often vessels are built in such a manner that when steel is put around certain parts, they are no longer accessible, thereby making retrofitting of the vessel nearly impossible.[84] To this end, it was suggested that technology on the issue of treating ballast water be approved on the basis of operationality. This also follows the idea that policy being developed must be implementable, as well as practical.

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[82] Mary Pat McKeown, LT., USCG, "Ballast Water Management," 3 March 2000.
[83] Kathy Metcalf, American Bureau of Shipping, testimony given at a public hearing in preparation for MEPC 44, 29 February 2000.
[84] Ibid.

A new annex to the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78 is also being discussed to further regulate the discharge of ballast water in waters of the United States. As technology continues to develop, it is likely that legislation will morph along with it to keep up.

Chapter IV

• Background: Options for the Treatment of Ballast Water and Prevention of Exotic Species Invasions

Through all of the legislation, experts still agree that the best, and least expensive, way to approach this issue is to prevent invasions in the first place.[85] It is extremely difficult to control an invading species once it has successfully established itself, and some methods of regulation can be drastic. One example that was radical, albeit successful, took place in Darwin, Australia. A routine inspection of a marina revealed the presence of thousands of black-striped mussels, a cousin of the zebra mussel, where there had not been any just six months before. To put a quick stop to the spread of these invaders, officials closed off the area where the black striped mussels had been found, and wiped out the mussels with a mixture of chlorine and copper.[86] The mixture killed off all of the organisms in the water, but bioremediation is bringing back the native species, and there is no sign of the black striped mussels.[87]

Although successful, poisoning the waters effected by invasions is not a viable option for many areas, due to the fishing or shellfish industries that are in the same vicinity. The focus then turns to ways to prevent invasions from the outset. The favored method of prevention thus far is the exchange of ballast water in the open ocean, so that water will have a salinity greater than thirty parts per million when discharged into areas such as the Great Lakes. While this may be perfectly

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[85] Jocelyn Kaiser, "Stemming the Tide of Invading Species," Science 285 (17 September 1999): 1838.
[86] Ibid., 1836.
[87] Ibid.

suitable for freshwater areas, Captain Michael Donohoe of the U.S. Coast Guard points out that this method may have "little or no effect on organisms taken on and discharged into salt or brackish water."[88]

Aside from the fact that exchange may not be effective in all waters, there are other drawbacks to ballast exchange. In addition to being potentially stressful to the structure of the ship, ballast exchange is time-consuming, and adds additional work to the crew and officers of the ship. Given that the Oil Pollution Act of 1990 limits the number of hours that on-board crew can work; this may cause other shipboard duties to go unfulfilled.[89] Ballast exchange is also expensive, as the pumps are either electric motor or steam turbine driven. Either way, extra fuel must be burned in boilers or generators to provide the energy for pumps.[90] Ballast exchange is mandated by present legislation when a vessel leaves the two hundred mile exclusive economic zone. Most vessels sailing from the Gulf of Mexico to the East Coast of the United States must pass outside the EEZ for a very limited time. Even though the vessel is travelling from one U.S. port to another, a ballast exchange must be performed to be in compliance, and the vessel would not be out of the EEZ long enough to be able to complete an exchange. As a result, an increasing number of vessels opt to divert the vessel to stay inside the EEZ and avoid a ballast exchange and subsequent report.[91]

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[88] U.S. Congress, House, Committee on Merchant Marine and Fisheries, Subcommittees on Merchant Marine Fisheries Management and Coast Guard and Navigation, *The Ballast Water Control Act: Hearing Before the Subcommittees on Merchant Marine Fisheries Management, Coast Guard, and Navigation of the Committee on Merchant Marine and Fisheries*, 103rd Cong.,1st sess., 27 October 1993, 94.

[89] John LaRese, personal communication, 16 November 1999.

[90] Ibid.

[91] Ibid.

There are guidelines set forth by the Coast Guard and the International Maritime Organization for preventing the uptake of sediments in coastal areas as well. Tankers and cargo vessels are advised to avoid taking in ballast water in very shallow water, in the vicinity of sewage outfalls, where there is a known outbreak of communicable diseases, where the incoming or outgoing tide is known to be turbid, or where the tidal flushing is poor.[92] Of course, there will be situations where ballasting in port will be necessary for safe passage of the vessel, or when a ballast exchange simply cannot be performed. In light of these situations, many new treatment options are in various stages of development today, all of which center around water treatment.

One of the potential solutions is utilizing shipboard filtering systems. This method would call for water to be passed through a succession of self-cleaning filters, each with finer mesh than the previous one, until the ballast tank is reached (see Figure 2).[93] This would ensure that the water entering the ballast tank would be free of living organisms and bacteria. The filtered organisms would be stored aboard ship, and disposed of once a suitable shore facility has been reached. This is a good idea in theory, however implementation of this method may be though, as it could be assumed that forcing water through a succession of smaller and smaller filters would add a significant amount of time to the ballasting and de-ballasting processes, a consequence that would be seem unacceptable to the shipping industry.

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[92] Ibid.

[93] Committee on Ships Operations, Marine Board, Commission on Engineering and Technical Systems of the National Research Council, *Stemming the Tide: Controlling Introductions of Nonindigenous Species by Ships' Ballast Water*, 60.

Another potential method of water treatment is the use of biocides in ballast water. This method would use pumps to feed a pre-mixed and measured biocide concoction to the water as it was being taken in.[94] This way, organisms would enter the ballast tank alive, but by the time they are released overboard, they would be dead, and pose no risk of invasion. The question that this poses is would the organisms have any biocide left in their systems when they are pumped overboard, and therefore cause any harmful effected to the receiving ecosystem. It appears that non-oxidizing biocides would pose few adverse effects to the ecosystem that would receive the water, as the byproducts of this type of reaction decay rapidly into non-toxic compounds.[95]

Another possibility that shows some viability is the method of thermal treatment. This would use waste heat from the ship's propulsion to treat the ballast water and render the environment in the ballast tank unlivable for any and all organisms.[96] Though heat treating might be a viable option, there are still many issues surrounding the viability of this method on shorter voyages, as well as the thermal pollution this could potentially cause in the receiving port.

Filtering, using biocides, and heat-treating are the top three most potentially viable treatment options for ballast water, according to the National Research Council. Additional methods of treating ballast water that have been

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[94] Ibid., 64.
[95] Ibid., 66.
[96] Ibid.

suggested by those in the industry or working on this issue include ultraviolet radiation, hydrocyclonic separation, and ozonation of ballast water.[97]

Ultraviolet radiation would pass UV waves through the ballast tank in order to kill all organisms present in the water. When pumped overboard, those creatures that are present would no longer pose a threat to the receiving ecosystem. Likewise, ozonation of ballast water would work along these same lines. However, both of these methods would require intensive retrofitting of existing ships, and may impart a heavy cost to the shipping industry. Because of this, these options do not seem to be the most viable.

Hydrocyclonic separation is steadily moving to the forefront of potential ballast water treatment technology. This method of treatment works on a simple principle; water is pumped into the hydrocyclone, which is a cone-shaped mechanism that initiates a vortex using centrifugal force. This vortex is accelerated as it moves downward through the tapered hydrocyclone. This action serves to separate heavier solids from the water. The clean water will come straight down through the immediate center of the mechanism, while the solids will move out to the sides. The water and solids are discharged through different sections of the apparatus, and the solids may be discharged to a holding tank or pumped overboard and back into the environment from which they came.[98] However, it is unclear how well this method would fare in practice, as it is left out of the 1996 National

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[97] Committee on Ships Operations, Marine Board, Commission on Engineering and Technical Systems of the National Research Council, *Stemming the Tide: Controlling Introductions of Nonindigenous Species by Ships' Ballast Water*, 62.

Research Council study that includes potential methods for successful treatment of ballast water in order to prevent exotic species invasions. The United States Coast Guard is currently testing this and other mechanisms for the viability.

[98] Advanced Pollution Control Technology, "Hydrocyclone Separator Systems" <www.advanced pollutioncontr.com/cyclon4.htm>

Chapter V
Methodology

Data were collected using a survey composed of closed-ended questions on a Likert scale, as well as open-ended questions (see Appendix). Questions were intended to gather the perceptions of current and possible future legislation regarding ballast water discharge and non-indigenous species invasions from those who are actively involved with this issue on a day to day basis. Accordingly, members of the Executive Branch of government, the Coast Guard, research, and other agencies and organizations were surveyed. Surveys were personally distributed, mailed, and distributed via a Coast Guard list serve. Twenty-eight surveys were personally handed out at a Marine Environmental Protection Committee meeting, thirteen surveys were mailed out, and an uncertain number were spread out over the internet.

A general inductive approach, specifically grounded theory, will be used to form theories that will serve to address the hypotheses laid out the beginning of the project. The general purpose of the inductive approach is to allow the common and dominant themes that are present in data to emerge.[99] These themes, though present in most every research project, can often be obscured by the restraints imposed by quantitative, structured methodologies.[100] Especially with projects involving such complex issues as ballast water and non-indigenous species where innovative thinking and new perspectives are vitally important, the advantages of utilizing a

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[99] David R. Thomas, "Qualitative Data Analysis: Using a General Inductive Approach,"
[100] Ibid.

methodology that will be more likely to lead to "serendipitous findings and to new integrations"[101] is substantial.

Unlike quantitative methods of data analysis, a grounded theory approach allows for identification of key themes that are often obscured, re-framed, or invisible because of the preconceived notions of data collection and analysis procedures of deductive experimental and hypothesis testing research.[102] Grounded theory is similar to the general pattern of qualitative data analysis methods described by others in this research area (see Miles and Huberman, 1994 and Pope et al. 2000).

Inductive approaches are intended to aid an understanding of the meaning of data sets through development of summative themes and categories that have been derived from the raw data. There are several objectives that are inherent in the practice of this type of assessment. They are:

1. To condense extensive and varied raw data into brief, summative format.
2. To establish a clear link between the research objectives and the summary findings which are derived from the raw data to ensure the links are both transparent (able to be demonstrated to others) and defensible (justifiable given the objectives of the research).
3. To develop a model or theory about the underlying structure or phenomena or processes which are evident in the raw data.[103]

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[101] Matthew B. Miles and A. Michael Huberman, *Qualitative Data Analysis: An Expanded Sourcebook* (Thousand Oaks, CA, Sage, 1994): 1.
[102] Ibid.
[103] Anslem Strauss and Juliet Corbin, *Handbook of Qualitative Research* (Thousand Oaks, CA: Sage Publications, 1994): 273.

Because grounded theory is a general methodology in terms of a way of thinking about and conceptualizing data, it is easily adapted by originators and students of diverse academic endeavors. There is a latitude in procedure that allows the researchers to make the most of the data analysis phase of the project, to put forth the best conclusions and resolutions of the issue at hand. Researchers tend to bring to their work the "sensitizing possibilities" of training, reading, and research, as well as explicit theories, that can be very useful when utilized along with the systematically gathered data and the recurring themes that emerge from the qualitative analysis of this data.[104] One potential weakness of this methodology is that it does allow this latitude to the researcher, thus leaving results open to a multitude of interpretations. Here, there is no methodologically rigorous approach to prove that one means of interpreting results is any better than another. However, the strengths of this method are numerous.

Strengths of Grounded Theory

Grounded theory is a general methodology for developing ideas that are rooted in data that is systematically collected and analyzed; the data is central to this methodology, as well as the back-and-forth interplay that keeps the theories derived from analysis grounded. One must always come back to the data, which keeps things on track and pertinent. This characteristic of grounded theory methodology ensures that the tentative solutions developed can be applied to the problem at hand, unlike the outcomes of qualitative analysis that can sometimes be "speculatively

[104] Ibid., 277.

remote from the phenomena it purports to explain."[105] These factors prove the practical use of grounded theory methodology in guiding policy development.

Grounded theory is designed to guide researchers in producing theories that are conceptually dense, meaning that they have many conceptual relationships for scientific understanding.[106] The conjectures that are formed are always traceable to the data, resulting in grounded theories that are fluid, emphasizing temporality and process. This feature makes this methodology timely and applicable to this type of research project, given the need for policy development on this issue to have these same qualities. Because these conjectures are interpretations made from a given perspective, they are not forever and immutable; rather, these proposed plans of action may be invalidated as conditions change. Not only is does this most closely mirror how things actually unfold in the policy-making realm, but the expiration of a theory would give rise to a cycle of creating new and current ones to replace those that are no longer pertinent.

Also important to note is that the outcomes and results of qualitative analyses have a property of "'undeniability' to them; they have a more vivid, concrete, and meaningful flavor that often proves far more convincing than pages of summarized numbers."[107] For all of these reasons, this methodology could prove to be extremely valuable to the extremely dynamic and continuously developing world of ballast water treatment technology and non-indigenous species research.

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[105] Ibid., 282.
[106] Ibid., 278.
[107] Miles and Huberman, *Qualitative Data Analysis: An Expanded Sourcebook*, 1.

Grounded Theory in Practice

An example of how grounded theory has been put into practice in a policy research oriented setting is offered in a study by the Department of Community Health in New Zealand. Here, surveys were administered to patients to determine the nature of doctor and patient relations, as well as the barriers to referral in the hospital setting. This in turn was used to improve the hospital policy in an effort to better doctor/patient relations and overall healthcare policy.

The procedure for grounded theory is straightforward and quite simple. The steps are as follows:

1. Preparation of the raw data files – it is recommended that the format of data be uniform before analysis begins to facilitate the process and reduce mistakes. This includes utilizing a specific format from the outset, or re-doing data to have a common font, margin, and question order.
2. Close reading of the text/data files– once the data are in a uniform format, it should be read through very carefully and in detail so that the researcher is familiar with the context, as well as becomes familiar with the themes and tone of the data.
3. Creation of categories and identification of common themes – as the data is read through again, common themes will begin to emerge. These should be recorded for summation and eventual conclusions. Upper level and more specific categories are likely to come from basic research aims, while highly specific categories will be derived from repeated analysis of the data.

4. Continued refinement and revision of the categories – as analysis continues through repeated scrutiny of the data, categories can be broken down into further detail and specification.[108]

In this case the surveys are, in a sense, already coded, as they were constructed on a Likert scale. This allows for easy translation into a chart form and scrutiny in order to identify recurrent or single themes in responses. Open-ended questions can be coded, and then broken down into broader categories that are created from the themes that occur in the responses.

Analysis of raw data via grounded theory allowed creation of conjectures that permit affirmation or rejection of the hypotheses set forth at the outset of this research project, and can be extended to provide a broader, general theory that lies behind the issue as a fundamental problem. It is important to note that grounded theory methodology itself does not itself directly answer the hypotheses that have been presented at the outset of this project; rather, the theories that are derived can address the project hypotheses.

As Table 1 indicates, certain questions pertain directly to particular hypotheses, while other questions are intended to clarify and/or add greater dimension to the testable questions on the survey.

[108] Thomas, "Qualitative Data Analysis: Using a General Inductive Approach."

Table 1. Subject Areas, Hypotheses, and Corresponding Questions

Subject Area	Hypothesis	Corresponding	Supporting
Funding	H1	4	-
	H2	7	-
	H3	8	5,6
Effectiveness and Improvements	H4	15	16,19,20
	H5	21-24, 33-36	37,38
Implementation and Monitoring	H6	17	9-14
	H7	25-27	28,29
	H8	30	31,32
Benchmarks	H9	18	-

Grounded theory analysis will play off of the themes that are introduced by the responses to questions set forth in the questionnaire. The end result will be to devise potential solutions, or at least a first step, for moving toward new and effective legislation to prevent and control invasive species.

Chapter VI
Data and Analysis

Data collected from surveys were first read through several times, as per the grounded theory methodology specifications, then transcribed into workable chart form. Data were derived from completed and returned surveys. In total, the number of returned surveys equaled ten. Though the response rate was low, the surveys were completed in enough detail and by a representative cross-section of policy actors to be sufficiently utilized for this analysis. Respondents were spread over a range of sectors, and included those associated with the ballast water and non-indigenous species issue through federal agencies, state agencies, non-governmental organizations, academic and research areas, and representatives of the shipping industry. Table two indicates the number of respondents, and the agencies or organizations to which they belong.

Table 2. Type and Number of Respondents

Sector	Number of Respondents
Federal agencies	4
State agencies	3
Non-governmental organizations	1
Academic/Research	1
Shipping Industry	1

Charts were utilized to organize the data and facilitate finding the repeated or differing responses by examining the coded responses for pattern or lack thereof.

Synopses of responses are included in the Appendix on page 105 as Tables 3 through 9.

The analysis of all responses to questions on the survey will be utilized in order to draw conclusions on the possibilities of the next step in designing effective ballast water legislation.

Respondents to the survey include members of state and federal agencies, a non-governmental organization, an agency that is a combination of state and federal agencies, and a representative from the academic/research world. If a category of a particular respondent is not mentioned in the write-up of a particular question, it may be assumed that he/she did not provide an answer to a particular question. The analysis section is arranged by subject area, with the pertinent hypotheses and supporting questions included under the specific subject heading.

Overall Perception of the Problem

Hypothesis one states that it is expected that there are no significant differences in the perception of the ballast water and non-indigenous species issue as a serious problem. This hypothesis was affirmed by the theory that was devised from the responses to the corresponding survey questions. Analysis of data showed that respondents do indeed perceive this issue as a serious problem that demands the attention of legislators.

Funding

Hypotheses included under this heading are numbers two and three.

The second hypothesis states that it is expected that there are no significant differences in the perceptions of the adequacy of allocation of funding for technology development for ballast water treatment between response groups was disproved by the theory derived from survey responses to the corresponding questions. Analysis of data showed that respondents associated with the issue through state agencies range from disagree to strongly disagree that funding for technological development is adequate, while those respondents associated through federal agencies agree that development of technology receives adequate funding. This leads to the formation of the theory that there are significantly diverging opinions on this subject, and that this dissention may be contributing to the stalled formation and implementation of ballast water policy.

Hypothesis number three states that it is expected that there are significant differences in perception of the adequacy of funding for ecological impact and risk assessment research among response groups. This hypothesis was affirmed by development of theory derived from analysis of corresponding survey responses. Analysis of the data show that those associated through state agencies disagree that ecological impacts and risk assessment research receives adequate funding, while those associated with the issue through federal agencies, with one exception, believe that funding for this aspect of the issue is sufficient.

The theory that emerged from analysis of supporting questions is that there is an overall disparity in the perception of the adequacy of funding for the ballast water and non-indigenous species issue and in the perception of the adequacy of attention

given to the issue. Thus, the disparity could be seen as a significant impediment to the formation and implementation of policy. Responses to these questions indicate that those associated with the issue through state agencies range from disagree to strongly disagree that their agency allocates sufficient funds to the issue overall. Those associated through federal agencies agree that their respective agencies do allot sufficient funds to the issue. This fundamental dissimilarity could stem from the differing perceptions of whether or not the ballast water issue in general receives adequate attention within the various agencies that are involved. Those associated through state agencies respond that they disagree that their agencies give sufficient attention to the issue, while those associated with the issue through federal agencies agree that their agencies give enough attention to the issue.

Effectiveness of existing legislation and suggestion for improvement of future regulations

Hypotheses included under this heading are numbers four and five.

The fourth hypothesis states that it is expected that there are no significant differences in the perception of the effectiveness of NISA 1996 among the response groups. This hypothesis was disproved by the theory that was formed through analysis of responses to the corresponding survey questions. The emergent theory is that the differing perceptions of effectiveness of NISA could contribute to the lack of an effective policy to deal with ballast water and non-indigenous species. Analysis of the survey responses showed a division in the perception of the effectiveness of ballast water legislation, as respondents associated through state agencies disagree

that NISA 1996 has been effective. Those associated through federal agencies somewhat agree/agree that NISA 1996 has been effective, and the respondent associated through the agency combining federal and state characteristics agree that NISA 1996 has been effective.

Theory that came out of analysis of supporting questions indicates that there are two clear categories that respondents feel should be included in the re-authorization of NISA 1996, giving rise to the theory that change should be made to develop an effective policy, and these changes are specific to two categories. One type of change that could be included in reauthorization of ballast water legislation is that there should be a strong element of ballast water treatment contained in revised legislation, including exchange technology, mandatory treatment, and development of standards. The second category centers on funding issues, including grants for technological development and less geographic specification of research dollars. Also suggested by a federal respondent is a more clearly defined role of the state.

Theory derived from supporting questions also indicates that reauthorization of policy should include some sort of framework of time in which to devise and implement technology to treat ballast water. Analysis of survey data shows that there is a strong consensus in support of timeframes and/or deadlines for development of technology for ballast water treatment to be included in the re-authorization of NISA 1996. However, there are differing opinions on whether or not the revision of ballast water legislation should focus on the design and construction of new ships, rather than focusing on the retrofitting of existing ships. The respondent associated through state agencies answered ranging from disagree to

neutral; those associated through federal agencies also disagreed, with one exception, as did the respondent affiliated with a non-governmental organization, and the respondent associated through an agency that is a combination of state and federal somewhat agrees that new legislation should focus more on new, rather than existing, ships.

Hypothesis number five states that it is expected that there are significant differences in the perception of what would be the most effective means of managing ballast water among response groups. This hypothesis is affirmed by the theory that comes out of analysis of varying responses to the corresponding survey questions. As the examination of survey data shows, there are a number of ideas as to the best course of action to reduce and control exotic species invasions. Here, respondents associated with this issue through both state and federal agencies disagree/ strongly disagree that unilateral action, meaning states forming their own aquatic nuisance species prevention and control regimes, would work against the ultimate goals of non-indigenous species policy. Those associated through non-governmental agencies, academic/research, and the agency combining state and federal responsibilities agree that unilateral action would work against non-indigenous species policy goals. It was suggested by a respondent that others might follow the example that could be set by the United States in implementing ballast water treatment methods.

When asked whether or not they believe that region-specific management would be more effective than blanket federal policies, state, academic/research, and all but one federal respondent disagree/ strongly disagree that region-specific

management will be more successful in preventing and controlling non-indigenous species introductions than blanket federal policies. Respondents associated through non-governmental and combination of federal and state agencies, and one respondent associated through a federal agency agree/strongly agree that action focused on specific regions would be more effective than blanket federal policies. The theory that emerges here is that the differing ideas on this subject could present a significant problem in devising an effective policy that everyone can live with.

When considering ballast water management areas as a means of regulating ballast water, respondents associated through state agencies range from neutral to disagreeing that this would be an effective means of management. All but one federal respondent disagree as well. The respondent associated through a combination agency agrees that ballast water management areas would be effective in mediating ballast-borne invaders, while the respondent associated through a non-governmental organization took a neutral stance on this particular question.

As for the potentiality of utilizing fresh water from port supplies as ballast, in place of seawater, most state and federal respondents are neutral, with the exception of one federal respondent, who strongly disagrees, the non-governmental organization respondent who disagrees, and one state-affiliated respondent who agrees that this could be a successful means of preventing invasions.

When questioned on whether shore-based treatment would be the most viable solution to ballast water management, most respondents were neutral; two federal and academic/research respondents disagree, and one state respondent agrees that this would be the most viable solution to the ballast water management issue.

Responses to the question of en-route treatment being the most viable solution to ballast water management were spread across the scale. Most federal respondents agree/ strongly agree that this would be a viable solution, while academic/ research respondents disagree that this has potential for success. The respondent associated through the combination agency is neutral, as are two state respondents. One respondent affiliated through a state agency agrees, and likewise the non-governmental organization affiliated respondent. Due to the disparate nature of the responses, it is difficult to draw a firm conclusion as to the potential success of en-route treatment from these survey responses.

Likewise, the responses to whether or not precautions taken in the port of origin would be a viable solution to ballast water management are also spread across the scale, with answers ranging from disagree to neutral to agree. Hence, it is difficult to draw a conclusion as to the viability of port precautions in managing ballast water.

A conclusive result can be drawn from the analysis of one supportive question that asks respondents to consider the possibility of utilizing a combination of all three options – port precautions, en-route treatment, and shore-based monitoring – for managing ballast water. All respondents, except for one federal respondent, agree that combinations of all three potentialities would in fact be the most viable solution to managing ballast water.

Supporting questions also allowed respondents to offer their views on the methods of ballast water treatment that are believed to have the most potential for success. Respondents offered very similar suggestions, and also stated that they

should be used in conjunction with one another. The methods believed to have the most theoretical potential for success fell into two categories: physical separation (either hydrocyclonic separation or filtering) and some form of chemical treatment (biocides).

An additional question revealed that the top three considerations for development of technology to treat ballast water are effectiveness, ease of overall use, and safety. The theory that follows this series of questions is that a combination of all three potential treatment sites plus the use of combined physical separation and chemical treatment will move toward successful prevention of non-indigenous species invasions.

Implementation and Monitoring of Ballast Water Regulations

Hypotheses included under this heading are numbers six, seven, and eight.

The sixth hypothesis states that it is expected that there is a significant difference in perception of whether the implementation of NISA 1996 would benefit from partnerships among the agencies and organizations involved with ballast water technology research and development, formation of risk assessments, and ecological implication research. This hypothesis was disproved by an across the board agreement from all respondents that partnerships would indeed benefit the implementation of NISA in coming years, thus the theory being that there is widespread support for the formation of partnerships, and that they could contribute to successful policy.

Supporting questions indicate that there is a difference in perception of whether or not the appropriate and key players are presently involved with the ballast water and non-indigenous species issue, thus allowing the theory that this could be a roadblock to effective policy to emerge. Those respondents associated through state agencies range from somewhat agree to strongly disagree on this question. Suggestions from these respondents as to who should be involved include: Environmental Protection Agency (EPA) for discharge standards, Department of Environmental Management (DEM), Food and Drug Administration (FDA), and government staff. Those associated through federal agencies, however, all strongly agree that the appropriate and key players are involved with this issue, and offer no suggestions for improvement.

When asked about their perceptions of whether or not the appropriate players are involved with risk assessment and biological research, those associated with the issue through state agencies answered ranging from disagree to neutral, yet offered no suggestions for additions. Those associated through federal agencies largely agree that the appropriate players are involved with this aspect, except for one federal respondent, who suggested that ecologists and researchers should have more of an expanded role on this front. Again, these responses support the theory that differing perceptions of the various policy actors involved with this issue could be a significant roadblock to devising and implementing effective ballast water policy.

Questions regarding the perception of whether or not the appropriate players are involved with development of technology for ballast water treatment revealed that those associated through state agencies disagree that the right agencies and

organizations are involved, and suggested several options for additions, including naval architects, marine engineers, the EPA, Navy, Coast Guard, and the commercial fleet. Those respondents associated through federal agencies largely agree that the apropos players are involved in development of technology, with one excepted respondent who stated that the shipping industry needs to be more involved.

When asked whether or not the appropriate players are involved with policy and legislation development, the responses of those associated through state agencies range from strongly disagree to neutral. Suggestions as to the agencies and/or organizations that should have a higher level of involvement with the overall issue include: DEM on state levels, Department of Health (DOH), EPA, FDA, and Coastal Resources Management Council (CRMC). The responses of those associated through federal agencies, however, range from agree to strongly agree that the right agencies and organizations are involved in development of policy and legislation. One federal respondent suggested that the Navy should have a higher level of involvement with the overall issue of ballast water and non-indigenous species. The remainder of the federal respondents did not believe that there are any other organizations or agencies other than those presently involved with the issue that should have a higher level of involvement with the overall issue. The respondent associated through an non-governmental organization answered that the shipping companies should have more involvement with the issue, and the respondent associated through academic/research means believes that the USDA and APHIS should increase their level of involvement. Also answering in the affirmative is the

respondent from a combination agency, who believes that NOAA-Sea Grant should have more involvement with this issue.

When asked if there is any agency that should decrease its level of involvement, the overwhelming response was that there is not, except for one respondent who stated that the EPA should have less involvement with the issue overall.

Hypothesis number seven states that it is expected that there is a significant difference in perception of the most successful means of monitoring ballast water management methods. This hypothesis was backed by the theory that came out of responses to the corresponding survey questions. The theory that emerged is that there are a number of differing ideas on this particular issue, and this could be impeding progress toward implementation of effective monitoring methods. Because responses reflected the varying ideas from different respondents, one concrete theory as to what the best method of monitoring ballast water cannot be made; a pair of state respondents and the respondent affiliated through a combination agency agree that on-board monitoring of basic water quality parameters would be a successful management tool. Another state, all federally and non-governmental organization affiliated respondents disagree that these means would be successful for monitoring ballast water treatment methods being utilized.

State respondents and a single federal respondent agree that biological and basic water quality monitoring of ports would be a successful monitoring tool. The remaining federal respondents disagree that this means would be a successful monitoring tool.

All respondents, save one, agree or strongly agree that assessment of areas for indigenous species to establish baseline data is important for monitoring the effectiveness of ballast water management, thus allowing for development of a theory that asserts that baseline data collection is an important step in effective non-indigenous species prevention and control. The one excepted respondent is associated through a federal agency and disagrees that baseline data is important to monitoring the effectiveness of ballast water management methods.

Supporting questions indicate that there are two distinct categories of ballast water treatment monitoring methods with potential for success that have been suggested. The first involves shipboard treatment and monitoring, including periodic review of ships' logs and maintenance records, utilizing biocides, and implementation of treatment technologies. The second category of potential monitoring methods is more shore based, and includes and international indigenous species assessment and random ballast water sampling with port-state control.

When asked about the importance of developing a framework of risk assessment and biological control, responses run the gamut, even within categories of agencies themselves. State agency-affiliated respondents range from strongly disagree to neutral to agree on this question; federally affiliated respondents range from disagree to agree. Those respondents affiliated through non-governmental organizations and combination agencies agree that developing a framework of risk assessment and biological control is important.

The eighth hypothesis states that it is expected that there is no significant difference in the perceived importance of addressing the treatment and disposal of

sediments from ballast water tanks. This hypothesis was affirmed by the theory derived from the analysis of responses to the corresponding survey questions. The emergent idea is that treatment of sediments is agreed upon as important, and treatment areas are divided into three distinct areas of assent. All respondents, except for one neutral federal respondent, agree that it is important to address the treatment and disposal of sediments from ballast water tanks.

Supporting questions indicate that categories of feasible treatment of ballast water tank sediments are: upland disposal, burning, avoidance in the first place, and disposal at sea. Options for disposal of sediments to minimize the risk of transferring non-indigenous species include land disposal, at-sea disposal, and burning. Analysis of survey responses showed that all respondents except for one neutral federal respondent agree that it is important to address the treatment and disposal of sediments from ballast water tanks.

Perception of Existing Ballast Water Treatment Methods and Opinions on the Challenges of Change

Hypothesis number nine encompasses a very specific subject area, and therefore stands alone. This hypothesis states that it is expected that there is no significant difference in the perception of ballast water exchange as a benchmark, and the pervasiveness of the opinion that the development and implementation of new technology to treat ballast water will be challenging. This hypothesis remains unconfirmed or affirmed, as the analysis of the data turned out inconclusive results, because of scattered and inconsistent responses. Because of the nature of these

answers, the emergent theory here is that ballast water exchange is perceived differently among the various policy actors involved with this issue. Thus, it may or may not be seen as a benchmark among the policy community, and will not impede the implementation of new and more effective treatment technologies. State respondents range from neutral to agreeing that ballast water exchange is a benchmark and implementation of a new treatment technology will be difficult to implement. Federal respondents were split on this question, with responses ranging from disagree to agree. Respondents affiliated through combination agencies are neutral. Respondents affiliated through non-governmental organizations disagree that exchange is a benchmark. Academic/research respondents strongly disagree on this question, suggesting that ballast water exchange is just a stopgap measure.

From these very narrow and specific theories, it is possible to create several more general and broad ones. These wider-reaching theories can serve as an important component of the next step in attempting to reconfigure ballast water and non-indigenous species legislation. These overall theories are: 1) the significantly diverging opinions on issues ranging from funding to current policy effectiveness to agency involvement can be contributing to the stalled evolution of effective ballast water policy; 2) there are specific changes that could support more effective means of devising and implementing ballast water policy for the prevention of exotic species; 3) ballast water exchange is perceived differently among the policy actors, and thus may or may not impede the creation and implementation of more modern and effective ballast water treatment technology.

Chapter VII
Results and Discussion

At the outset of this project, it was presumed from background research and observation that there would be an overall sense of shared points of view among the agencies and organizations that are involved in the ballast water and non-indigenous species prevention and control issue. However, analysis of the survey data turned up areas of clear contention and assent between response groups. Perhaps most notable is the unforeseen discrepancy in the perspectives of the state respondents and those of the federal respondents. Analysis of survey data shows that, in large part, where the state respondents answered in the affirmative, or agreed with the statement offered, federal respondents answered negatively, or disagreed with the statement offered and vice versa.

Areas of assent among federal and state respondents included agreeing that certain actions should be taken and are believed to be successful. There is also a fundamental agreement that the ballast water treatment and non-indigenous species issue is a significant problem facing the environment today. Additional topics of accord include components that should be present in future ballast water regulation and legislation, general methods of treatment, general methods of monitoring the ballast water treatment technology that is implemented, the treatment and disposal of sediments, and the organizational structure that would be most beneficial to the future development of ballast water legislation.

These areas of agreement would seem to give way to a neat and uncomplicated passage of new and more effective legislation. However, these topics

of assent are overshadowed by the larger and deeper areas of dissension. Though analysis of survey data does show that respondents largely agree on what should be done, the logistics of actually getting there appear to pose a significant roadblock in the progression of successful ballast water legislation.

Considering the nature of the perceptions of the respondents involved, and in light of the problems in the fundamental elements of the issue, it would appear that the best course of action from this point would be to revisit the construction of ballast water and non-indigenous species policy from the beginning in order to address some of the previously-stated issues. There is an obvious need to take steps toward eradicating fragmented policy, especially in cases such as this, where many jurisdictions can be effected. Yet it would be too much to expect full integration of agencies; this would require reorganization and the formation of an agency with larger scope.[109]

Instead, policy makers could look toward partial integration that would serve to "better mesh agencies' actions with one another."[110] There could be some sort of regularized mechanism for interagency coordination,[111] perhaps in the form of a committee or council composed of reorganized members of the numerous and scattered working groups, task forces, and committees that currently exist to work toward ballast water policy. A form of this possible committee was suggested in the 3 February Executive Order issued by President Clinton. This new council could consider operating on two levels. One would be a higher political order, where

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[109] Ibid., 292.
[110] Ibid.
[111] Ibid.

agency heads could meet periodically. The other could exist on a working group level that would meet on a more regular basis and pull staffs together from different agencies, and also spawn specialized committees that can work on very specific problems and provide knowledge to other levels working on policy. This council could have a specified set of goals and values that they could always refer back to in the process of devising new ideas for programs, thus ensuring that the programs and policies that they devise would serve to uphold the goals of the overall policy and those involved in the issue.

Taking this route, there exists the possibly for utilizing a different and forward-thinking model of a policy instrument. It is clear that a line of communication needs to be put into place and utilized among the parties involved with the ballast water and non-indigenous species issue. This communication is a necessary step that must be taken before effective legislation can be devised and implemented, and the council that serves as the mechanism for interagency coordination could serve as the first step in this process. This council would then need that set of overarching principles and values to refer back to. This is where a new policy model could prove to be very valuable.

The Model

In light of the attention that must be focused on the fundamental components of policy-making before development of legislation can begin, it would appear that one potential way to successfully address this issue is to utilize the core and periphery model. This model is set forth by policy researcher Giandomenico Majone

in the text of *Evidence, Argument, and Persuasion in the Policy Process*. A particularly intriguing characteristic of this model is that it considers that policy, and the development thereof, is a constantly changing process.[112] This fluid nature seems especially apparent when considering environmentally centered policy issues; natural conditions can be in constant flux, and technology continues to develop to improve and reduce the levels of pollutants that we emit into the environment.

While the environment and its needs are not static, the need for an element of policy that is stable is just as crucial to the policy development process. This continuity is important, especially for policy analysts. Without some consistency of the actions and expectations of a policy, there would be no way to discover a pattern in a stream of otherwise apparently disconnected decisions and discrete pieces of legislation and regulations.[113] Also, this continuity and stability would provide for some method of analysis for the policy that is implemented, as there would be an existing basis for expectation and evaluation. The core and periphery model addresses the need for both continuity and flexibility in the process of developing policy of any kind. It seems especially suited to this type of policy problem, as the ballast water and non-indigenous species issue would require both elements of the model to be devised, implemented successfully, and perhaps most importantly, evaluated for effectiveness.

The elements that compose the core are the goals and values that are central to the policy, as well as the methods and strategies for translating general policy

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[112] Giandomenico Majone, *Evidence, Argument, and Persuasion in the Policy Process* (New Haven: Yale UP, 1989): 150.
[113] Ibid.

principles into concrete activities, such as the formation of task forces and other such organizational committees that can work to further and uphold policy basics. These activities can also be represented by positives or negatives; positive being permissible activities or courses of action, while negatives are those approaches or actions that are discouraged or prohibited. The core represents the stable part of the policy, but is by no means immutable; rather, this piece of the policy puzzle is the one that is slow to change, even to the point of being considered to be somewhat resistant to change.

This resistance to change extends out to the first few rings of the periphery. The closer a particular program or activity is to the core, the greater the pull is to retain it, and the more important it is considered to the central values of the core.[114] The periphery is intended to give effect to the core principles by utilizing programs or other concrete administrative activities; an additional purpose of the periphery is to provide flexibility. The distinction between the two areas of this policy model articulates the intuitive notion that not all policy changes are of equal weight and significance, nor are all programs equally important to the support of the core values.[115] The rings that make up the periphery form a kind of protection around the core, doing as much to deflect criticism from the basic principles and values of the policy as to implement them.[116] If the core is designed with the intent of providing continuity and consistency in the policy-making process, then it is necessary that these 'protective belts' be in place to protect it as much as possible from too frequent

[114] Ibid., 151.
[115] Ibid.
[116] Ibid., 152.

or far-reaching changes.[117] The importance of the program or activity on the periphery depends on the location of that ring in relation to the core; the closer that ring is to the center, then the more resistant to change or elimination that program will be. This is because the elements situated closer to the core are considered to be essential to the implementation and character of the policy itself. Should any changes reach these innermost peripheral rings, a sense of discontinuity would follow, and the effectiveness of the policy would likely suffer as a result. This notion reinforces the idea that the incremental approach is pervasive in the policy-making world.[118]

Additional benefits of this policy model include the allowance for clear and sharp definition of the core principles that compose and characterize the legislation. The unmistakable definition of these crucial principles may "facilitate incremental change and adaptation to a situation by clearly distinguishing the essential from the expendable".[119] Also, this policy practice would set up guidelines within which a wide variety of approaches to the issue that policy attempts to deal with to be developed.[120] This characteristic of the core and periphery model is vital to the success of the policy instrument overall. Policies that are built around "poorly articulated or ill-understood principles tend to become too rigid and discourage experimentation for fear of exposing the ambiguities that made the initial consensus possible".[121] In short, the articulation and clarification of the core values at the

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[117] Ibid.
[118] Ibid.
[119] Ibid.
[120] Ibid.
[121] Ibid.

outset of the policy development can actually help along experimentation and learning in the execution of the policy that may uncover an even more successful means of managing the problem that the policy is intended to mediate.

Application of the Core and Periphery Model to Ballast Water Legislation

When applied to the issue at hand, the core and periphery model sets in motion the identification of those goals, values, and actions that form the backbone of the ballast water and non-indigenous species policy. Agreeing on the elements of the core will involve compromise and trade offs for all the policy actors involved, yet this is a necessary part of identifying the goals of the policy, and of the policy process in general. The specification and agreement of common elements for legislation on this issue allows those working on the formation and/or revision to begin their reauthorization, or construction, to work with a common outlook from the outset, and to devise plans of action that support these goals. Additionally, these programs that are devised and implemented have a method of evaluation in place before they begin. With the core holding the values and goals that are to be met by the implementation of the peripheral programs, ensuring that these goals are being met would be a means of evaluating the effectiveness of the programs. This is be a step toward ensuring that the programs that are intended to support the goals of the legislation are in fact doing just that. If not, then the program, being located on the flexible rings of the periphery, can be revamped to serve the established goals better.

In progressive stages of utilizing this policy model, experimentation and innovative programs can be added on the outer periphery on 'test-run' terms;

different things can be tried, while not losing sight of the central values and goals. If the program or technology for treatment or whatever the addition may involve is successful, then it may move closer in toward the core to more effectively support those goals. However, if the addition is not successful, then it can be removed with virtually no disruption of the core whatsoever.

Utilizing the shared, though conflicting, goals of ballast water technology development and prevention of biological invasions as the basis of the model, a preliminary core and periphery model can be constructed. This model does not purport to solve all the issues that plague that ballast water issue, but it is a meaningful first step in moving toward effective policy.

Analyzed survey data provides the foundation of the model. Analysis via grounded theory will allow for construction of the model using those values, methods, and activities that have been found to be common and repeated themes among survey respondents. Overall, broad theories derived from the analysis of survey data can be used to help create the core goals and values, or at least identify those issues that should be dealt with and somewhat ironed out to a workable level before construction of legislation begins.

The fundamental goals and values of policy on this issue are difficult to align, merely because of the nature of the issue. Legislation purports to mediate the negative effects of invasions by aquatic nuisance species, while at the same time maintaining the integrity and character of the shipping industry. These two concerns are generally considered to be somewhat mutually exclusive. The shipping industry is resistant to any mandated treatment methods that will cost large amounts of money

to install and add time to the voyage. Environmentalists are not likely to be satisfied with regulations that do not sufficiently kill the organisms in ballast water. Other agencies must be concerned with the safety of actually using the technology that is implemented on board vessels. This is the challenge that policymakers face, and where the nature of the political system will likely enter.

In the process of creating policy there are not any absolutes involved; no interested party will get exactly what it wants. Rather, the policy process is characterized by a give and take custom. A method of creating policy through compromise and finding something that all policy actors involved can live with. This is where model policy based on the core and periphery model can greatly benefit the issue at hand. Though this model does not claim to resolve inherent policy conflicts, it does facilitate communication and movement toward agreement on trade offs that must occur between policy actors.

In light of this, a compromised agreement on the issues that theory presents, as well as the goals and values of the core could clear the path for the programs that would support them. Existing activities, such as the numerous Task Forces and committees, could be looked at through the values that have been agreed upon by all interested parties to discern whether or not these programs, as they currently exist, are furthering or preventing these goals from being achieved.

Utilizing the analyzed survey data and additional research, a preliminary core and periphery model can be constructed for the issue at hand. The nature of politics will show through in the construction of this model, especially in the programs that give meaning to the values of the core. There will have to be agreement on the core

values and goals, as well as on the activities that support them. Being a political issue, there will be no absolutes, and no one agency or party involved will get exactly what they want. There will have to be compromise and positive incentive to spur on the interagency cooperation and collaboration. This, coupled with the concrete identification of overarching goals and values, can smooth out the currently rocky path to successful construction of ballast water regulatory policy.

The model begins with identification of the goals and values that will compose the core. Utilizing elements derived from analysis of survey data and background literature, while being cognizant of the drawbacks of the system and political nature, these core components can be identified as: 1) prevention of non-indigenous species invasions with the goals of protecting ecosystems, economies, and human health; 2) devising technology to effectively treat ballast water and associated sediments; 3) interagency cooperation and communication – meaning working to keep policy as unfragmented and harmonized as possible, especially considering that areas of jurisdiction are traversed by numerous aspects of the issue, keeping common goals, and working with equitable and resilient partnerships; 4) maintaining the safety of ships and crews; 5) maintaining the integrity and efficiency of the shipping industry.

Considering these goals, as well as the fundamental nature of policy-making, there must also be some positive incentive for agencies to collaborate included in the process of building policy. It should always be kept in mind that the core should serve as those overarching principles that can be referred to in the process of constructing policy, and unfailingly held constant. Because of the political nature of

the policy-making process, it was also suggested that the core should contain its own system of checks and balances. This could be in the form of a scientific think tank that adds an unbiased, factual element to the often politically-weighted decisions that are offered[122], as well as serve as a check point to keep the analysis objective. This would be one method of addressing the idea that politics tends to ignore scientific input unless votes or money are at stake.[123]

The peripheral rings can be composed of the programs, practices and policies that will serve to reinforce the core. Again utilizing analyzed survey data, the provisional model can be built up. Keeping in mind that the closer any particular practice, program, or policy is to the core, the more difficult it will be able to change, the first ring could be the level of involvement of the federal, state, and other organizations and agencies that are involved with this issue. Subsequent rings can hold the levels of funding for various aspects of ballast water treatment and biological research, technological development of treatment methods for ballast water that would prevent introductions of exotic species, development of technology to treat and dispose of sediments from ballast water tanks, and partnerships and collection of baseline data. For an illustration of the articulation of this model, please see the figure included in the appendix.

Beyond serving as the overarching set of values and goals for future ballast water and non-indigenous species policy, this policy model can effectively unify the agencies, organizations, and independent researchers that are involved with this issue. Analysis of survey data showed the respondents expressed an overwhelming

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[122] Chris Deacutis, RIDEM, personal communication, 21 February 2001.

desire to move ballast water and non-indigenous species policy and legislation forward in a unified manner, and not with separate states having separate programs. This model would be especially important, considering that individual state action seems to be moving ahead in various arenas, despite the realization that a piecemeal approach generally gives way to differences in the regulatory systems on a global scale. However, in the "absence of a single, uniform, international legal instrument for the regulation of ballast water management, individual jurisdictions at the national, provincial, and local level are proceeding with implementing their own regulatory regimes".[124] It is likely that this trend will continue until a method of harmonizing the numerous agencies, organization, and governments that are involved with this issue is found.

The core and periphery model would fill in this gap, and also serve as a starting point for the construction of effective policy. The model can also be applied to smaller issues within the larger picture of ballast water legislation. Because the fundamental nature of this model encourages communication and laying out basic goals that will be held constant through the evolution of policy, no matter how far-reaching or extensive, it could certainly prove to be valuable not only to policy makers in the United States, but far beyond as well.

The core and periphery model would serve many positive purposes in the formation of effective ballast water legislation. The most important of these purposes, perhaps, is movement toward a policy that will successfully address the

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[123] Chris Deacutis, RIDEM, personal communication, 21 February 2001.
[124] Global Ballast Water Management Programme, "Unilateral Actions Surge Ahead", *Ballast Water News*, Issue 3 October-December 200: 6.

issue of exotic species invasions and ballast water treatment in a system that is considered by many to by a futile place to try and devise or implement environmental policy.

As stated, scrutiny of data turned up an unanticipated rift between the perception of state and federal agencies on topics ranging from funding to whether or not the right agencies and organizations are involved to the overall effectiveness of existing and current ballast water legislation. In short, the data illuminates an overall disagreement on what has been done, as well as how to do it in the future. The core and periphery model would serve to bridge the gap between state and federal agencies that is currently prohibitive to successful legislation by facilitating communication and encouraging partnerships among the policy actors involved with this issue by defining the important parts of the policy and subsequently working to support them. This model puts all policy actors on the same page, thus facilitating cooperation and potentially more successful policy.

To better understand this split on perception between the state and federal respondents, background research on the nature of the two jurisdictions in relation to coastal and ocean policy was conducted. Through this investigation and personal communications with those currently actively involved in agencies, several significant conjectures can be offered as to why these differences occur. These include a jurisdictional split between levels of government, often adversarial decision making, a short timeframe for results to be produced, and a number of problems with the system overall.

First, the problems with the overall system of ocean policy should be addressed. It is not the intent of this research project to change the process through which legislation pertaining to the ocean and coastal resources is crafted, but it can be very important to the construction of policy that those devising it are at least cognizant of these pitfalls. This way, lawmakers may be able to address certain aspects of these overall problems within the context of one specific issue, such as creating legislation for ballast water and non-indigenous species.

The core and periphery model also addresses the fundamental problems that apply not only to ballast water and non-indigenous species policy, but to the broader category of ocean and coastal policy as well. There are four specific problems with development of ocean policy that are identified by policy researchers. Though these issues pertain to ocean policy, these matters are an issue with the policy at hand as well. These issues are:

1. Policy often attempts to fit rigid jurisdictional frameworks with set boundaries onto highly fluid and dynamic environments.
2. Decision-making is fragmented and compartmentalized, while ocean resources are interconnected and correlated.
3. There are no overarching statements of national policy or priorities that can be referred back to when creating new legislation on order to guide or harmonize ocean programs, or mediate the conflicts that may arise between them.

4. There is no organized or coherent way for the federal government to deal with coastal states on ocean planning and use issues. [125]

These fundamental problems can serve only to exacerbate the existing problems that are specific to the ballast water and non-indigenous species issue, as well as ocean policy overall.

Related to the issue that the creation of policy is fragmented and compartmentalized, is the jurisdictional split that exists between the levels of government.[126] Coastal and ocean areas are governed by three separate levels of authority: local, state, and federal. Local governments tend to have control of the shoreline and the use of the coastal resources; state control extends from the low tide line out to three nautical miles; and the federal government has control from three nautical miles out to two hundred miles. The inherent problem is not necessarily that these lines of jurisdiction exist, but rather that the most important of ocean activities tend to traverse, or at least impact, all of these areas of control.[127] This, then, refers back to the systemic problem that no guidelines exist for harmonizing ocean policy among users, and adds another element of complexity to the already-convoluted process of devising policy for management and regulation of ocean uses. However, even if a resource use does fall solely under one band of jurisdiction, it is generally then under the control of two or more different agencies that have authority within the area.[128] When this occurs, there is often no chance for agencies to debate the

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[125] Biliana Cicin-Sain and Robert W. Knecht, *The Future of U.S. Ocean Policy: Choices for the New Century* (Washington DC, Island Press, 2000):281-282.
[126] Ibid., 279.
[127] Ibid., 279.
[128] Ibid., 280.

overall priorities and goals for the resource because they are managed on a use-by-use basis, and because of the fact that no agency or organization has jurisdiction to resolve use conflicts.[129]

Another possible reason that can explain the division of state and federal agencies could be that decisions are often narrowly-based and adversarial.[130] Policy for ocean and coastal resources is generally driven by interest groups that are focused on specific resources or commercial concerns, and federal ocean managers are left to create policy around the goals of their own agencies[131], thus leading to adversarial decision-making that focuses on the desires of the agencies involved, rather on the best interest of the resource.

Related to the idea that policy makers must act in the best interest of their agencies, is the idea that they must also keep up the money and support for the policies and programs that are created to support the interests. Another problem arises from this reality. Because results must be produced quickly to satisfy constituents and maintain flow of money for the program, long-term planning that makes up more successful means of managing ocean resources is often replaced with more hastily put together short-term programs.[132] However, " 'successive short-term programs may not be the best way to achieve long term results'."[133] Yet the uncertainty that comes with devising programs that do not immediately show results can be a significant roadblock in these policies receiving the funding that is needed

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[129] Ibid.
[130] Ibid.
[131] Ibid.
[132] Ibid., 281.
[133] Burroughs and Juda, as quoted in Cicin-Sain and Knecht, 281.

to implement them. Also, these hasty policy decisions can sometimes be based on the scientific knowledge that is readily available, regardless of the depth, breadth, or reliability of the studies. This can have significant negative impacts on ocean policy, especially those concerning ballast water, as "solid management can be impeded by the uncertainty that exists about the fate and effects of discharges of various types and about the nature and severity of impacts".[134] This can be especially true when invasions go largely unnoticed until they have had an adverse and irreversible impact on an ecosystem.

All of these problems with the current framework and system for devising ocean policy can adversely effect the creation of successful regulation of harmful activities in these critically important areas. Specific to the issue at hand, the issues that could be considered most serious are the lack of policies and principles that those devising policy could refer back to in the process of constructing regulations. Also, because each federal agency serves as it own judge and jury regarding the implementation and interpretation of ocean use regulations through rule making, and there tends to be little coordination among agencies, the resulting policies are often inconsistent with successful management.[135] These two issues could impede the successful prevention and control of aquatic nuisance species invasions, as the means by which exotic species arrive in ecosystems cross lines of jurisdiction, involve many government agencies, and can significantly affect commercial concerns.

The core and periphery model would be a valuable tool in revamping the way that ocean policy, ballast water legislation in particular, is constructed. Considering

[134] Ibid.

the problems that are currently impeding the implementation and effectiveness of ballast water regulation, this novel means of constructing policy facilitates communication among the policy actors, set overarching goals and values to be retained for present and future regulations, and define criteria for evaluating programs through the statement of the core and the programs that compose the periphery.

The problems that plague current ballast water legislation as well as those affecting overall formation of ocean policy leave room for significant improvements in the upcoming reauthorization of the National Invasive Species Act of 1996, and suggest a optimal opportunity to mold these changes around the core and periphery model. The core and periphery model addresses each of the four fundamental problems with the overall formation of ocean policy. The model takes into account that ballast water regulation deals with a dynamic environment; it acknowledges this by allowing for flexibility of programs that support the core and allow changes to better reinforce the core without disrupting the fundamentals of the issue. The variables of nature create loopholes that nullify existing policy. The weather is one major factor that can result in the bypass of regulations; if weather is heavy, then ballast water exchange is subject to the captain's discretion. Though this is necessary to maintain the safety of the vessel, her cargo and crew, it does present an ecological and regulatory conundrum.

Another problem is presented by the lack of verification methods to authenticate the exchange. Currently, the only means of verifying whether or not the

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[135] Ibid.

exchange was completed is to review the ballast water exchange form that the Coast Guard requires of all vessels entering United States waters (see Figure 5). This form, however, has been submitted by approximately seventeen to twenty-five percent of the total vessel traffic entering United States waters[136]. This leaves no basis for judging the effectiveness of ballast water exchange in preventing invasions of aquatic nuisance species, and thus can perpetuate policy problems with the evolution of successful policy to prevent exotic species invasions. The core and periphery model would allow for evaluation of the effectiveness of supporting programs by using the core values and goals as a system of checks to ensure that the programs that are put into place support the core elements.

The core and periphery model also helps to keep decisions from being fragmented and compartmentalized. The core ensures that the various policy actors would hold the same goals, which themselves are crosscutting, in mind when devising policy. Retaining the same values would make policy more inherently cohesive and integrated, as the agencies and organizations have to consider other interests in the process of designing policy.

Addressing another of the problems plaguing ocean policy, the core and periphery model provides an organized and coherent way for the federal government to communicate with the states on this issue that involves both of their jurisdictions. The cooperation facilitated by this model may help the federal policy makers learn from the states that have had some success in devising a policy that has appeared to be successful in moving toward preventing introductions of exotic species. At the

[136] Penny Herring, USCG Research and Development, personal communication, 5 April 2001.

same time, this model would provide the base for cohesion of policy necessary to reverse the unilateral action that has been considered detrimental to the future success of overall ballast water policy.

Finally and perhaps most significantly, the core and periphery model can provide overarching statements of priorities in developing policy that can be referred back to in creating new policy, as well as to be utilized in harmonizing agency action or mediating conflicts. This far, these priorities can be defined as: 1) devising an implementing effective technology to treat ballast water and associated sediments; 2) preventing invasions of non-indigenous species; 3) safety of the vessel and her crew; 4) preserving the efficiency and character of the shipping industry; and 5) productive partnerships among the various agencies and organizations involved with this issue. This model of constructing policy addresses all of the problems that are common to ocean policy in general, as well as exhibiting potential to smooth out the path to a viable and effective ballast water policy. The core and periphery model retains the fundamental goals and values of ballast water policy, while encouraging experimentation and trials of technology to treat ballast water in order to prevent exotic species invasions. This model serves to promote incremental change and allow policy to evolve as the political and technological environments change. A responsive policy could be more likely to prove effective, especially when considering notoriously dynamic environmental issues. These attributes of the core and periphery model illustrate its great potential to facilitate the development of more effective policy to prevent invasions of alien species into the waters of the United States.

Chapter VIII
♦ Conclusion

Since 1989 and the zebra mussel infestation in the Great Lakes, invasions of non-indigenous species into the waters of the United States have been a matter of concern to policy makers. The uncertainty and variability of invasive species make these incursions difficult to predict, and the effects of an exotic that establishes itself are even harder to mediate. An invasive species that establishes a new population carries substantial ecological, economic and public health impacts along with it. Because of the nature and seriousness of these issues, effective legislation to prevent introductions of harmful organisms is necessary to protect our ecosystems and markets, as well as our own health.

However, legislation to this point has been criticized as being weak and ineffective. The current conditions that surround the ballast water and non-indigenous species issue leave the topic open for significant changes and improvements in areas that have proven problematic for legislation and regulation since the early 1980's. The substantial ecological, economic and health problems that can be associated with non-indigenous species invasions have brought the issue to the top of many political agendas around the country. The issue is even gaining the attention of the popular media, as is evident by the recent reports in more widely read popular magazines and in radio spots on National Public Radio. This wide recognition is likely to be necessary in moving toward an effective policy to address the issue. Though the detrimental consequences of discharging ballast water into our bays, estuaries, and harbors is evident to researchers, it is likely to be the influence

and demands of political constituents that will be the true motivating factor for policy makers. As is the case with so many political issues, as people become cognizant of risks and harm that can directly impact them, such as an outbreak of cholera, they tend to demand legislative attention and action. As species continue to arrive in our ecosystems, policy makers should be considering their next move, as a plan of action is likely to be demanded of them in the near future.

As a result of the need for a more effective policy toward invasive species in the near future, this project was built around the shortcomings of present legislation and the possibilities for future improvements. Surveys were administered on the perceptions of experts in this field regarding present legislative issues with the goal of identifying areas that are effective, as well as those with room for change and improvement.

Through analysis of survey responses, two general and overall conclusions can be drawn. The first is that there is a prevailing consensus that ballast water discharge and non-indigenous species invasions are significant issues that need to be addressed and regulated. The second conclusion that can be made is that thought this broad area of assent exists, policy progress is impeded by the fact that the policy actors involved can not agree on how to successfully regulate ballast water discharge or devise an acceptable treatment method for ballast water to be used in order to prevent introductions of exotic species.

These two general conclusions can be broken down into more specific areas of agreement and argument. On a number of issues, a sharp distinction between the perceptions of federal and state agencies was revealed. The first of these areas of

dissent among federal and state agencies was on their respective perceptions of the adequacy of various aspects of funding for ballast water and non-indigenous species work. When questioned on perception of adequacy of funding provided for technological development for treatment of ballast water, ecological impact/risk assessment research and overall money provided to support other related research, those respondents affiliated with state agencies disagree/strongly disagree that funding over these areas is adequate. However, when the same set of questions were posed to those affiliated with federal agencies, the responses indicate that they agree that funding for these research areas is adequate.

Another area of dissent between federal and state respondents is that of the effectiveness of existing legislation. State-affiliated respondents disagree that NISA 1996 has been effective in preventing and controlling non-indigenous species outbreaks, while federally-affiliated respondents agree that NISA 1996 has been effective. Follow-up questions indicate that policy actors would include two categories of change to make ballast water policy more effective. The first area of change to be included in reauthorization of ballast water legislation suggests that a strong element of ballast water treatment be contained within the revised or new legislation. This includes exchange technology, mandatory treatment and development of standards for discharged water as well as treatment. The second category to be included in reauthorization of policy centers on funding issues. Respondents suggest that availability of grants for technological development, as well as less specification of research dollars, would be beneficial to the future of

ballast water and non-indigenous species policy. Another option for improvement suggested was a more defined role of the state in regulating ballast water discharges.

Supporting questions indicate that there is a strong consensus that reauthorization should include some sort of framework of time in which to devise and implement technology to treat ballast water. However, there is disagreement over whether or not revision of legislation should focus on the design and construction of new vessels only, or also apply to existing vessels that would require extensive retrofitting to be in compliance with new regulations and standards.

A final area of disagreement between state and federal agencies is in regard to perceptions of whether or not the appropriate agencies are involved with various aspects of this issue. State respondents ranged from somewhat agree to strongly disagree on this question, while federal respondents all strongly agree that the appropriate and key players are involved. Accordingly, federal respondents did not offer any suggestions for who else should be involved. State respondents did offer suggestions for change, including increased involvement and input from the Environmental Protection Agency, Department of Environmental Management, Food and Drug Administration, and government staff.

Specific questions regarding involvement on particular issues elicited a range of answers. Respondents from state agencies disagree that the right agencies are presently involved with the development of technology for ballast water treatment. Suggestions for improvement include increasing the involvement of naval architects, marine engineers, the Environmental Protection Agency, Navy, Coast Guard and the commercial fleet in dealing with development of technology to treat ballast water.

On this same question, federal respondents largely agreed that the appropriate players are involved.

A similar response was seen on the question of whether or not the right players are involved development of policy and legislation. State respondents suggested that agencies such as the Department of Environmental Management, Department of Health, Environmental Protection Agency, Food and Drug Administration and the Coastal Resources Management Council should all have an increased level of involvement with legislation and policy development. Aside from one federal respondent who believes that the Navy should have a higher level of involvement here, no other suggestions were offered to improve development of legislation for ballast water.

Analysis of survey responses also turned up areas of assent among policy actors. Both state and federal respondents disagree/strongly disagree that unilateral action would help work toward the ultimate goals of ballast water policy. Likewise, these same respondents disagree/strongly disagree that region-specific management would be more successful than blanket federal policies for preventing the inundation of exotic species into the waters of the United States. Also, both state and federal respondents believe that partnerships would benefit the revision and implementation of NISA 1996, or other applicable ballast water policy that may be designed.

In terms of regulating ballast water under a legislative policy, respondents largely agree that utilizing a combination of shore-based, en-route and ballasting precautions would constitute the most viable solution to managing ballast water. Among respondents, the most recognized options for successfully treating ballast

water en-route were using some means of physical separation, such as filtering or hydrocyclonic separation, coupled with some form of chemical treatment, such as biocides. Also, the top three considerations for choosing a means to treat ballast water were identified as effectiveness, ease of use and safety. In terms of monitoring the treatment methods that are implemented, respondents identified two categories of monitoring the treatment of ballast water that are believed to have the most potential for success. These are: 1) shipboard monitoring, which would include the periodic review of the ship's logs/records and using treatment technology; and 2) shore-based monitoring, including indigenous species assessment and ballast water sampling at the discretion of the port state.

A final area of strong assent among respondents is that means of addressing sediments in ballast tanks must be addressed. Methods of treatment for sediments that were indicated by respondents include: upland disposal, burning, disposal at sea and avoidance in the first place (by using ballasting precautions). Likewise, respondents consider the disposal options of burning and land or at-sea disposal to be the most viable.

Analysis of survey data turned up one area where there was no definitive line of perception among respondents. When asked whether or not ballast water exchange was believed to be a benchmark that could impede future development and implementation of ballast water treatment technology, responses were varied and inconsistent across response groups. To some, this method represents only a stopgap measure until more thorough treatment can be developed. To others involved with this issue, ballast water exchange represents a benchmark of treatment technology

that has had policy built around it, and therefore will be difficult to overcome once newer and more effective technology has been developed and is ready to be implemented. Thus, a theory as to how this current component of ballast water legislation will affect future technological development and regulation would have to be the subject of further research.

Overall, the general conclusions from assessment of survey data are that there are serious discrepancies in the perceptions of state and federally affiliated respondents. Also, though respondents largely agree on the fact that something should be done, the logistics of reaching these goals seem to be a significant roadblock on the path to devising and implementing successful ballast water legislation.

In light of identified issues with current legislation, the upcoming reauthorization of NISA 1996 presents a significant opportunity to take steps toward forging effective ballast water policy. Utilizing a Council, such as the one suggested in the 1999 Executive Order to devise legislation, along with a different way of constructing policy, could help integrate agency actions and ultimately devise effective policy to prevent and control invasions of exotic species into the waters of the United States. This Council's working group could build policy based on an instrument that facilitates communication between the agencies and organizations involved as well as solidifies goals and values for ballast water policy and ensures that they are supported: the core and periphery model.

This model takes the fundamental goals and values of a policy (the core) and subsequently surrounds that core with peripheral activities and programs that serve to

reinforce the central elements of the policy. The potential success of this model lies in the fact that it both facilitates communication across the ranks of all policy actors involved, as well as taking into consideration that policy is a dynamic and on-going process. This characteristic is especially important when considering environmental and ocean issues, where policy is likely to work best when it is allowed to respond to the environment it is intended to serve.

Because of the way this model is set up, it allows for flexibility while at the same time it also holds certain elements constant. The flexibility of the model is articulated through the periphery, while the core provides continuity and stability for devising, implementing and evaluating policy. The core is not immutable, but it is difficult to change once the goals and values have been stated and put into place. This resistance to change is important to the integrity and effectiveness of the overall model, as it will aid in the definition of activities undertaken to support the core values. Also, clear articulation of core elements can encourage trials and experimentation that could lead to an even more effective means of treating ballast water by distinguishing the essential components of policy from those that are expendable. This model would also prove particularly useful in dealing with ballast water legislation, where technology continues to develop around treatment options, and policy is likely to have to change to keep up.

Using analyzed survey data and literature on this issue, a potential core and periphery model was composed. Here, the core elements of ballast water policy are: 1) protecting ecosystems, economies, and public health by preventing and controlling invasions of non-indigenous species; 2) designing and implementing

feasible treatment technology for ballast water; 3) interagency cooperation and communication (partnerships); 4) maintaining safety of vessels and crew; 5) maintaining efficiency and integrity of the shipping industry.

The periphery serves to support these goals, and forms successive rings around them. This support is operationalized by programs, practices and activities that supplement the core goals and values of the overall ballast water policy. Again utilizing analyzed survey data, provisional peripheral rings cab be built around the core. Here, the first peripheral ring holds the levels of involvement of the various policy actors and agencies involved. Subsequent rings hold levels of funding, technological development for ballast water treatment and sediments, and baseline data collection. Outer rings can always be added in an effort to experiment with new programs to support the core.

One of the many benefits of the core and periphery model is that it allows for clear definition of the fundamentals of policy before construction begins. Then these stated goals serve as reference when the policy is being built, as well as providing a base for evaluation of the programs and activities that are intended to support the core goals. Utilizing this model of policy would also facilitate holistic environmental policy, rather than fragmented or compartmentalized regulations that prove to be difficult to implement or monitor. Also, utilizing this policy instrument would create a way for the federal, state and local governments to communicate with one another. Setting up the model requires that policy actors communicate and cooperate with one another on establishing goals, as well as the programs and activities that will support these goals contained within the core. The same

overarching goals would be held be all the policy actors involved, thereby helping all involved to speak the same language and possibly begin to work to get away from unilateral actions and more toward a cohesive and effective federal policy.

In short, this model of creating policy to address the issue of ballast water and non-indigenous species would speak to each of the problems that are identified as being problematic to ocean policy overall, thus clearing the way to a more effective and easily implemented ballast water policy.

It is clear that a policy to protect environmental interests is needed, as well as regulations that will still allow the shipping industry to operate efficiently. The suggested model allows for experimentation and latitude for change, both important factors in successful policy pertaining to dynamic issues. Also, the core and periphery would facilitate a discourse between policy actors that would progress toward forging workable legislation and regulations regarding ballast water and non-indigenous species that all involved can live with. Fulfilling even simply its most basic function, this model of policy would serve to facilitate communication and help policy makers to work toward preventing exotic species invasions as well as maintain the integrity and vitality of the shipping industry. All policy actors could make their values and priorities known, as well as have a hand in the formation and implementation of the core and ensuing periphery. This involvement and discourse among policymakers could result in the design of a much-needed policy that effectively prevents introductions of non-indigenous species, and consequently protects our health, ecosystems and economies.

Overall, the core and periphery model would prove very valuable in devising policy to successfully address all the concerns that are encompassed in the ballast water and non-indigenous species issue. Policy to this point has been largely ineffective, and the loopholes and exemptions will continue to keep it so. Though utilizing a new model of devising policy will involve some risk, the gamble of continuing to try to fit a rigid set of regulations on a highly dynamic environment such as the marine environment is likely to prove far greater, and with more severe negative consequences.

Researchers have noted that most invasions are not noted by experts, but rather by the ordinary person walking the beach or simply observing the coastlines that they are familiar with. Likewise, the impetus for change is likely to be generated within the constituencies of policymakers that belong to coastal states. As the general public becomes more cognizant of the real dangers to things that are likely to matter to a greater number of people, such as increased taxes to mediate effects of an invasive species, they are likely to demand that those who represent their interests take action.

Reauthorization of existing policy regarding ballast water and non-indigenous species should consider that this issue is moving into the awareness of a larger public, and accordingly, consider a means of devising policy that will be likely to produce results. It will be up to the broader public to demand that those who act on our behalf and posses the power to bring about change do just that in the reauthorization of NISA 1996.

Change is essential in creating a policy that can be implemented successfully. Regulations thus far are flimsy for this very reason; they are wrought with inadequacies that render them virtually useless. It will be up to researchers to impress the gravity of this situation upon the general public, and in turn, the responsibility of the public to listen and demand action from the government. This succession of events is likely to be the only means of seeing effective legislation take place; left to their own devices, the policy actors involved here are likely to hold policy formation up with constant disagreement and unrelenting opposition to positions different from their own. This issue is one that has the potential to impact every single person. In the interest of our own health, essential economies and vital ecosystems, we must incite action and demand results from policymakers if this ecological roulette is to come to an end before we reduce the environment that we are bound to be stewards for to a system of only a handful of resistant organisms.

Ballast Water Legislation and Treatment Methods Questionnaire

1. What is the basis of your association with the ballast water/non-indigenous species issue?

Please check one State agency_____ Federal agency_____ NGO_____

Shipping industry_____ Other (please specify)_____

2. How long have you been involved with the ballast water/non-indigenous species issue?

Please check one < 5 years_____ 5-10 years_____ 11-15 years_____ 16+ years_____

3. Please rank the issues that your organization or agency addresses, from the issue that receives the most attention (1)to the issue that receives the least attention (7).

ballast water treatment issues_____ technology development_____

ecological impacts_____ impacts on the industry_____

risk assessment_____ policy/legislation development_____

other (please specify)_____

Please indicate your opinion on each statement by circling the number that corresponds to your response, or where appropriate, please provide an answer.

4. From an ecological and economic point of view, the transfer of non-indigenous species is a significant problem.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

5. My organization/agency gives sufficient attention to the issue of ballast water and non-indigenous species.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

6. My organization/agency allocates funds efficiently within the organization in order to address the ballast water/non-indigenous species issue.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

7. Development of technology receives sufficient allocation of funding from the government.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

8. Ecological impacts and risk assessment receives sufficient allocation of funding from the government.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

9. The issue of ballast water/non-indigenous species has been brought to the attention of the key organizations/agencies involved.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

If you disagree, who else do you feel should be involved? _____

10. The appropriate and key players are involved in biological and risk assessment research.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

If you disagree, who do you feel should also be involved? _____

11. The appropriate and key players are involved in development of technology for ballast water treatment.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

If you disagree, who do you feel should also be involved? _____

12. The appropriate and key players are involved in policy/legislation development.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

If you disagree, who do you feel should also be involved? _____

13. Is there any agency or organization that you believe should have a higher level of involvement with this issue?

YES or NO

If you answered yes, please indicate which one(s):

_____

_____

14. Is there any agency or organization that you believe should decrease its level of involvement with this issue?

YES or NO

If you answered yes, please indicate which one(s):

_____

_____

15. NISA 1996 has been:

1 2 3 4 5 5.5 6 7 8 9 10
extremely effective neither extremely ineffective

16. Please indicate elements that you would like to see included in the re-authorization of NISA 1996.

_____

_____

_____

_____

17. The implementation of NISA would benefit from partnerships among various agencies active in this issue area.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

18. Ballast water exchange is a benchmark, and development and implementation of new treatment technology will be difficult.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

19. Re-authorization of NISA should include timeframes and/or deadlines for the development of ballast water treatment technology.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

20. New/re-authorized federal legislation should focus on design and construction of ships rather than mandating retrofitting of existing ships.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

21. Unilateral action on this issue would work against the ultimate goals of ballast water/non-indigenous species policy.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

22. Region-specific management will be more effective than blanket federal policies.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

23. Ballast water management areas (i.e. locations approved for ballast water exchange) would be a successful means of managing ballast water.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

24. The use of fresh water from port water supplies as ballast is a feasible alternative to using seawater.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

25. On-board monitoring of basic water quality parameters of ballast water would be a successful monitoring tool.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

26. Biological and basic water quality monitoring of ports would be a successful monitoring tool.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

27. Assessment of areas for indigenous species in order to establish baseline data is important for monitoring the effectiveness of ballast water management.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

28. Are there any specific methods of monitoring, other than those mentioned, that you believe would be successful?

_____

_____

_____

29. How important is it to develop a framework of risk assessments and biological control?

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

30. How important is addressing the treatment and disposal of sediments from ballast water tanks?

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

31. What would be the most feasible treatment for ballast tank sediments?

_____

_____

_____

32. How should ballast tank sediments be disposed of in order to minimize the risk of transferring non-indigenous species?

_____

_____

_____

33. Shore-based treatment (i.e. offloading ballast to a treatment facility) would be the most viable solution to ballast water management.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

34. En-route treatment (i.e. ballast water exchange, chemical treatment, etc) would be the most viable solution to ballast water management.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

35. Precautions or measures taken in the port of origin (i.e. no ballasting at night or in areas of sewage discharge, or using fresh water from a port source) would be the most viable solution to ballast water management.

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

36. Combinations of any or all of the three would be the most viable solution to ballast water management

1 2 3 4 5 5.5 6 7 8 9 10
strongly disagree neutral strongly agree

37. Please rank the types or proposed types of ballast water treatment from the method you believe is most viable (1), to the one that you feel is the least viable (13).

Ballast water exchange______

Heat treating______

Filtering______

Biocides______

Precautions taken when ballasting (i.e. not at night, not near sewage outfalls, etc.)______

Electric pulse treatment______

Ultraviolet treatment______

Acoustic treatment______

Magnetic treatment______

Deoxygenation______

Biological control______

Anti-fouling coatings on ballast tanks______

Standard ballast tanks for which uniform treatment methods can be developed______

Other ______ (please specify_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _)

38. In developing technology for treating ballast water, what are the primary considerations? Please rank from that which you believe is most important (1) to that which you believe is least important (12)

Cost______

Safety______

Ease of maintenance______

Labor intensity______

Easy to train ship crews to operate______

Operating time to be effective______

Effectiveness______

Ease of installation______

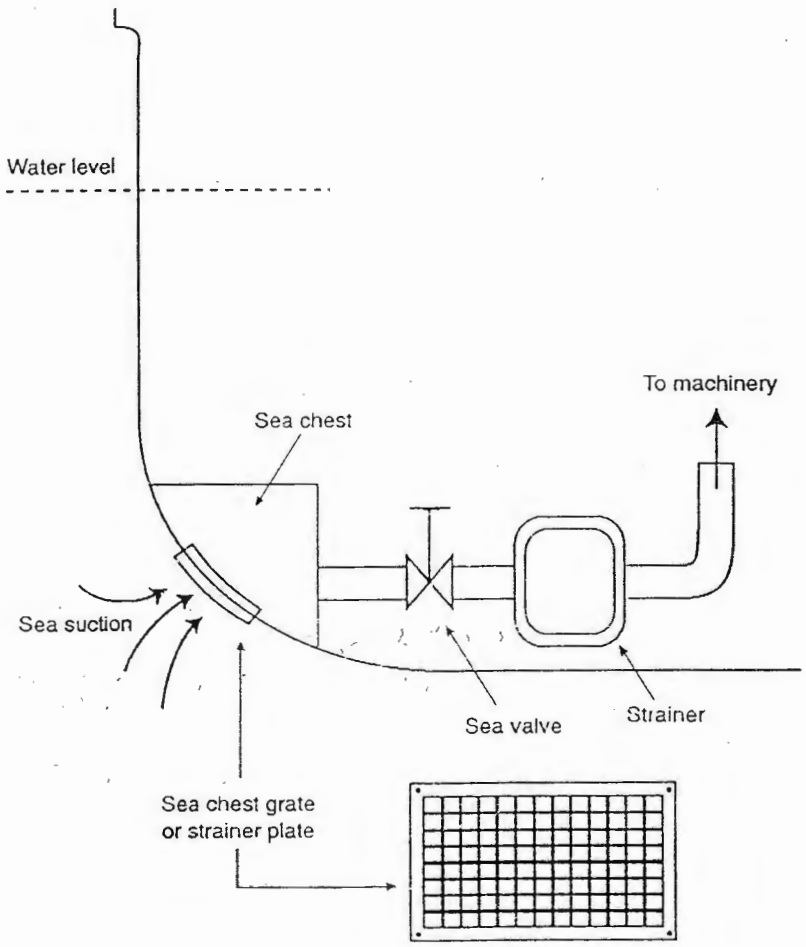
Ease of implementation______

Energy requirements to run______

Ease of monitoring______

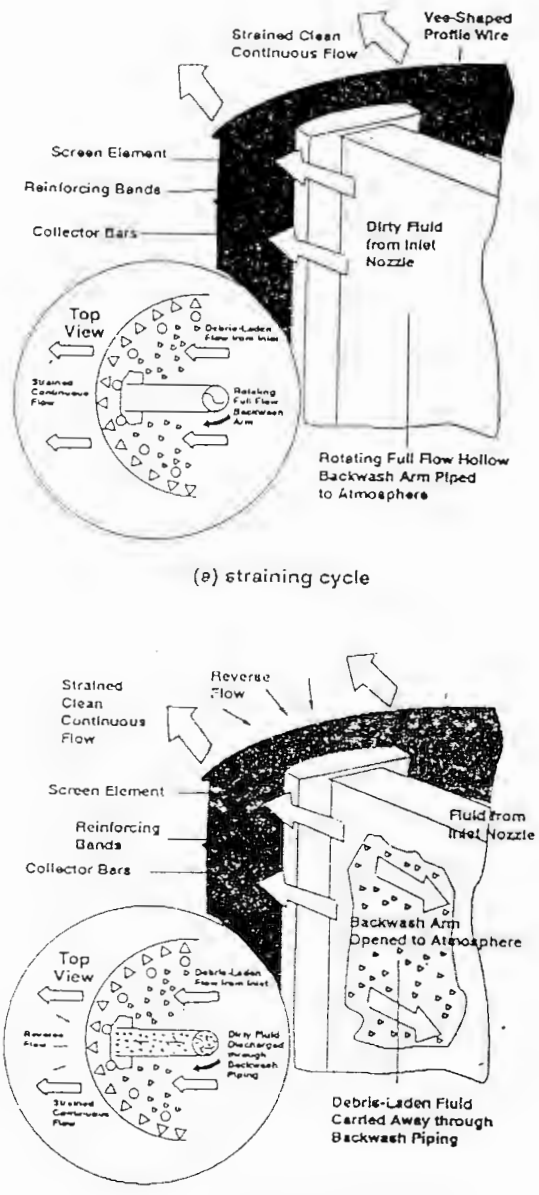
Other______ (Please specify_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _)

Figure 1. Ballast Water Intake System



From: Committee on Ships' Ballast Operations, Marine Board, Commission on Engineering and Technical Systems of the National Research Council, *Stemming the Tide: Controlling Introductions of Non-Indigenous Species by Ships' Ballast Water* (Washington DC: National Academy Press, 1996): 30.

Figure 2. Ballast Water Filtering Set-up



From: Committee on Ships' Ballast Operations, Marine Board, Commission on Engineering and Technical Systems of the National Research Council, *Stemming the Tide: Controlling Introductions of Non-Indigenous Species by Ships' Ballast Water* (Washington DC: National Academy Press, 1996): 62.

Figure 3. Effectiveness of Proposed Treatments

	Safety	Effectiveness	Commercial use			Chemical residuals	Recirculation[a]	Cost		Complexity	Size, Maintenance	Ease of monitoring
			Industrial	Marine	Power			Plant	Crew size			
Oxidizing biocides												
halogen	+	+	+	+	+	–	+	+	+	+	+	+
ozone	+	+	+	–	–	– saltwater + freshwater	–	–	–	–	–	+
Nonoxidizing biocides	+	+	+	+	+	–	+	+	+	+	+	–
Filtration systems												
media	+	++	+	–	+	+	+	+	+	–	+	+
screen	+	++	+	+	+	+	+	+	+	+	+	+
Thermal treatment	+	+	+	–	–	+	+	+	+	+	+	+
Electric pulse and pulse plasma techniques	+	+	–	–	–	+	–	– –	–	–	+	–
Ultraviolet treatment	+	–										
Acoustic systems	+	–										
Magnetic fields	+	–										
Deoxygenation	+	–										

Note: Key to ratings: + good; – poor; technologies judged to be markedly superior or inferior in a category are designated ++ or – – respectively.

[a] + indicates that recirculation of ballast water improves the efficacy of a treatment technology.

From: Committee on Ships' Ballast Operations, Marine Board, Commission on Engineering and Technical Systems of the National Research Council, *Stemming the Tide: Controlling Introductions of Non-Indigenous Species by Ships' Ballast Water* (Washington DC: National Academy Press, 1996): 37.

Figure 4. Ballast Water Reporting Form

U.S. COAST GUARD

BALLAST WATER REPORTING FORM

Note: This page may not print correctly with your web browser or printer. Download this Adobe formatted file imoballast.pdf (7k) for a copy that can be properly printed.

1. VESSEL INFORMATION | **2. BALLAST WATER**

Vessel Name:	Type:	IMO Number:	Specify units: m3, MT, LT ST
Owner:	GT:	Call Sign:	Total Ballast Water on Board:
Flag:	Arrival Date:	Agent:	
Last Port and Country:		Arrival Port:	Total Ballast Water Capacity:
Next Port and Country:			

3. BALLAST WATER TANKS Ballast Water Management Plan On Board? YES__ NO __ Management Plan Implemented? YES __ NO __
Total Number of Tanks On Board _____ Number of Tanks in Ballast _____ If None in Ballast Go to Number 5.
Number of Tanks Exchanged _____ Number of Tanks Not Exchanged _____

4. BALLAST WATER HISTORY: RECORD ALL TANKS THAT WILL BE DEBALLASTED IN PORT STATE ARRIVAL; IF NONE GO TO NUMBER 5.

Tanks/Holds (list multiple sources/tank separately)	BW SOURCE				BW EXCHANGE (circle one: Empty/Refill or Flow Through					BW DISCHARGE			
	DATE DDMMYY	PORT or LAT. LONG	VOLUME (UNITS)	TEMP (UNITS)	DATE DDMMYY	ENDPORT or LAT. LONG.	VOLUME (UNITS)	% EXCH.	SEA Hgt. (m)	DATE DDMMYY	PORT or LAT. LONG.	VOLUME (UNITS)	SALI (UN

Ballast Water Tank Codes: Forepeak = FP, Aftpeak= AP, Double Bottom = DB, Wing = WT, Topside = TS, Cargo H CH, O = Other

IF EXCHANGES WERE NOT CONDUCTED, STATE OTHER CONTROL ACTION(S) TAKEN:_____
IF NONE, STATE REASON WHY NOT:_____
5. IMO BALLAST WATER GUIDELINES ON BOARD (IMO RES. A.868(20))? YES ____ NO ____
RESPONSIBLE OFFICER'S NAME AND TITLE (PRINTED) AND SIGNATURE:_____

From: www.uscg.mil/dl4/units/nsohono/imoballast.htm. Accessed 4 April 2001.

Table 3. Survey responses

Survey #1			Survey #2	
Association	state agency		Association	state agency
Time	11-15 years		Time	<5 years
Top issues	ecological impacts,		Top issues	point source pollution control
	risk assessment			reg./ policy development
Bottom issues	policy development		Bottom issues	ecological impacts
				treatment issues
Q# 4	10		Q# 4	9
5	2		5	3
6	1		6	2
7	3		7	1
8	2		8	3
9	2 (DEM, EPA, FDA)		9	3 (gov't staff)
10	5.5		10	3
11	3 Navy, CG, commercial fleet)		11	3
12	1 (policy dev. not this far along yet)		12	4
13	yes (EPA, FDA, RIDEM, RIDOH)		13	yes (RIDEM, RIDOH, CRMC, EDC)
14	no		14	no
15			15	3
16			16	req. bw treatment- post bonds @US ports
17	8		17	8
18	5.5		18	7
19	8		19	7
20	4		20	3
21	6		21	3
22	3		22	3
23	5		23	5.5
24	5.5		24	5
25	8		25	4
26	8		26	7
27	10		27	8
28			28	biocide treatment
29	1		29	8
30	10		30	7
31			31	high heat destruction
32			32	inland/away from salt water
33	5.5		33	8
34	9		34	5.5
35	5.5		35	5
36			36	6
37 (top)			37 (top)	biocides /anti-fouling paint/heat
(bottom)			(bottom)	electric pulse/magnetic/uptake precautions
38 (top)			38 (top)	effectiveness/ease of imp./ease of monitoring
(bottom)			(bottom)	ease of installation/cost/labor intensity

Table 4. Survey responses

Survey #3

Association	state agency
Time	<5 years
Top issues	bw discharge regulation
	bw treatment issues
Bottom issues	technological development
	industry impacts
Q# 4	10
5	5.5
6	2
7	1
8	3
9	6 (USEPA-discharge stds)
10	5.5
11	3 (EPA, marine engineers/nav.architects
12	5.5
13	yes (EPA-effluent guidelines)
14	no
15	4
16	strong bw treatment element
17	8
18	8
19	10
20	5.5
21	1
22	1
23	3
24	8
25	6
26	7
27	8
28	imp. of treatment technology, review of op/maint. records
29	5.5
30	10
31	removal on regular basis
32	upland
33	5
34	6
35	7
36	6
37 (top)	std. tanks and treatment/filtering/biocides
(bottom)	acoustic/magnetic/electiric pulse
38 (top)	effectiveness/easy to train/safety
(bottom)	energy to run/ease of monitoring/cost

Survey #4

Association	federal agency
Time	11-15 years
Top issues	ecological impacts
	outreach/education
Bottom issues	impacts on industry
	tecnological development
Q# 4	10
5	5.5
6	6
7	8
8	2
9	8
10	4 (ecologists & academic research)
11	6
12	8
13	yes (Navy)
14	no
15	7
16	req. bw exchange/CA-WA-like view
17	8
18	2
19	8
20	3
21	3
22	2
23	3
24	4
25	3
26	7
27	9
28	pre-loading monitoring to verify pre-treatment
29	4
30	5.5
31	avoidance of seds
32	onsite before taken aboard
33	5
34	2
35	2
36	2
37 (top)	filtering/UV2nd/biocides
(bottom)	precautions/std tanks/ biological control
38 (top)	effectiveness/safety/labor intensity
(bottom)	energy req./ ease of implementation/ ease of installation

Table 5. Survey responses

Survey #5

Association	federal agency
Time	<5 years
Top Issues	policy/legislation development
	treatment issues
Bottom Issues	risk assessment
	industry impacts
Q# 4	10
5	8
6	6
7	8
8	4
9	10
10	6
11	4 (shipping industry)
12	9
13	
14	
15	7
16	grants for tech. dev/dev. stds w/o ties to exc. tech.
17	10
18	5.5
19	8
20	4
21	2
22	7
23	4
24	5.5
25	5
26	4
27	9
28	
29	8
30	8
31	
32	
33	5
34	6
35	7
36	10
37 (top)	hydrocyclonic separation/filtering/heat/biocides
(bottom)	electric/acoustic/magnetic/biological control
38 (top)	safety/cost/efficiency
(bottom)	ease of installation/ease of implementation/monitoring

Survey #6

Association	federal agency
Time	5-10 years
Top Issues	policy/legislation development
	industry impacts
Bottom Issues	risk assessment
	ecological impacts
Q# 4	10
5	7
6	9
7	7
8	7
9	10
10	10
11	10
12	10
13	no
14	no
15	6
16	mandatory nationwide
17	10
18	9
19	9
20	10
21	4
22	3
23	8
24	5.5
25	3
26	4
27	4
28	
29	5.5
30	7
31	discharge at sea/source locations
32	discharge at sea/source locations
33	2
34	7
35	7
36	10
37 (top)	enhanced bw exchange system/bw exch./precautions
(bottom)	filtering/deox/biocides
38 (top)	all choices mean big bang for the buck
(bottom)	

Table 6. Survey responses

Survey #7

Association	federal agency
Time	<5 years
Top Issues	bw treatment
Bottom Issues	ecological impacts
	risk assessment
Q# 4	9
5	9
6	9
7	7
8	5.5
9	10
10	5.5
11	7
12	9
13	no
14	no
15	7
16	clearer role of states/mandatory bw treatment
17	10
18	3
19	7
20	2
21	2
22	2
23	2
24	1
25	2
26	2
27	10
28	random sampling of bw tanks w/port state control-boarding
29	2
30	9
31	
32	at sea-outside EEZ or shore-based
33	1
34	10
35	3
36	10
37 (top)	filtering/UV/ozone
(bottom)	deox./bio.control/anti-foulong paint
38 (top)	effectiveness/ease of imp./ease of installation
(bottom)	ease of monitoring/labor intensity/energy req.

Survey #8

Association	NGO
Time	<5 years
Top Issues	policy/leg development
	impacts on industry
Bottom Issues	ecological impacts
	risk assessment
Q# 4	7
5	7
6	5
7	3
8	5.5
9	5.5
10	5.5
11	5 (DOT)
12	6
13	yes (shipping co./manufacturer)
14	
15	
16	
17	7
18	4
19	9
20	7
21	6
22	7
23	5
24	3
25	4
26	5
27	9
28	int'l indigenous species assessment
29	7
30	10
31	
32	
33	5.5
34	8
35	6
36	10
37 (top)	filtering/UV/biological control
(bottom)	doex./be ex./std. tanks & treatment
38 (top)	effectiveness/ease of maintainence/ease of implementation
(bottom)	ease of monitoring/training/energy requirements

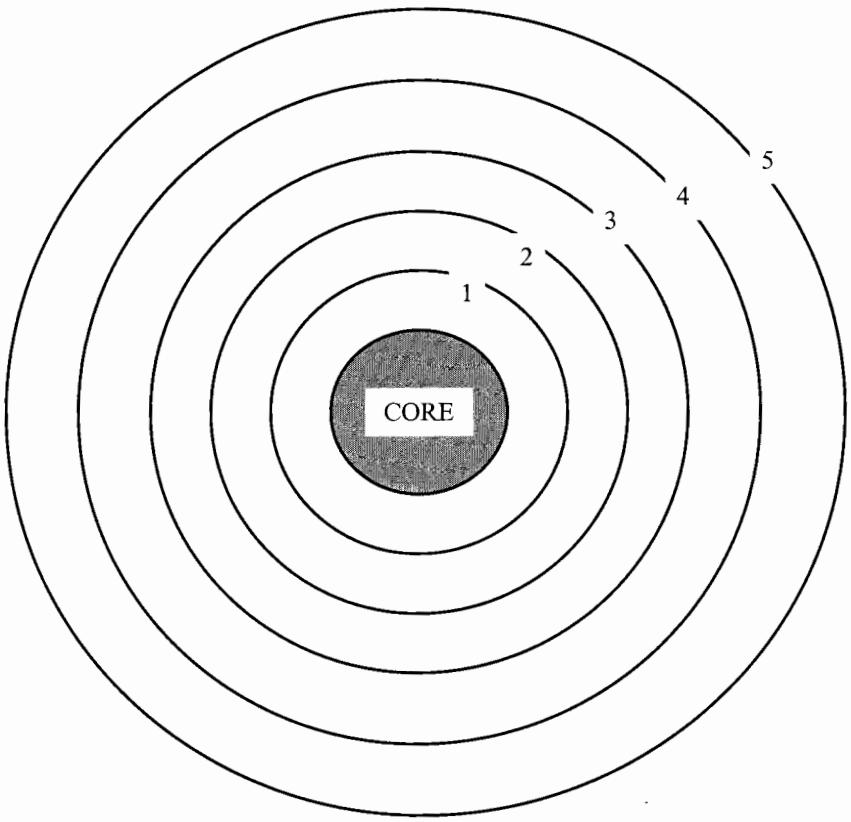
Survey #9

Association	federal/state combined
Time	<5 years
Top Issues	ecological impacts
	risk assessment
Bottom Issues	technological developrnent
	industry impacts
Q# 4	10
5	5.5
6	7
7	5
8	5
9	5
10	6
11	5 (too much power in CG, too little agency linkage & resource pooling)
12	5.5 (most legislators do not have a clue)
13	yes (NOAA-SG w/ERF)
14	yes (EPA)
15	5
16	less geographic specification of research $
17	7
18	5
19	5
20	6
21	9
22	9
23	7
24	5.5
25	6
26	6
27	8
28	integration of existing/future data
29	8
30	6
31	pump out/burning
32	burn them
33	5
34	5
35	5
36	8
37 (top)	separation/filtering/bw exchange
(bottom)	acoustic/magnetic/biological control
38 (top)	ease of implementation/maintainence/safety
(bottom)	labor intensity/operating time/ease of installation

Survey #10

Association	academic/research
Time	16 + years
Top Issues	ecological impacts
	policy/legislation
Bottom Issues	
Q# 4	10
5	
6	
7	2
8	2
9	7
10	7
11	5.5
12	7
13	yes (USDA & APHIS)
14	NO
15	
16	
17	10
18	1 (just stop-gap)
19	9
20	
21	10
22	2
23	
24	
25	
26	
27	
28	
29	
30	10
31	land disposal
32	land disposal
33	2
34	3
35	
36	
37 (top)	filtering/UV/heat/bwexchange
(bottom)	
38 (top)	effectiveness and safety
(bottom)	

Core and Periphery Model for Ballast Water Legislation



Core elements

* Protecting ecosystems, economies, and public health by preventing and controlling introductions of NIS
* Designing and implementing feasible treatment technology
* Interagency support and coordination
* Maintaining safety of vessels and crews
* Maintaining efficiency and integrity of the shipping industry

Peripheral Elements

1. Cohesive federal policy
2. Level of involvement of various agencies and organizations
3. Technological development for treating ballast water
4. Technological development for treating sediments
5. Provisional programs

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